REPORT
ON THE EXECUTION OF MARINE RESEARCH IN THE BERING STRAIT, EAST SIBERIAN AND THE CHUKCHI SEA BY THE RUSSIAN-AMERICAN EXPEDITION UNDER THE PROGRAM OF "RUSALCA" DURING THE PERIOD FROM 23 AUGUST THROUGH 30 SEPTEMBER, 2009

This report presents the description of expeditionary works and field explorations, as well as the preliminary results of analysis of the data obtained by the Russian-American expedition in the Bering Strait, East Siberian and the Chukchi Sea during the period from 23 August through 30 September 2009 under the "RUSALCA" program (The Joint Russian-American Long-term Census of the Arctic (RUSALCA)).

Within the frameworks of preparation of the expedition, the following works have been accomplished:

– the program of marine scientific research have been elaborated;

– the authorisation have been obtained from the Federal agency for science and innovations, for the accomplishment of marine scientific research;

– technical facilities for the execution of comprehensive research have been prepared.

Primary objective of the project

Primary objectives of the expedition, as well as scientific goals which determined the programme of works included:

– determination of thermohaline structure and dynamics of water masses in the East Siberian and the Chukchi Seas and the Bering Strait;

– investigation of thermodynamic processes in the frontal zones for the purpose of determination of vertical and horizontal scale of heat-haline convection;

– evaluation of heat-mass exchange processes between water masses of the various origins;

– investigation of the processes of transformation of water masses within the district of the East Siberian and the Chukchi Seas and the Bering Strait;

– determination of the influence of wind-wave mixing upon the structure of waters;

– monitoring of seasonal changes of water masses for the purpose of investigation of the variability of waters and testing of oceanographic models;

– Evaluation of boundaries of the district featuring a high concentration of biomass of ground invertebrates in the East Siberian and the Chukchi Sea.

Tasks of the Expedition

Based on the formulated objectives, the following tasks were to be solved by the expedition during the year of 2009:

- recovery of the three autonomous buoy-based stations, deployed during the year of 2008 within the territorial waters of the Russian Federation and five autonomous buoy-based stations within the territorial waters of the USA;
- deployment of the three autonomous buoy-based stations within the territorial waters of the Russian Federation and five autonomous buoy-based stations within the territorial waters of the USA;
- vertical profiles of temperature, conductivity, fluorescence, light transmission, CDOM fluorescence and water samples along transects of stations in the northern Bering Sea, western and eastern channels of Bering Strait and several transects across the Chukchi Sea using Rosette system;
- acoustic sounding of seabed for the purpose of investigation of underwater congelation and availability of gaseous-hydrates within the sedimentary layer;
- sampling of bottom for the evaluation of the district featuring a high concentration of biomass of bottom invertebrates in the East Siberian and the Chukchi Seas;
- video filming of the sea bottom surface.

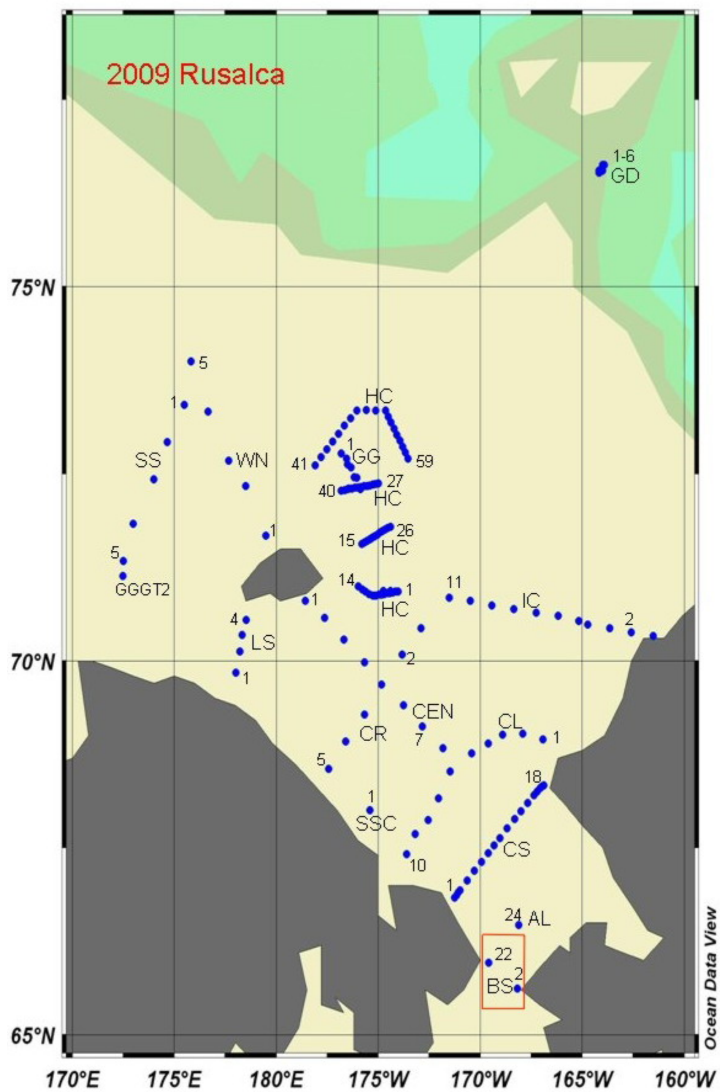

Diagram of proposed of "RUSALCA-2009" program

LIST OF PARTICIPANTS OF THE EXPEDITION

50 scientists and specialists from 6 countries (Russia, USA, Germany, Great Britain, Canada and Korea) took part in the expedition.

Table 1 – List of participants during the Leg 1

№	Name and surname	Country	Science group	Organisation
1.	Aleksey Ostrovskiy	Russia	Oversight	Group Alliance
2.	Alexander Bosin	Russia	Geology	POI, RAS
3.	Alexander Kolesnik	Russia	Geology	POI, RAS
4.	Alexander Savvichev	Russia	Microbiology	INMI, RAS

5.	Alexey Sazonov	Russia	ROV	VNIIO
6.	Alexey Sherbinin	Russia	Deck equipment	FERHRI
7.	Boris Smirnov	Russia	ROV	VNIIO
8.	Dan Naber	USA	Moorings	U. of Alaska
9.	Daria Petrova	Russia	Fish fauna	ZIN, RAS
10.	David Leech	USA	Moorings	U. of Alaska
11.	Dmitry Korshunov	Russia	ROV	VNIIO
12.	Elena Zakharova	Russia	Microbiology	INMI, RAS
13.	Elizaveta Ershova	USA	Zooplankton	SIO, RAS
14.	Elena Bondareva	Russia	Moorings	AARI
15.	Evgeny Vekhov	Russia	Deck equipment	FERHRI
16.	Iouri Pashchenko	Russia	Deck equipment	FERHRI
17.	Jeff Jones	Canada	Reporter	Reuters
18.	Kathleen Crane	USA	Oversight	NOAA
19.	Kevin Taylor	USA	Moorings	U. of Alaska
20.	Kevin Wood	USA	Logistics	U. of Washington
21.	Konstanin Kramchanin	Russia	Geology	POI, RAS
22.	Marshall Swartz	USA	CTD-Rosette	WHOI
23.	Michael Kong	USA	Moorings	U. of Alaska
24.	Natalia Chernova	Russia	Fish fauna	ZIN, RAS
25.	Petr Strelkov	Russia	Epibentos	ZIN, RAS
26.	Rebecca Woodgate	Great Britain	Chief scientist	U. of Washington
27.	Sergey Yarosh	Russia	Deck equipment	FERHRI
28.	Stanislav Denisenko	Russia	Epibenthos	ZIN, RAS
29.	Terry Whitledge	USA	Science coordinator	U. of Alaska
30.	Vladimir Bakhmutov	Russia	Head of Expedition	Nav-Hydrographic institute, RF MoD
31.	Wendy Ermold	USA	Moorings	U. of Washington

Table 2 – List of participants during the Leg 2

№	Name and surname	Country	Science group	Organisation
1.	Aleksey Ostrovskiy	Russia	Oversight	Group Alliance
2.	Alexander Bosin	Russia	Geology	POI, RAS
3.	Alexander Kolesnik	Russia	Geology	POI, RAS
4.	Alexander Savvichev	Russia	Microbiology	INMI, RAS

5.	Alexey Sazonov	Russia	Sonar, ROV	VNIIO
6.	Alexey Sherbinin	Russia	Deck equipment	FERHRI
7.	Boris Smirnov	Russia	Sonar, ROV	VNIIO
8.	Brenda Holladay	USA	Fish fauna	U. of Alaska
9.	Catherine Mecklenburg	USA	Fish fauna	Point Stephens
10.	Christine Gleason	USA	Fish fauna	U. of Alaska
11.	Christine Patrick	USA	Outreach	NOAA
12.	Cornelia Jaspers	Germany	Zooplankton	U. of Alaska
13.	Daniel Torres	USA	CTD-Rosette	WHOI
14.	Daria Petrova	Russia	Fish fauna	ZIN, RAS
15.	Dmitry Korshunov	Russia	Sonar, ROV	VNIIO
16.	Elena Zakharova	Russia	Microbiology	INMI, RAS
17.	Elisaveta Logvina	Russia	Geology	VNIIO
18.	Elizabeth Carvellas	USA	Benthos	U. of Maryland
19.	Elizaveta Ershova	USA	Zooplankton	SIO, RAS
20.	Elena Bondareva	Russia	CTD	AARI
21.	Evgeny Vekhov	Russia	Deck equipment	FERHRI
22.	Hyoung Min Joo	Korea	Phytoplankton	KOPRI
23.	Iouri Pashchenko	Russia	Deck equipment	FERHRI
24.	Jacqueline Grebmeier	USA	Benthos	U. of Maryland
25.	Jared Weems	USA	Epibenthos	U. of Alaska
26.	Kevin Wood	USA	Oversight	NOAA
27.	Konstanin Kramchanin	Russia	Geology	POI, RAS
28.	Ksenia Kosobokova	Russia	Zooplankton	SIO, RAS
29.	Marlene Jefferies	Canada	CO2	BIOS
30.	Marshall Swartz	USA	CTD-Rosette	WHOI
31.	Michael Kong	USA	Productivity	U. of Alaska
32.	Morgan Busby	USA	Fish fauna	NOAA
33.	Natalia Chernova	Russia	Fish fauna	ZIN, RAS
34.	Petr Strelkov	Russia	Epibenthos	ZIN, RAS
35.	Robert Pickart	USA	CTD-Rosette	WHOI
36.	Russell Hopcroft	Canada	Zooplankton	U. of Alaska
37.	Sang H. Lee	Korea	Productivity	KOPRI
38.	Sarah Mincks	USA	Fish fauna	U. of Alaska
39.	Sergey Yarosh	Russia	Deck equipment	FERHRI
40.	Stanislav Denisenko	Russia	Epibenthos	ZIN, RAS
41.	Sue Moore	USA	Marine	NOAA

			mammals	
42.	Terry Whitledge	USA	Chief scientist	U. of Alaska
43.	Vladimir Bakhmutov	Russia	Head of Expedition	Nav-Hydrographic institute, RF MoD

EXPEDITIONARY WORKS

The works during the expedition were carried out in the Bering Strait, the East Siberian and the Chukchi Seas during two legs.

Leg 1

On the 23 of August, 2009, at 20.35 (here and hereinafter local time of Nome is used as the ship's time), after the completion of embarkation of the equipment and taking the participants in the expedition aboard, the Research Vessel (RV) "Khromov" left the port of Nome for passage to the area of destination, where the automated buoy-based stations in the Bering Strait were deployed in 2008.

During the period from 16.05 through 18.25 on the 24 of August, three automated buoy-based stations were taken aboard in the western part of the Bering Strait within the territorial waters of the Russian Federation.

During the period from 09.00 through 18.25 on the 25 of August, five automated buoy-based stations were taken aboard in the eastern part of the Bering Strait within the territorial waters of the USA.

During the period from 12.12, on the 26 of August, through 10.17, on the 27 of August, five automated buoy-based stations (A3-09, A2-09, A4-09, A4W-09 и A2W-09) were deployed in the eastern part of the Bering Strait within the territorial waters of the USA.

During the period from 12.00 through 15.42, on the 27 of August, three automated buoy-based stations (A1-3-09, A1-1-09 и A1-2-09) were deployed in the western part of the Bering Strait within the territorial waters of the Russian Federation.

During the period from 09.45, on the 28 of August through 03.52, on the 30 of August, the CTD measurements were performed, along with the sampling of sea bottom and water in the sections BC1 – BC24 and AL1 – AL24.

After the completion of the works on the September 2, at 09.15, the vessel arrived to the port of Nome for the change of the scientific equipment and the participants of the expedition.

Leg 2

On the 3 of September, 2009, at 08.48 RV "Khromov" left the port of Nome for passage to the district of destination.

During the period from 4 through 17 of September, RV "Khromov" was working on the combined oceanological stations in the sections CS, CEN, LS, SS, WN, HC.

During the period from 19 through 21 of September, RV "Khromov" was working on the pockmark area (77º29,2´N Д=166º21,6´W) with the use of the side-scan sonar and on the geological stations in the section GD1 – GD8.

After this work during the period from 22 through 29 of September RV "Khromov" was working on the combined oceanological stations in the section SL1, SL2, X1 – X7, CL1 – CL10, CS1 – CS17, BS2,8,22.

After the completion of the work on the 30 of September the vessel arrived at the port of Nom for disembarkation of the scientific equipment the participants of the expedition.

General Cruise Objectives

A series of hydrographic transects were taken to allow sampling of all water masses during this summer period. A high priority of the hydrographic survey was to collect samples across Bering Strait in support of the Russian and American mooring(s) in western Bering Strait during leg 1 and to collect a series of high-speed transects across Herald Valley and to enhance the knowledge of faunal distributions for census of marine life during leg 2. The long-term goal is to obtain continuous and comprehensive monitoring within Bering Strait for several years which would require routine access to the eastern and western portions of the study area for scientific operations. The hydrographic, biochemical and productivity sampling were integrated from all stations sampled and the data from US and Russian collaborators were combined for the joint assessment of climate change, water mass properties and census of marine life in the Arctic.

Hydrographic, Velocity, and Video Plankton Recorder Measurements

R.S. Pickart, H.M Swartz, and D.J. Torres, *Woods Hole Oceanographic Institution*

E. Bondareva, *Arctic and Antarctic Research Institute*

Introduction

The physical oceanographic component of RUSALCA-2009 leg II consisted of an investigation of the circulation and water masses of the Chukchi Sea using vertical profile measurements, with particular emphasis on Herald Canyon. The flow of Pacific water into the Chukchi Sea is of fundamental importance to the western Arctic ocean-atmosphere-ice system, with consequences for ice-cover, carbon cycling, and ventilation of the interior halocline. A major, yet largely unexplored, conduit through which the Pacific water enters the Arctic basin is Herald Canyon. The primary goals of the physical oceanographic component are to (1) quantify the dynamics in the canyon, (2) explore the relationship between conditions in the canyon and interannual climate variability, and (3) understand the impact of the canyon flow on the distribution of nutrients, zooplankton and fish entering the Arctic. In addition to this, the circulation and water masses of the broad Chukchi shelf, and part of the East Siberian shelf, are being examined in support of the biogeochemical measurements of RUSALCA-2009.

CTD/Rosette System

A WHOI-provided rosette mounted with twenty-one 10-liter bottles, Sea-Bird model SBE911+ CTD profiler, upward- and downward-looking RDI Workhorse 300kHz lowered ADCPs (LADCP) and a SeaScan Video Plankton Recorder (VPR) were used for hydrographic stations on RUSALCA-2009 leg II. Due to depth limitations, the VPR was removed from the rosette on 17 September, prior to transiting to the northern stations in deep water. The CTD sensor suite included dual temperature and conductivity sensors, dissolved oxygen, 660-nm transmissometer, chlorophyll-α and CDOM fluorometers, underwater and surface PAR sensors, and an altimeter. Details of the hydrographic equipment used and the associated data products are given in the appendix.

A total of 134 CTD stations were occupied on leg II, counting both normal hydrographic and primary productivity sampling casts at the same station locations. No significant problems were encountered with the CTD system other than a failure of the oxygen probe near the end of the cruise. The sensor was quickly swapped out and only a couple of stations were impacted. During two stations in the Alaska

Coastal Current on the CL line the air vent purge hole of the primary pump became clogged with silt. The secondary sensors worked fine however, and the purge hole was successfully cleaned out. At the northern stations (series GD and IE), air temperatures of -5˚C caused icing of the sensors, which required significant time to thaw in the water column. Cold conditions contributed to several failures of the PVC sampling bottles, reducing the total available rosette positions to 19 bottles by the end of the northern stations. Evaluation of primary and secondary salinity showed that the temperature and conductivity channel differences remained nil through most of the cruise, lending confidence to the readings as taken.

The lowered ADCP system was deployed on essentially all of the CTD lowerings except for the primary productivity casts, for a total of 121 stations. No operational problems were encountered with the lowered ADCP, and data were recovered from all attempted stations, losing only part of one profile due to an operator error.

The VPR was deployed on 90 stations. Recharge time for the VPR batteries resulted in skipping deployments when working on lines with closely spaced CTD stations. Consequently, the VPR was used on every other station during the high-speed Herald Canyon survey. VPR operations were made more difficult by several factors, including unstable Ethernet connection to the on-deck VPR to download data, uncertain power switch behavior on the VPR underwater unit, the requirement to physically change out and uncase the batteries for the VPR, and the erratic behavior of the charger for the VPR batteries.

Preliminary Results

Over the course of the 27-day cruise, 11 hydrographic/velocity/VPR transects were completed (Fig. 1). The three southern Chukchi Sea transects were repeat occupations from the 2004 cruise. In addition, another high speed survey of Herald Canyon was carried out. New elements of the 2009 survey included: (1) an investigation of the area surrounding Wrangel Island, including stations in the East Siberian Sea; (2) extension of the Herald Canyon survey into the mouth of the canyon; (3) measurements taken on the Chukchi Cap and at the edge of the ice pack.

The hydrographic conditions in the Chukchi Sea were vastly different than in 2004. There was a smaller volume of weakly-stratified Anadyr water in the southern Chukchi Sea, confined to the middle portion of the shelf. This may be largely a seasonal effect since the 2009 cruise occurred roughly a month later than the 2004 cruise (September vs. August). Detailed analysis of the hydrographic data in conjunction with the meteorological conditions will allow the relative influences of seasonal versus interannual variability to be sorted out. The water masses on the western side of Herald Canyon were considerably warmer than in 2004, likely because the resident Chukchi winter water had already drained from the canyon by the time of the survey. On the eastern side of the canyon the Chukchi summer water was present farther north into the canyon than observed in 2004. The reasons for this are not entirely obvious and require further investigation. In general, the hydrography of the canyon was surprisingly different from RUSALCA-2004.

Another notable difference during RUSALCA-2009 was the presence of the Siberian Coastal Current, whose influence extended more than 70 km offshore. Again, the meteorological data should prove useful in understanding why the current was present this year but not in 2004. A full-scale analysis of the hydrographic and velocity data will not only provide context for the biogeochemical measurements, but enable us to better understand the circulation and water mass structure of the Chukchi shelf and why it was so different from RUSALCA-2004.

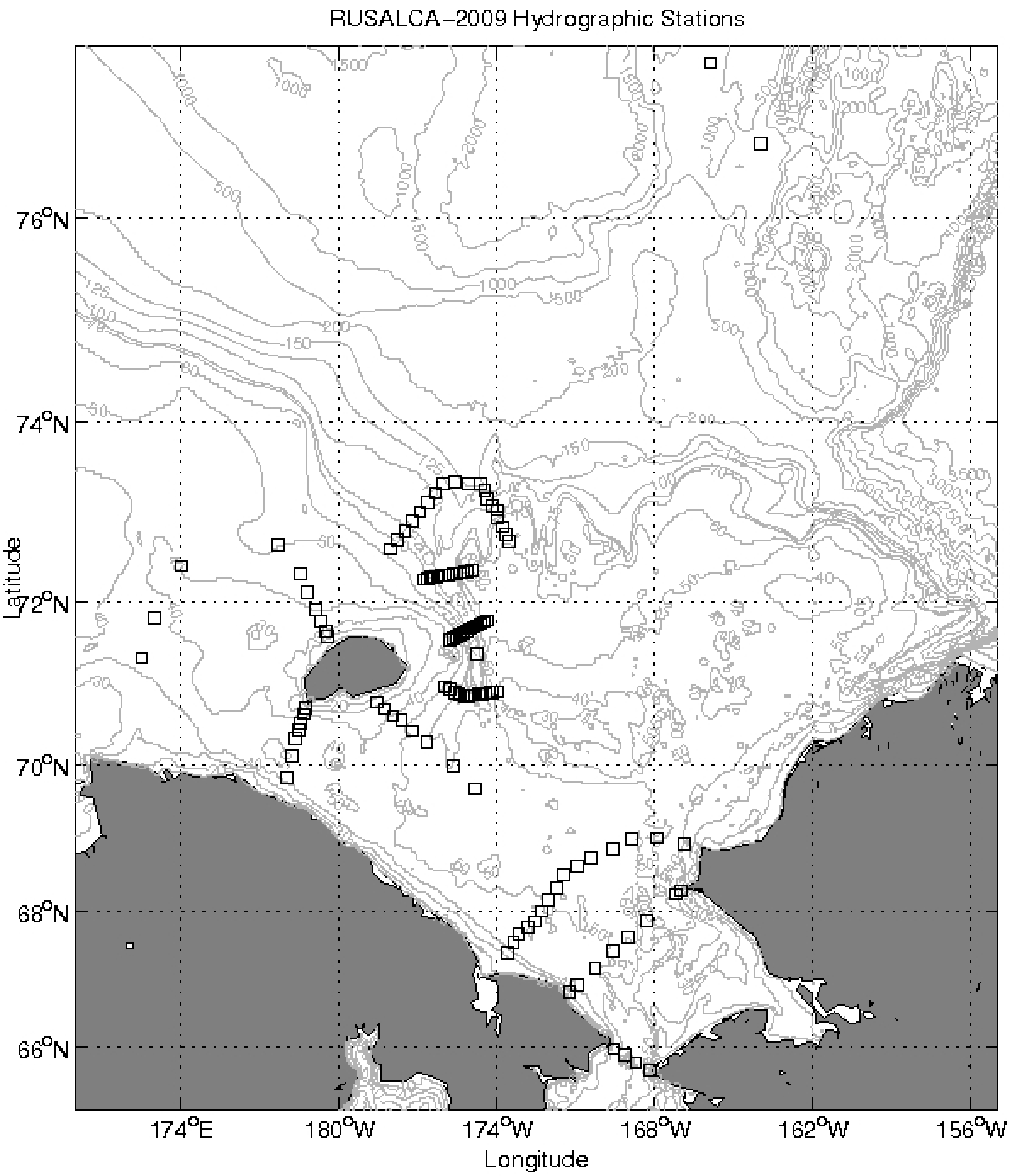

Figure 1: CTD/LADCP stations occupied during leg II of RUSALCA-2009. VPR data were collected at most stations except for the four Herald Canyon transects where every other station included the VPR. The bathymetric contours are from IBCAO-v2.

Appendix: RUSALCA 2009 Hydrographic Support – Equipment Summary

Compiled by Marshall Swartz, WHOI 29 Sept 2009-09-29

For RUSALCA 2009 cruise aboard Prof. Khromov, WHOI supplied and operated the equipment described below to enable hydrographic measurements for the RUSALCA program.

ROSETTE:
A custom built stainless-steel rosette with 21 10-liter bottles was used on every CTD station. This included a SBE32 24-position release pylon.

CTD:
The CTD equipment on the rosette:
(Note: specific details of serial number, channel assignment and calibration data are in the configuration file for each station.)
SBE9+ CTD rated to 7000m
SBE11+ CTD Deck unit, ver V2.
Dual SBE3 (temperature) and SBE4 (conductivity) sensors with two SBE5 pumps.
SBE43 oxygen sensor on the primary pump.
WETLabs Cstar 660nm, 25cm pathlength transmissometer
WETLabs ECO-FLRTD chlorophyll-α fluorometer
WETLabs ECO- CDOM fluorometer.
Biospherical QSP-2300 underwater PAR sensor
Benthos PSA-916 altimeter
Biospherical QSP-2200 surface PAR sensor

LADCP:
Two RD Instruments WHS-300 300kHz lowered ADCP systems with WHOI 48-volt underwater battery mounted on rosette.

VPR:
SeaScan AVPR with SeaScan battery mounted on rosette.
Data downloaded after each VPR station with Cat-5 cable attached from deck to lab.
Computer in lab connects to VPR as a mapped network drive. Data is transferred by windows copy.
Data is backed up from lab computer to external hard drive.

GPS:
Garmin GPSMap182 with Garmin GA29 external antenna mounted on the 500 (bridge-level) deck. GPS serial port is setup to deliver 2-second NMEA GPGGA sentences.

GPS logging PC and capture software:

An Acer One 160GB 1.6GHz laptop running Win XP-Pro SP3 OS was dedicated to acquire the NMEA data from the Garmin GPSMap182. A Keyspan USA49WG serial-USB adapter provided the required serial port, with a Keyspan version 3.6 driver installed on the PC. Hyperterminal software was used to open the serial port and capture the NMEA data at 4800baud to a capture file. The capture file was kept open continuously until it grew large enough to be gracefully ended and a new capture file started. The capture file is ASCII text readable with Notepad. The files were not concatenated into one file.

Depth logging PC and capture software

An Acer One 160GB 1.6GHz laptop running Win XP-Pro SP3 OS was dedicated to acquire depth data from the NMEA depth output of the Khromov bridge depth finder. Unfortunately, it was not possible to attach our serial cable to the unit, since the only output port of the depth sounder was attached to the ship's Sperry data management system. A solution was found by which we ran a Cat-5 cable from the Bridge to the CTD lab, one end attached to the Sperry ship data system network port, and the other to the Ethernet RJ45 connector on the Acer PC.

On the Acer PC we installed software provided by the Khromov Radio Operator to link to the Sperry Vessel Data Recorder (VDR) Explorer software, by Danelec Marine A/S, version 1.40.00. This linked to the VDR via a TCP/IP port and provided a graphical interpretation of the seafloor depth using the $SDDBK (Depth below keel) NMEA sentence, as well as GMT time, date, latitude, longitude, COG, heading and other parameters. Every 30 seconds the software display was captured using Snag-it version 6 software, writing a .BMP file with sufficient resolution to enable reading the depth display.

The resulting space taken on the laptop hard drive is about 66 GB. We will attempt to reduce the required file space by importing the files into IView Media Pro 3 software to create a Quicktime version 3 .MOV file, to enable rapid viewing of the depth field along with time, date and position by manual viewing and transcription.

Data Products - RUSALCA 2009 CTD/LADCP/VPR/Underway

CTD Data

- First and second leg
- Total size ~310MB
- Data readable by SeaSave 7 software.
- Five types of raw files:
  - .CON
  - .HDR
  - .HEX
  - .NAV
  - .BTL
- Three types of processed files:
  - BTL,
  - _PAVG.CNV, 1-decibar pressure averaged data.
  - _TAVG.CNV, 1 second averaged data.

LADCP Data

- Second leg only
- Total size 560MB
- Data readable by ADCP software.

VPR Data

- Second leg only.
- ~1GB per station.
- Total size ~48GB.
- Not human-readable, requires special software.
- Two external hard drives for data backup.

Underway Data

- Second leg only

Depth screen captures

- Total size
- 30 second screen grab from Khromov Sperry bridge data.
- Made into quicktime movie to reduce size.
- Shows GMT date, time, GPS lat, lon, depth (m) under keel.

GPS data capture

- Total size ~600MB
- 2 second update on NMEA data from WHOI GPS in lab.
- Nearly continuous data on leg 2

CTD station logbook
LADCP station logbook

- Separate books
- Original paper.
- One sheet per station each book.

Hydrochemical Nutrient Distributions and Dynamics

Terry E. Whitledge and Mike Kong, University of Alaska Fairbanks

We conducted a coordinated and quantitative study of the productivity responses to nutrient and biological processes in the northern Bering and Chukchi Seas. Our goals were to:

1. Quantify the range of nutrient, phytoplankton biomass and productivity in water masses distributed in the northern Bering and Chukchi Seas
2. Establish physical and chemical factors that are conducive to maintenance of relatively large rates of primary production.
3. Compare contemporary rates with those obtained in the previous decade for assessment of rate changes under the present warm temperatures.

Samples were collected at all CTD stations for both legs 1 and leg 2 and were analyzed for nutrients onboard. Raw data peaks were recorded for each sample and future data processing will be necessary to determine final concentrations.

Equipment utilized

1. Alpkem Model 300 Rapid Flow Nutrient Analyzer (5 channels for analysis of phosphate, silicate, nitrate, nitrite, ammonium) including 5 photometers, 2 pumps and 1 sampler.

Biological Oxygen Demand

Elana Bondareva

The main objective of this investigation was to collect data about biological oxygen consumption in the Chukchi Sea.

Equipment utilized:

1. Digital burette BRAND (Germany)
2. Digital pipettes Lenpipet (Russia) 0.1 – 1мл, 0,5 – 5 мл
3. Oxygen bottles

Water samples were collected at biological stations at the bottom horizons and analyzed for biological oxygen consumption. Two samples were taken from one Niskin bottle. In one of them oxygen was measured right away, second was measured after 5 days. Then the biological oxygen consumption was calculated as difference between first and second values.

List of stations were water samples were collected is shown in table 1.

Table 1.

Data	Nst	Cast	Depth
09/06/2009	cen4	3	bottom
09/07/2009	cen3	4	bottom
09/07/2009	ls4	5	bottom
09/07/2009	ls3	6	bottom
09/08/2009	ls1	7	bottom
09/09/2009	ss4	8	bottom
09/10/2009	wn3	9	bottom
09/11/2009	wn1c	10	bottom
09/11/2009	wn2	11	bottom

09/11/2009	wn1	12	bottom
09/13/2009	hc49	13	bottom
09/14/2009	hc55-1	14	bottom
09/14/2009	hc58	15	bottom
09/15/2009	hc45	16	bottom
09/15/2009	hc42	17	bottom
09/15/2009	hc40	18	bottom
09/16/2009	hc26	19	bottom
09/16/2009	hc21	20	bottom
09/17/2009	hc15	21	bottom
09/17/2009	hc1	22	bottom
09/17/2009	hc60	23	bottom
09/20/2009	gd1	24	bottom
09/22/2009	ie2	25	surface
09/22/2009	ie2	26	bottom
09/24/2009	cl1	27	bottom
09/24/2009	cl2	28	bottom
09/24/2009	cl3	29	bottom
09/25/2009	cl6	30	bottom
09/25/2009	cl7	31	bottom
09/26/2009	cs4	32	bottom
09/27/2009	cs12	33	bottom
09/28/2009	cs16	34	bottom

RUSALCA CO2 Processes Cruise Report, September 2009
Marlene Jeffries
Bermuda Institute of Ocean Sciences

With sea ice retreating further each year during the summer months, the exposure of CO2-undersaturated waters requires the need to understand how this water will uptake atmospheric CO2 and what the consequences of that additional CO2 are in the Arctic ocean e.g ocean acidification. For the Rusalca cruise, the main objective of our lab was to take inorganic carbon samples and total organic carbon (TOC) samples at all stations to gain more understanding about the CO2 processes in the Arctic Ocean. To do this, we sampled each depth from all CTD rosette casts for both DIC/Alkalinity and TOC.

Sample methods.

The DIC/TA samples were drawn from the rosette first before other samples were taken to reduce loss of CO2 through offgassing. They were drawn into 200ml glass bottles using a silicon tube to fill from the bottom and allowing the water to overflow 3-4 times the bottle volume. The tube is removed leaving a small headspace and the samples are capped. The samples were then treated with 100μl of mercuric chloride to kill biology within the sample and stored in cases. The samples were stored on deck for a while in cool temperatures, but were moved into the lab when possible freezing could have occurred and were then stored at or near room temperature.

The TOC samples were drawn into 60ml Amber high-density polyethylene wide mouth bottles from the CTD
rosette. Once drawn, the samples were capped and stored in a freezer for the remainder of the trip.

Underway pCO_2

Unfortunately, the Professor Khromov did not have an underway system to which we could hook up the underway pCO_2 (SAMI) system. There were no measurements taken for pCO_2.

Stations and samples

Leg 1

For leg 1, DIC was collected by Terry Whitledge's group during the transects of Bering Strait. Every station was sampled during the BS line and alternating stations were sampled during the AL line. In total, 37 stations were sampled with a total of 108 samples taken at various depths. See the below table for the stations and number of samples per station. TOC was not sampled during this leg.

Leg 2

During leg 2, 116 CTD casts were sampled for both DIC and TOC. In total, the number of DIC/TA samples drawn was 651 (including duplicates) and the number of TOC samples was 641. See the below for the stations and number of samples per station during leg 2.

Leg	Station	Date (UTC)	Time (UTC)	# DIC	# TOC
1	BS1	-	-	3	0
1	BS2	-	-	3	0
1	BS3	-	-	3	0
1	BS4	-	-	3	0

1	BS5	-	-	3	0
1	BS6	-	-	3	0
1	BS7	-	-	2	0
1	BS8	-	-	3	0
1	BS9	-	-	3	0
1	BS10	-	-	2	0
1	BS11	-	-	3	0
1	BS12	-	-	3	
1	BS13	-	-	3	0
1	BS14	-	-	2	0
1	BS15	-	-	3	0
1	BS16	-	-	3	0
1	BS17	-	-	3	0
1	BS18	-	-	3	0
1	BS19	-	-	3	0
1	BS20	-	-	3	0
1	BS21	-	-	3	0
1	BS22	-	-	3	0
1	BS23	-	-	3	0
1	BS24	-	-	3	0
1	AL1	-	-	2	0
1	AL2	-	-	3	0
1	AL4	-	-	3	0
1	AL6	-	-	3	0
1	AL8	-	-	3	0
1	AL10	-	-	3	0
1	AL12	-	-	3	0
1	AL14	-	-	3	0
1	AL16	-	-	3	0
1	AL18	-	-	3	0
1	AL20	-	-	3	0
1	AL22	-	-	3	0
1	AL24	-	-	2	0
2	CS8	20090904	2308	11	10
2	CEN5	20090906	0907	12	11
2	CEN4	20090906	1732	10	9
2	CEN3	20090906	2212	12	11
2	CEN2A	20090907	0405	6	6
2	CEN2	20090907	0555	6	6
2	CEN1B	20090907	0727	7	6

2	CEN1A	20090907	0847	5	5
2	CEN1	20090907	1000	4	4
2	LS4B	20090907	1836	5	4
2	LS4A	20090907	1957	5	5
2	LS4	20090907	2124	6	6
2	LS3A	20090907	2312	6	6
2	LS3	20090908	0254	8	8
2	LS2	20090908	0958	5	5
2	LS1	20090908	1303	8	8
2	SS5	20090909	1117	9	9
2	SS4	20090909	2100	9	9
2	SS3	20090910	0621	9	9
2	WN3	20090910	2143	12	12
2	WN2	20090911	0659	9	9
2	WN1C	20090911	1216	5	5
2	WN1B	20090911	1453	6	6
2	WN1A	20090911	1638	5	5
2	WN1	20090911	1800	6	6
2	WN0	20090912	0234	4	4
2	HC49	20090913	2116	11	11
2	HC50	20090914	0505	6	5
2	HC51	20090914	0708	6	6
2	HC52	20090914	0907	5	5
2	HC53	20090914	1116	4	4
2	HC54	20090914	1234	5	5
2	HC55	20090914	1850	0	4
2	HC56	20090914	2158	5	5
2	HC57	20090914	23145	5	5
2	HC58	20090915	0030	4	5
2	HC59	20090915	0144	5	5
2	HC48	20090915	0823	6	6
2	HC47	20090915	0944	6	6
2	HC46	20090915	1121	5	4
2	HC45	20090915	1358	5	5
2	HC44	20090915	1531	5	5
2	HC43	20090915	1701	5	5
2	HC42	20090915	1830	5	5
2	HC41	20090915	1947	5	4
2	HC40	20090916	0016	6	6
2	HC39	20090916	0144	5	5

2	HC38	20090916	0228	5	5
2	HC37	20090916	0303	5	5
2	HC36	20090916	0343	5	5
2	HC35	20090916	0424	5	5
2	HC34	20090916	0507	6	5
2	HC33	20090916	0608	5	4
2	HC32	20090916	0652	5	4
2	HC31	20090916	0731	5	5
2	HC30	20090916	0813	5	5
2	HC29	20090916	0856	4	4
2	HC28	20090916	0937	4	4
2	HC27	20090916	1017	4	4
2	HC26	20090916	1622	4	4
2	HC25	20090916	1742	4	4
2	HC24	20090916	1825	5	5
2	HC23	20090916	1904	5	5
2	HC22	20090916	1941	5	5
2	HC21	20090916	2018	5	5
2	HC20	20090916	2145	5	5
2	HC19	20090916	2222	4	4
2	HC18	20090916	2305	4	4
2	HC17	20090916	2344	4	4
2	HC16	20090917	0020	4	4
2	HC15	20090917	0055	4	4
2	HC14	20090917	0525	4	4
2	HC13	20090917	0630	5	5
2	HC12	20090917	0733	5	5
2	HC11	20090917	0815	5	5
2	HC10	20090917	0900	5	5
2	HC9	20090917	0936	5	5
2	HC8	20090917	1016	5	5
2	HC7	20090917	1120	5	5
2	HC6	20090917	1155	5	5
2	HC5	20090917	1238	5	5
2	HC4	20090917	1321	5	5
2	HC3	20090917	1405	5	5
2	HC2	20090917	1441	4	4
2	HC1	20090917	1549	4	4
2	GD7	20090920	0947	11	11
2	GD6	20090921	0947	11	11

2	IE1	20090922	0139	11	11
2	CL1	20090924	1300	10	9
2	CL2	20090924	2125	6	6
2	CL3	20090925	0104	6	6
2	CL4	20090925	0703	6	6
2	CL5	20090925	1009	6	6
2	CL5A	20090925	1159	5	4
2	CL6	20090925	1409	6	6
2	CL6A	20090925	2017	5	5
2	CL7	20090925	2239	5	5
2	CL7A	20090926	0014	5	5
2	CL8	20090926	0154	5	5
2	CL8A	20090926	0621	5	5
2	CL9	20090926	0751	5	5
2	CL9A	20090926	0912	5	5
2	CL10	20090926	1112	4	4
2	CS1	20090926	2048	4	4
2	CS4	20090926	2242	5	5
2	CS6	20090927	0441	5	5
2	CS8	20090927	0806	5	5
2	CS10	20090927	1131	6	6
2	CS12	20090927	1455	6	6
2	CS16	20090927	2328	5	5
2	CS17	20090927	0059	4	4
2	BS2-2	20090929	0004	6	6
2	BS8-2	20090929	0318	4	4
2	BS14-2	20090929	0719	6	6
2	BS22-2	20090929	1039	3	3

Microbiological and biogeochemical aspects of carbon and sulfur cycles in water column and bottom sediments of Chukcha Sea.

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The information on the biogeochemistry of the carbon cycle in the Chukchi Sea water column and sediments which was available before the works of RUSALCA project was limited to the data on primary production and organic carbon content in the upper sediment levels (2001; Naidu et al., 2004). The only microbiological publication was concerned with the total bacterial numbers in the Chukchi Sea water column (Tsyban' et al.).

In the course of RUSALCA-2004 expedition, the first quantitative characterization was obtained of the role of microorganisms in the key processes of the carbon cycle: dark CO_2 fixation, methane oxidation, and syntrophic decomposition of organic matter with methane and sulfide emission. Methane supersaturation of the upper water layers was recorded for several stations in the Herald canyon; CH_4 emission to the atmosphere is therefore probable.

The goal of the planned RUSALCA-2009 work was to verify and specify the microbiological and biogeochemical data, focusing on the bottom sediments of the Chukchi Sea. Unusually high concentrations of biogenic elements were recorded in the silt water of the upper horizons of these sediments at several stations. A more detailed study of anaerobic microbial processes, primarily of methanogenesis in the bottom sediments is also required. The small number of bottom samples collected with geological cores was sufficient only for an approximate estimate of the role of microorganisms in methane production in the Chukchi Sea.

Extensive material collection for the study of stable carbon isotope distribution in organic matter and in the products of microbial geochemical activity was also planned within the frame of the proposed project.

3. Project Description:

Microbial Biogeochemistry of Carbon Cycle in the Sediments and Water Column in the Chukchi Sea

- The research program is a part of the complex of research of the short- and long-term changes of the matter turnover in the Arctic basin. In order to calculate the rates of the processes of transformation of organic matter in the sediments and water column of marine environments, quantitative data on microbial biogeochemical processes are necessary. The knowledge of the rates of microbial processes is essential for the comprehensive description of Chukchi Sea ecosystem.
- A warming of the Arctic climate is expected, which can cause a substantially increase in microbial methane production; the quantitative characterization of this process is therefore important. Increased methane production may lead to elevated concentrations of this greenhouse gas in the atmosphere and therefore to further warming.
- The proposed research project is based on the results of the RUSALCA-2004 project. As its first stage, the proposed program includes the monitoring of the complex of microbiological and biogeochemical measurements in the

southern part of the Chukchi Sea and in the Herald Canyon. The need to expand the region of research to the north of Herald Canyon was determined on the basis the previously obtained data on methane concentration and activity of the key microbial processes.

- The results of RUSALCA-2004 project indicated the necessity of the investigation of the interactions between sediments and the water column. The biogenic processes in the upper sediment layers are genetically related to the processes of organic matter production and transformation in the water column of the Chukchi Sea. The trophic chain of the processes of the Chukchi Sea ecosystem includes aerobic and anaerobic decomposition of organic matter by the microbial population of the sediments. Long (over 2 m) cores of bottom sediments are necessary for the quantitative estimation of microbial methane production in these sediments. Unfortunately, the amount of this material obtained in the course of RUSALCA-2004 project proved insufficient.
- Extension of the research season at the southern monitoring stations, which are free from ice cover for more than three months would have constituted a fundamental breakthrough in the data accumulation required for completion of the tasks of the RUSALCA project. Knowledge of the contribution of microbial processes in the functioning of the whole Chukchi Sea benthic and pelagic ecosystem is essential for the monitoring of both short- and middle-term changes of the water masses and flows of this region.
- The particular tasks proposed below (determination of plankton productivity, quantitative biogeochemistry of the biogenic elements in the bottom sediments, functioning of the benthic community, etc.) are completely integrated with the interests of American partners.

The goal of the program: quantitative determination of the rates of microbial processes of transformation of methane and organic matter in the water column and in the bottom sediments of the region of research, and integration of these results in a general RUSALCA program.

Particular tasks of experimental research:

- determination of total microbial numbers (number of bacrerioplancton) in the water column of the region of investigation,
- analysis of methane distribution in water and in bottom sediments, specification of the RUSALCA-2004 expedition results,
- direct measurement of the daily values of methane production and consumption by incubation with labeled compounds ($H^{14}CO_3^-$, $^{14}CH_3COONa$, $^{14}CH_4$),
- quantitative characterization of the isotopic composition of carbon in the mineral and organic matter of the water suspension,
- measurement of bacterial sulfate reduction rates in the sediments with labeled sulfate ($^{35}SO_4^{2-}$),
- quantitative determination of biogenic elements in the silt water of the bottom sediments,
- analysis of the content and isotopic composition of the suspended organic matter in ice samples,
- comparison of the experimental data with the results of the RUSALCA-2004 expedition, analysis of short-term changes.

Materials and methods

Sediment samples were placed in 5-ml plastic syringes with an edge cut off and closed with a gas-tight rubber stopper. The water from bathometer was dispensed into 30-ml glass flasks which were closed (without leaving an air bubble) with gas-tight rubber stoppers and aluminum caps with a perforation for the introduction of required reagents.

The rates of microbial processes of glucose consumption and dark assimilation of carbon dioxide, sulfate reduction, methane oxidation, and methane production were determined radioisotopically using uniformly labeled ^{14}C-glucose, $NaH^{14}CO_3$, $^{14}CH_4$, $Na_2{}^{35}SO_4$, and $^{14}CH_3COONa$. The syringes with sediment samples and glass flasks with water samples were supplemented, using a syringe, with 0.1 – 0.2 µl of a solution of the necessary labeled compound and were incubated in a refrigerator at a temperature of 1 – 3^oC for 1- 4 days. The flasks where dark assimilation of carbon dioxide was to be determined were wrapped with foil before the introduction of the samples. Upon completion of the incubation, the samples were fixed with 0.5 ml of 2M KOH solution and transported to the mainland laboratory. The rate of methane oxidation was determined with the use of ^{14}C-methane dissolved in gas-free distilled water that was introduced at a rate of 2 μCi per sediment samples. The rate of sulfate reduction was determined with ^{35}S-sulfate (10 μCi per sample); methane production with using ^{14}C-bicarbonate (10 μCi per sample) and ^{14}C-acetate labeled at the second position (10 μCi per sample); utilization of glucose with evenly labeled ^{14}C-glucose (2 μCi per sample); and CO_2 assimilation with ^{14}C-bicarbonate (10 μCi per sample). Sediment samples fixed with KOH and stored in a refrigerator for 6 h prior to the addition of the labeled substrate served as controls.

For definition of a number of microorganisms, samples of water filtered through nuclear filters (diameter of perforation 0.2 microns) and fixed by 70 % alcohol. The further processing of filters will be carried out in laboratory INMI with use DAPI.

The samples of bottom sediments sampled for analysis of isotope composition of carbon and sulfur, dried up in a drying case at T 60^oC. The further processing of samples will be carried out on mass - spectrometer MI-1201B equipped with three-channel system of gas.

Definition pH and Eh in sediment samples were carried out with use of portable ionomer pH 320/Set-1 Best.-Nr.100740 (Germany) and replaceable selective electrodes. Pore waters from sediments were separated onboard a vessel on a centrifuge at 7000 revolutions in one minute. Alkaline reserve (Alk) - direct titration of water samples by a hydrochloric acid at the presence of the mixed indicator at continuous blowing off by air, deprived dioxides of carbon.

Preliminary results of researches.

Water samples.

For definition of an aggregate number of bacteria and activity of microbiological processes samples of water from 10 l bottles complex Rozett have been selected. Onboard a vessel the filtration and preservation of samples, and also definition pH, oxidation-reduction potential and by the Alk was carried out. 178 samples of water and bottom sediments for definition of concentration of the dissolved methane are isolated.

For definition of isotope composition of carbon weighed organic substances carried out a filtration of great volumes of water (up to 10 liters) on preliminary muffled and weighed glass-fiber filters GF/F. In total 36 samples of water suspension are received. Results of determination of isotopic composition will give the information on organic matter genesis.

It is known, that values Eh of sediments specify a reduction degree of sediments and can serve as criterion for a tentative estimation of activity of microbiological processes of organic matter transformation.

Grey pelitic sediments of all investigated stations had the negative values Eh varying from -10 up to - 310 мV.

Processes of diagenesis render also essential influence on Alk values. Alk values raises, mainly, due to organic matter mineralization during bacterial sulfate reduction.

It is supposed, that proofs of various productivity of the investigated zones of Chukcha Sea in the geological past will be received after determination in sediments isotopic compositions of reduced sulfur.

The basic source of a sedimentary material are the rests of phytoplankton, submitted in the most part diatoms algae. An additional source of substance of these deposits was eolic material from sea ice.

As a whole, preliminary results of researches specify rather high activity of microorganisms determining substantially modern processes of diagenesis of deposits of Chukcha Sea.

The List of Samples of Water and Sediments:

N St., horizon, depth, m, sm; methane concentration [CH_4], DAC - $^{14}CO_2$ assimilation, MG – methane generation, SR – sulphate reduction, N – The number of bacteria, GF/F filtration to $\delta^{13}C_{org}$,Eh, mV, Alk - mg-ekv.

N station	Horizon, m, sm	[CH_4]	DAC	MG	SR	GF/F	(	N b	Eh, mV	Alk
BS-1	2 surf.	+						+		
BS-7	2	+								
BS-14	2	+						+		
BS-24	2	+						+		
CS-8	2	+	+					+		
	48	+	+					+		
	G_0-2	+	+				+		-145	3.6

CS-5	2	+	+		+		
	50	+	+		+		
	G_0-2	+	+	+		-105	3.4
CS-3	2	+	+		+		
	56	+	+		+		
	G_0-2	+	+	+		-125	3.6
CS-1	2	+	+		+		
	27	+	+		+		
	G_0-2	+	+	+		-40	3.2
LS-3	2	+	+		+		
	49	+	+		+		
	G_0-2	+	+	+		-50	3.2
	C_8-12	+	+	+		-140	3.8
SS-5	2	+	+		+		
	17	+	+		+		
	20	+	+		+		
	25	+	+		+		
	39	+	+		+		
	G_0-2	+	+	+	+	+20	3.0
SS-4	2	+	+		+		

		36	+	+		+		
	2	G_0-	+	+	+	+ 120	+ .0	3
	12	C_8-	+	+		+ 170	- .4	4
	-37	C_32	+	+		+ 290	- .5	5
	-63	C_58	+	+		+ 210	- .0	5
	-95	C_90	+	+		+ 240	- .2	5
	5-120	C_11	+	+		+ 180	- .0	5
WN -3		2	+	+		+		
		70	+	+		+		
	2	G_0-	+	+	+	90	- .8	3
WN -2		2	+	+		+		
		42	+	+		+		
	2	G_0-	+	+	+	60	- .6	3
WN -1		2	+	+		+		
		26	+	+		+		
	2	G_0-	+	+	+	+ 80	+ .2	3
	-15	C_10	+	+		+ 230	- .5	4
	-26	C_22	+	+		+ 130	- .0	5

St. 2							
72º16'46''	C_5-10	+	+		+	+0	3.4
175º57'22''	C_50-55	+	+		+	-80	4.0.
WN-7	C_90-95	+	+		+	-190	4.0
	C_135-140	+	+		+	-100	4.5
	C_165-170	+	+		+		
HC-55_100	2	+	+		+		
	130	+	+		+		
	G_0-2	+	+	+		+40	3.6
HC-40_85	2	+	+		+		
	70	+	+		+		
	G_0-2	+	+	+		+180	3.2
HC-60_148	2	+	+		+		
	82	+	+		+		
	G_0-2	+	+	+		+80	3.4
GD-7	2						
	200						
	600						

	C_5-10	+	+		+	-40	
	C_30-35	+	+		+	-60	4.5.
	C_50-55	+	+		+	-80	4.0
	C_100-105	+	+		+	-110	4.5
	C_170-175	+	+		+	-100	4.5
IE-1	2	+	+		+		
	660	+	+		+		
	G_0-2	+	+	+		+105	3.4
CL-1	2	+	+		+		
	42	+	+		+		
	G_0-2	+	+	+		+90	3.2
CL-4	2	+	+		+		
	50	+	+		+		
	G_0-2	+	+	+		-40	4.4
CL-9A	2	+	+		+		
	42	+	+		+		
	G_0-2	+	+	+		+180	3.0
CS-4	2	+	+		+		

	37	+	+		+		
	G_0-2	+	+	+	180	+	2 .8
CS-16	2	+	+		+		
	41	+	+		+		
	G_0-2	+	+	+	200	+	3 .0
CS-17	2	+	+		+		
	36	+	+		+		
	G_0-2	+	+	+	160	+	3 .0

Carbon and nitrogen productions of phytoplankton and their species compositions in the Chukchi Sea (2009 RUSALCA)

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To estimate carbon and nitrogen uptake of phytoplankton at different locations, productivity experiments were executed by incubating phytoplankton in the incubators on the deck for 3-4 hours after stable isotopes (^{13}C, $^{15}NO_3$, and $^{15}NH_4$) into each bottle were inoculated. Total **23** productivity experiments (Table 1) were completed during the cruise. Each station had 6 different light depths (100, 50, 30, 12, 5, and 1%). In addition, special experiments (Light enrichment for 1% light depth water and Nutrient enrichment for surface water) were done at **13** productivity stations in order to determine whether light or nutrients are limiting factors. After the incubation, all productivity sample waters were filtered on GF/F (ø = 25 mm) filters for laboratory isotope analysis at University of Alaska Fairbanks after this cruise.

Along with the small (1 L) productivity bottle experiments, **8** large volume (8.8 L) productivity experiments for three depths (100 and 1%) were executed to study the physiological status and nutritional conditions of phytoplankton at the productivity stations. These filtered (GF/F, ø = 47 m) samples will be chemically analyzed for the macromolecular level products (such as lipids, proteins, polycarbonates and LMWM) of photosynthesis.

To identify species composition of phytoplankton, water samples were taken from the CTD casts from 6 standard depths (0, 10, 20, 30, 50, bottom) at **49** stations including every productivity station. Based on the HPMA slide method, the total **330** slides were made for identifying species compositions of phytoplankton later at the laboratory in KOPRI. In comparison, large amount (15 L) of 20 m depth of water at **7** stations was filtered and the filters were kept frozen for DNA analysis to identify species composition of phytoplankton.

Table 1. Sample list for 2009 RUSALCA.

No.	Station	Phyto composition by Microscope	Phytoplankton by DNA work	PP	Macro PP	Light/Nuts enrichments
1	CS8	V		V		V
2	CEN5	V				
3	CEN4	V		V		V
4	CEN3	V				
5	CEN2A	V	V			
6	CEN1	V				

7	LS3	V		V		
8	LS1	V		V	V	V
9	SS5	V		V	V	V
10	SS4	V		V		
11	SS3	V				
12	WN3	V	V	V		V
13	WN2	V				
14	WN1	V		V		V
15	HC49	V	V	V		
16	HC52	V				
17	HC59	V				
18	HC48	V				
19	HC41	V				
20	HC40	V				
21	HC34	V				
22	HC29	V				
23	HC26	V				
24	HC24			V	V	
25	HC21	V				
26	HC15	V				
27	HC14	V				
28	HC10	V				
29	HC1	V				

30	HC60	V		V	V	V
31	GD7	V	V	V	V	V
32	IE2	V				
33	CL1	V	V	V	V	V
34	CL2	V				
35	CL3	V		V		
36	CL4	V				
37	CL5	V				
38	CL6	V		V		
39	CL7	V				
40	CL7-A			V		
41	CL8	V				
42	CL9	V				
43	CS1	V	V	V		
44	CS4	V		V	V	V
45	CS6	V				
46	CS8	V	V	V		V
47	CS10	V				
48	CS12	V		V	V	
49	CS16	V		V		V
50	BS2	V		V		
51	BS8	V		V		V

A CENSUS OF ARCTIC ZOOPLANKTON COMMUNITIES

RUSALCA 2009 CRUISE REPORT

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The Chukchi Sea represents a key oceanographic gateway into the Arctic, but our ability to understand its complex dynamics have been hampered by the political border that has generally prevented critically needed synoptic surveys. The RUSALCA 2009 expedition represents an extensive survey and census of zooplankton species in the Bering Strait through the southern and western Chukchi Sea, plus the East Siberian Sea at 63 stations to understand the transport patterns of Pacific zooplankton into the Arctic and serve as a both a baseline and time-series for future studies on ecosystem change in this climatically sensitive region.

The survey in 2009 encompassed 63 stations, conducted using a package of vertically deployed 150 and 53 µm mesh nets, combined with a 505 µm oblique Bongo net at many of the stations. Post-cruise sample analysis will involve a combination of traditional taxonomic enumeration and identification. Entire 150 µm nets were curated for molecular sequencing of the region's species, along with specimens identified during sorting of the live nets used for experimentation. To assess the 'health' of the zooplankton populations in the region, egg production experiments were conducted at 32 stations with several of the dominant copepod species in this region (i.e. primarily *Pseudocalanus* spp., with only several cases for *Metridia pacifica*, *Metridia longa*, and *Calanus glacialis*). Compared to 2004, almost twice as many samples were collected and 50% more egg production experiments were executed, due largely to the increased size of the zooplankton team (to 4 in 2009, compared to only 2 in 2004). Photographic documentation of the fauna of the region started in 2004 was continued, with ~2,000 images taken during the cruise, about half of which have been retained.

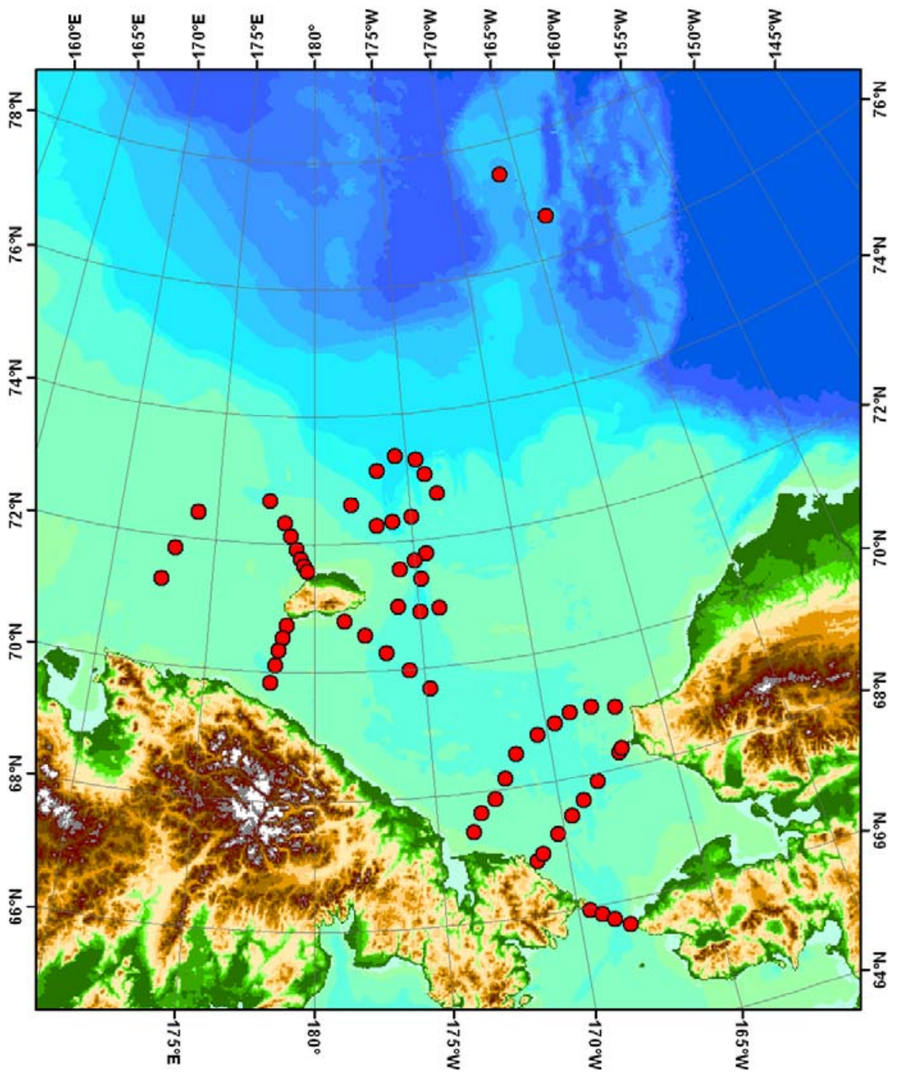
As observed in 2004, the differences in zooplankton communities encountered on the cruise have been striking. Strong across-shelf differences occurred in the northern sampling domain, and strong east-west gradients occurred in the southern Chukchi Sea. The copepod *Pseudocalanus* dominated all collections with the exception of the northern most stations on the Chukchi Plateau, followed by variable numbers of *Calanus* copepods and the chaetognath *Parasagitta elegans*. Small jellyfish were common or even abundant at the northwestern stations, while large jelly fish became common only in the southern Chukchi. Ctenophores, particularly *Mertensia* and *Bolinopsis* were present at most stations, and their abundance was quantified. Alaska Coastal Current water had abundant populations of the pteropod *Limacina helicina*. Compared to 2004, meroplankton and the larvacean *Oikopleura vanhoeffeni*, were less abundant, although it is unclear if this reflects between-year difference in seasonal timing of the cruise. Like 2004, many of the stations had extremely thick communities of phytoplankton retained by our nets. Species composition of *Pseudocalanus* was variable across the sampling region, as were their rates of reproduction. A fuller characterization of the communities and their reproductive rates will require more detailed analysis of the samples.

Station Name	Latitude	Longitude	Date	Egg Production
CS8(13)	67.43	-169.60	4-Sep	Ps
CEN5	69.68	-174.83	6-Sep	Ps
CEN4	69.98	-175.67	6-Sep	
CEN3	70.28	-176.67	6-Sep	Ps
CEN2	70.57	-177.63	7-Sep	
CEN1	70.80	-178.57	8-Sep	Ps
LS4B	70.74	178.70	8-Sep	
LS4	70.54	178.53	8-Sep	
LS3	70.34	178.34	8-Sep	
LS2	70.12	178.22	8-Sep	
LS1	69.84	178.02	8-Sep	Ps
SS5	71.33	172.50	9-Sep	Ps
SS4	71.83	173.00	9-Sep	Ps, Cal
SS3	72.42	174.00	9-Sep	Ps, Cal
WN3	72.67	177.67	10-Sep	Ps, Cal
WN2	72.33	178.50	10-Sep	
WN1C	72.13	178.79	11-Sep	
WN1B	71.92	179.10	11-Sep	
WN1A	71.77	179.30	11-Sep	
WN1	71.67	179.50	11-Sep	Ps, Cal

WN0	71.57	179.63	11-Sep	
HC49	73.35	-175.58	13-Sep	Ps, Cal
HC52	73.26	-174.50	14-Sep	Met
HC55	73.02	-174.08	14-Sep	Ps
HC59	72.70	-173.53	14-Sep	
HC46	73.14	-176.65	15-Sep	Ps, Met
HC41	72.61	-178.08	15-Sep	
HC40	72.27	-176.80	15-Sep	Ps
HC34	72.31	-175.98	15-Sep	Ps
HC27	72.37	-174.98	16-Sep	Ps,Met
HC26	71.79	-174.39	16-Sep	Ps,Met
HC21	71.68	-175.03	16-Sep	Ps
HC15	71.56	-175.79	16-Sep	Ps
HC14	70.99	-175.98	16-Sep	Ps
HC8	70.88	-174.97	17-Sep	Ps
HC1	70.92	-174.02	17-Sep	Ps
HC60(58B)	71.40	-174.78	17-Sep	
GD7	76.66	-163.95	19-Sep	
IE1	77.49	-166.36	21-Sep	
CL1	68.95	-166.91	24-Sep	Ps
CL2	69.02	-167.92	24-Sep	
CL3	69.01	-168.89	24-Sep	Ps
CL4	68.89	-169.61	24-Sep	
CL5	68.76	-170.42	25-Sep	
CL6	68.52	-171.46	25-Sep	Ps
CL7	68.16	-172.05	25-Sep	
CL8	67.87	-172.55	25-Sep	Ps

CL9	67.68	-173.19	25-Sep	

Station Name	**Latitude**	**Longitude**	**Date**	**Egg Production**
CL10	67.41	-173.60	26-Sep	Ps
CS1	66.83	-171.26	26-Sep	Ps
CS4	66.93	-170.99	26-Sep	
CS6	67.19	-170.29	26-Sep	Ps
CS8	67.43	-169.60	26-Sep	
CS10	67.63	-169.02	27-Sep	
CS12	67.88	-168.31	27-Sep	Ps
CS16	68.25	-167.20	27-Sep	
CS17	68.30	-167.05	27-Sep	Ps
BS2	65.96	-169.57	28-Sep	
BS8	65.86	-169.14	28-Sep	
BS14	65.75	-168.72	28-Sep	
BS22	65.62	-168.18	28-Sep	



160°E
165°E
170°E
175°E
180°
175°W
170°W
165°W
160°W
155°W
150°W
145°W
78°N
76°N
74°N
72°N
70°N
68°N
66°N
64°N
175°E
180°
175°W
170°W
165°W

Epibenthos Cruise Report, RUSALCA 2009
Team members: Sarah Mincks Hardy & Jared Weems (UAF)

Project Title: Arctic epibenthic community structure and benthic food web structure (Iken & Bluhm, PIs)

Project goals: Benthic ecosystems act as indicators of long-term of change in marine systems because they tend to integrate both seasonal and inter-annual variability in overlying water column processes. The epibenthos component of RUSALCA thus aims to establish base-line data for megafaunal community structure, and quantitative estimates of species-level diversity, abundance and biomass for all invertebrates obtained in beam trawl samples. In addition, food web structure and trophic links to pelagic food resources are being examined, such that potential long-term changes in bottom-up processes may be observed.

Sample collection: Quantitative data on community structure, abundance, and biomass of epibenthic megafaunal invertebrates was collected from successful beam trawls at 15 stations throughout the sampled region, with maximum spatial coverage around Wrangell Island and in the Siberian Sea, and the Southern Chukchi. Two stations were also sampled in the northern Herald Canyon line. Quantitative trawls were not collected at the pock-mark sites due to depth limitations on trawl gear; only otter trawls were taken at these sites for surveys of fish and invertebrate diversity. Stations where quantitative data were collected are marked in the attached table under "Quantitative epibenthos." Bottom time and start/end positions were recorded for each quantitative trawl so that area sampled can later be calculated. All taxa were sorted live, and individuals of each taxon were counted and weighed on board ship. Species-level identifications were made wherever possible, in collaboration with Russian colleagues, and voucher specimens were preserved for future reference.

Our food web analysis will use stable isotopes of carbon and nitrogen to examine trophic linkages, food chain length, and potential sources of carbon entering the food web. This analysis requires sampling of a variety of organisms from throughout the food web, as well as potential food sources such as zooplankton, phytoplankton, and sediment detritus. These samples were thus taken from a variety of sampling gear deployed by the other groups. Water samples from the Chl-a maximum (where present) were taken from the CTD casts and filtered on GF/F filters to obtain particulate organic material (POM). Surface sediments and infaunal invertebrates were taken from non-quantitative grab samples; infauna were sorted live on board ship and frozen for future analysis. Selected species of live zooplankton were provided by the zooplankton group from vertical plankton tows. Tissue samples from fishes and epifaunal invertebrates were taken from specimens collected in both beam and otter trawls. Samples were dried on board ship and will be analyzed at the isotope ratio mass-spectrometer at UAF.

Description of results: Based on results of earlier RUSALCA sampling (Bluhm et al., submitted) and preliminary observations from the 2009 cruise, epibenthic community structure appears to be largely a function of substrate type rather than water mass distribution. Regional similarities between stations were found within the north-central Chukchi and in the southern Chukchi, with the "hot-spot" area of high productivity northwest of Bering Strait dominated by infaunal bivalves. Soft-bottom areas of the central Chukchi are inhabited by high densities of brittle stars, crabs, and "mud stars" (*Ctenodiscus crispatus*). Similar soft-bottom taxa were found at the Siberian Sea stations (SS3 – 5, WN3), with the addition of large isopods and a variety of large amphipod species, and a few species of holothurians. Crabs were largely absent from these sites. Sites adjacent to Wrangell Island on the south side were rocky and thus not sampled, but north of the island (WN1) high densities of large isopods and a wide variety of amphipods were recovered. High-flow areas like Bering Strait and the axis of Herald Canyon were dominated by sea urchins, tube-dwelling polychaetes, bryozoa, and other hard-bottom fauna.

Results of stable isotope analyses will not be available until additional lab work is completed, but see Iken et al. (in press, DSR II) for results of the 2004 expedition.

Station number	Station Name	Sampling gear from which samples were obtained	Quantitative epibenthos	Preserved specimens	Stab Epifa
11	CS8	otter trawl, beam trawl, CTD, Vertical plankton tow, grabs	X	X	X
127	CEN5	otter trawl, CTD, Vertical plankton tow, grabs			X
125	CEN3	beam trawl	X	X	
121	LS 3	otter trawl, CTD, Vertical plankton tow, grabs			X
119	LS 1	beam trawl	X	X	
145	SS5	otter trawl, CTD, Vertical plankton tow, grabs			X
144	SS4	otter trawl, beam trawl, CTD, Vertical plankton tow, grabs	X	X	X
143	SS3	otter trawl, CTD, Vertical plankton tow, grabs			X
138	WN3	otter trawl, beam trawl, CTD, Vertical plankton tow, grabs	X	X	X
136	WN1	otter trawl, beam trawl, CTD	X	X	X
94	HC49	otter trawl, beam trawl, CTD, Vertical plankton tow, grabs	X	X	X
100	HC55	beam trawl	X	X	X
148	HC60	otter trawl, CTD, Vertical plankton tow, grabs			X
149	GD 7	otter trawl, CTD, Vertical plankton tow, grabs		X	X
118	GD 6	otter trawl, CTD		X	X
151	SL 1	otter trawl		X	
152	SL 2	otter trawl		X	
23	CL1	otter trawl, beam trawl, CTD, vertical plankton tow, grabs	X	X	X
25	CL3	otter trawl, beam trawl	X	X	
28	CL6	otter trawl, beam trawl	X	X	
30	CL8	otter trawl, beam trawl	X	X	
32	CL10	otter trawl, beam trawl, CTD, vertical plankton tow, grabs	X	X	X
7	CS 4	otter trawl, beam trawl, CTD, vertical plankton tow	X	X	X
15	CS 12	otter trawl, beam trawl		X	
20	CS 17	otter trawl, beam trawl, CTD, vertical plankton tow, grabs	X	X	X
2	BS 22	otter trawl, beam trawl, CTD, grab		X	X

FIELD REPORT

PRELIMINARY RESULTS OF ZOOBENTHOS SAMPLING, EXECUTED BY ZIN SCIENTIFIC GROUP IN EXPEDITION "RUSALCA-2009" ON VR "PROF. KCHROMOV" IN SEPTEMBER 2009

The main goal of zoobenthos sampling, executed by scientific group from Zoological Institute (ZIN) of Russian Academy of Sciences (St. Petersurg), was the collecting of faunal material for further study of biodiversity, bioresources, trophic structure and quantitative distribution of bottomliving organisms in the Chukchi Sea.

The group was represented by Stanislav Denisenko (ZIN RASc), Petr Strelkov (ZIN RASc – St. Petersburg State University) and Darya Petrova (ZIN RASc – St. Petersburg State University).

For sampling were chosen mostly the stations situated in the areas not covered by the analogous research of previous expeditions during 1988-2009. Moreover, due to kindly permission of expedition leader, an additional grab zoobenthos sampling was executed at some stations, were not included into beginning expedition plan.

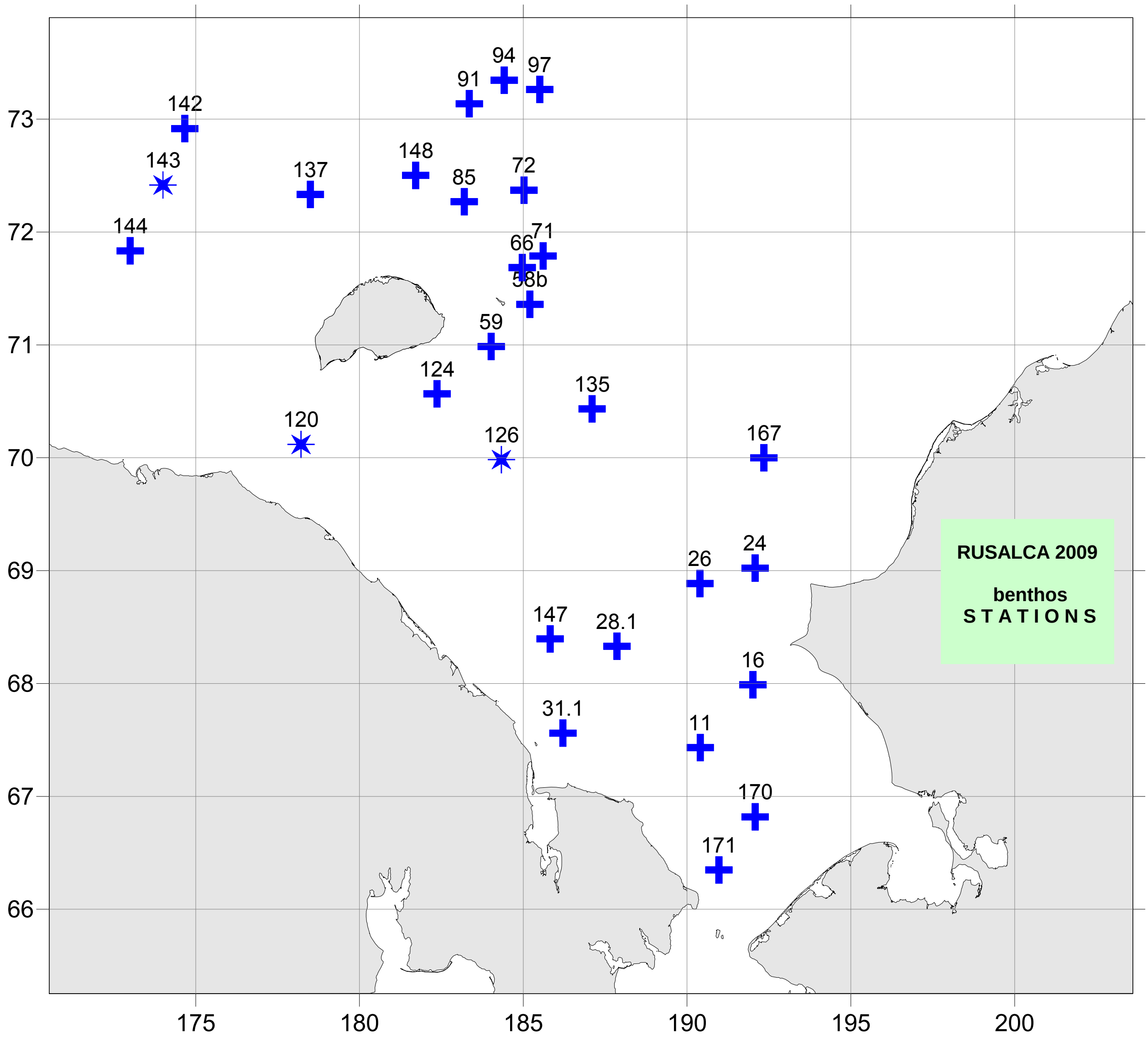
During the expedition the group has collected quantitative zoobenthos samples at 29 stations (see map below). At each station three samples were taken by van Veen grabs (0.1 m^2). Two samples were sorted and all animals were separated from the sediment and dominants were identified up to possible lowest taxonomic level. Then all three samples were preserved by buffered formaldehyde and stored for further evaluation in ZIN laboratories.

Additionally 270 tissue samples of invertebrates and fishes from catches of bottom trawl were collected and stored in 96% ethanol. The material is meant for study of genetic relations between Eastern- and Western Arctic populations of circum-Arctic and amphiboreal species at the Sub-faculty of Ichthyology and Hydrobiology of St. Petersburg State University.

According to results of the preliminary sample analysis the following summary can be made:

1. Zoobenthos biomass to the north-west of Vrangel Island at 50 m depth is much higher then it was registered by the previous expeditions.

2. The results of video recording executed by VNIIOg group clearly show that the brittle star biomass is heavily underestimated by van Veen grab.



Positions of ZIN zoobenthos stations in "Rusalca-2009" expedition (the station to the north of 76 parallel is not shown).

3. Strongly marked mosaic patterns are common for spatial distribution of zoobenthos assemblages in the Chukchi Sea, what makes too difficult the using of standard statistic and clustering methods for their description.

4. More than 80% of zoobenthos biomass in the Chukchi Sea is represented by bivalve mollusks, echinoderms, polychaets and gefyreas. Nine key species constitute 50% of the biomass.

28.09.2009.

Doct. of science,

leading scientist

of Marine Research Laboratory

of ZIN RASc

Denisenko S.G.

<u>Cruise Report: Grebmeier and Cooper Component: RUSALCA, 30 September 2009</u>

A. Project Title: Marine Infaunal Benthic Community Structure and Benthic Carbon Cycling, PIs: Jacqueline Grebmeier and Lee Cooper, Chesapeake Biological Laboratory, University of Maryland Center for Environmental Science, 1 Williams Street, Solomons, MD 20688

B. Personnel:

1. Dr. Jacqueline M. Grebmeier, USA; jgrebmei@cbl.umces.edu
2. Elizabeth Carvellas, USA

C. Objectives

Within the RUSALCA program our objectives are to evaluate the benthic community structure and carbon cycling in the Pacific-influenced waters in the Ameriasian Arctic. Our overall programs has 5 objectives:

1. The determination of macroinfaunal abundance, biomass, and community structure.
2. Measurement of sediment oxygen consumption as an indicator of carbon supply to the benthos.
3. Analysis of sediment chemistry parameters important to these benthic communities (sediment chlorophyll a content, total organic carbon content, sediment grain size, and sedimentation rates using ^{7}Be and ^{137}Cs as indicators of particle settling rate).
4. Analysis of ^{18}O stable oxygen isotope composition in the overlying water column, indicative of water mass variation and freshwater input.
5. Comparison of RUSALCA marine community analyses with those undertaken on previous Russian-U.S. cruises in this same region as a time-series analysis, particularly the BERPAC sponsored cruises that involved Russian and U.S. scientists in 1988 (*Akademik Koralev*), 1993 (*Okean*), 1995 (*Alpha Helix*) and RUSALCA 2004.

<u>D. Field Sampling, Equipment, Sampling Time, Chemical Inventory, and Space Requirements</u>

1. Five 0.1 m2 van Veen grabs were used to collect infauna and sediments at 25 stations for both quantitative benthic infaunal population studies and sediment tracer studies, respectively. Surface sediment was collected from the first van Veen grab and frozen for subsequent analyses at CBL for sediment grain size and total organic carbon (TOC) and organic nitrogen (TON) content. Two syringe subsamples (1 cm) of surface sediments were collected from the top 0-1 cm of the grab or HAPS core, depending on station depth, for determination of chorophyll a content. Following dark storage for 12 hr in 90% acetone at 0-2°C, chlorophyll *a* concentrations from these sediment aliquotes were determined fluorometrically using a Turner Designs 10-AU fluorometer shipboard. The remaining sediments from the first grab were sieved for the Iken/Bluhm component to evaluate stable C and N isotopes of the infauna. Other sediment subsamples from the first grab were collected by our Russian microbiology and geology collaborators as well as sometime by Christy Gleason, a graduate student at the University of Alaska Fairbanks for fish study.

The remaining 4 van Veen sediment collections were sieved for infaunal collections. Each van Veen sediment sample was placed in a 1 mm stainless steel screen box and sieved using seawater, the remaining animals subsequently preserved in 10% sea water formalin, buffered with hexamethylenetetramine, stored in plastic containers for later organismal identification and biological community structure analysis at CBL. Post-processing statistical analyses will be undertaken for determining faunal composition for similarity clustering of faunal groups, and measurements of benthic faunal biomass. Additional van Veen grabs (3) were collected by our Russian colleagues from the Zoological Institute in St. Petersburg.

2. We collected three sediment cores at biological stations using a single barrel 0.133 m^2 HAPS sediment corer. Two cores were collected for shipboard incubation studies at **14 stations** and were maintained in the dark at in-situ bottom temperatures in a refrigerator with temperature controlled to CTD bottom readings.. Bottom water for these experiments were collected from the CTD rosette system. Subsamples from the overlying water in these cores were collected from the chambers and analyzed shipboard for dissolved oxygen content, nutrients, alkalinity, and pH. Subsequent to the end of the experiment, cores were sieved and fauna preserved with formalin for land-based taxonomic identification.

3. One additional HAPS core was collected for downcore dating at 14 stations. Sediments from this core were sectioned at 1 cm intervals from 0-4 cm depth, 2 cm intervals from 4-20 cm, and 4 cm intervals to the bottom of the core. Ninety (90) cm^3 of each sediment increment were added to aluminum cans that are calibrated geometries for direct counting, using our land-based gamma spectroscopy system. These analyses will be undertaken on two detectors maintained at CBL.

4. Water samples were collected for $\delta^{18}O$ value analysis at 3 depths (bottom water, mid-depth or chlorophyll maximum) from the rosette. The oxygen-18/oxygen-16 samples were collected in small (20 mL) plastic vials and sealed for land-based analyses on a mass spectrometer.

E. Preliminary Results

1. Highest observed infaunal benthic biomass was observed at the head of Herald Valley in the southeast Chukchi Sea in the known "hotspot" of *Macoma* bivalves the extends from across the US-Russian boundary. This high biomass region results for the high productivity of the Anadyr Water and tight pelagic-benthic coupling between the upper water column production zone and underlying benthos during annual primary production.

2. Lowest observed infaunal biomass occurred in the furthest northern station at about 600 m at the "pockmark" sites. Very fine sediments were observed at this site where the downcore sectioning of the HAPS core was characterized by chocolate brown surface sediments to light brown downcore.

3. Sediment oxygen uptake and surface sediment chlorophyll was highest under the Anadyr water in the SE Chukchi Sea and in portions of the East Siberian Sea and Long Strait, indicative of efficient carbon export to the benthos.

Table 1. Station log for RUSALCA09 Grebmeier/Cooper component.

RUSACLA09 Station Log Grebmeier

Station Name	Station Number	Date	Local time (ADT)	GMT (ADT+8 hrs)	CTD Latitude (□N)	CTD Longitude (□W unless stated □E)	Depth (m)	Sediment chl (2 reps)	Sediment total organic carbon and grain size	4 van Veens-US infaunal populations	HAPS corer-sediment metabolism	Haps corer-downcore sections	O-18 (Cooper) CTD cast
CH8=CS8	11	9/4/09	1445	2245	69 25.956	169 37.436	46	x	x	x	x	x (10 cm)	
X1	147	9/5/09	1200	2000	68 23.677	174 08.964	49	x	x	x (1)			
CEN5	127	9/6/09	0255	1055	69 41.819	174 52.835	54	x	x	x		x(14 cm)	
CEN3	125	9/6/09	1453	2253	70 17.501	176 40.464	57	x	x	x			
CEN1	123	9/6/09	0151	0951				x	x	no-rocks/mud	rocks/mud		
LS4A	122.2	9/7/09	1215	2015				x	x				
LS4	122	9/7/09	1400	0200 (9/8/09)				x	x				
LS3A	121.1	9/7/09						x	x				
LS3	121	9/8/09	1713	0313(9/9/09)	70 20.525	178 20.078E	50	x	x	x	x	x(16 cm)	
LS1	119	9/8/09	0540	1340	69 49.799	178 00.386E		x	x	x	x	x(16 cm)	
SS5	145	9/9/09	0400		71 20.271	172 29.354	44	x	x	x			
SS4	144	9/9/09	1338	2138	71 50.653	173 00.125	40	x	x	x	x(1)	x(?)	
SS3	143	9/9/09			72 25.337	174 25.337E	44	x	x	x	x	x	
WN3	138	9/10/09	1415	2215	72 39.852	177 40.176E	75	x	x	x		x(?16)	
WN2	137	9/10/09	0000	0800	72 20.158	178 30.589E	48	x	x	x	x	x(16)	
WN1	136	9/11/09	1000	1800	71 39.874	179 29.890	29	x	x	x	x	x	
HC49	180=94	9/13/09	1416	2216	73 20.689	175 34.406	146	x	x	x	x	x(23 cm)	x
HC55	100	9/14/09	0900	1700	73 01.501	174 04.555	97	x	x	x			
HC59	104	9/14/09	1800	0143(9/15/09)	72 41.994	173 32.325	58			1 day G&G			x
HC47	92	9/15/09	0152	0952	73 14.316	176 21.720	130			Hi res CTDs			x
HC44	89	9/15/09	0728	1528	72 55.601	177 13.802	80			(84 hr)			x
HC41	86	9/15/09	1147	1947	72 36.560	178 04.662	64	x	x				x
HC40	85	9/16/09	1600	0016(9/16/09)	72 16.135	176 47.913	66	x	x				x
HC34	79	9/16/09		0504	72 18.878	175 59.189	99						x
HC27	72	9/16/09	0217	1017			54		x				x
HC25	70	9/16/09	0942	1742			60						x
HC21		9/16/09							x				
HC20	65	9/17/09	1342	2142			69						x
HC15	60	9/18/09	1555	0055(9/18/09)			40	x	x				x
HC14	59	9/18/09	2154	0524(9/19/09)			54	x	x				x
HC7	52	9/19/09											x
HC1	46	9/19/09	0747	1547			43	x	x				x
HC60	148	9/19/09	1154	1954	71 23.619	174 46.899	86	x	x	x	rocky/mud	x	x
GD7	118.1	9/20/09	0142	0942	76 39.866	164 00.974	570	x	x	x	x	x (21 cm)	x
GD6		9/21/09	2345	0745 (9/22/09)	76 30.995	164 13.673	565		x	Pock mark			x
IE1		9/21/09	0144	2144	77 29.101	166 21.997	658		x	move N to ice			x
IE2		9/22/09	1344	2144	77 29.101	166 21.997				begin transit S			x
CL1	23	9/24/09	0459	1250	68 56.781	166 55.333	47	x	x	x	x	x(20cm)	x
CL2	24	9/24/09	1303	2130	69 01.376	167 55.237	46						x
CL3	25	9/25/09	1659	0059	69 00.270	168 53.745	50	x	x	x	x	x(20 cm)	x
CL4	26	9/25/09	2252	0652(9/26/09)	68 52.865	169 36.430	55	x	x				x
CL5	27	9/25/09	1409	1009(9/26/09)	68 45.105	170 25.507	56						x
CL6	28	9/26/09	0738	1538	68 30.514	171 28.356		x	x	x	x	x	x
CL7	29	9/26/09	1445	2245	68 09.165	172 03.112	49	x	x				x
CL8	30	9/26/09	1752	0152(9/27/09)	67 52.936	172 33.160	41	x	x	x	x	x(20cm)	x
CL9	31	9/26/09											x
CL10	32	9/26/09	0309	1109	67 24.184	173 36.302	33	x	x	x			x
CS4	7	9/26/09	1441	2241	66 55.955	170 59.040	43	x	x	x	x		x
CS12	15	9/27/09	645	1445			57			x	x	x	x
CS17	20	9/27/09	1655	0055(9/29/09)	68 17.885	167 02.661	40	x	x	x			x
X7		9/28/09						x	x	x	x		x
BS02		9/29/09					51						x
BS8-2		9/26/09	1130	1930	65 52.005		47	x	x				x
BS14	14	9/29/09		0723	65 46.168	168 42	46						x
BS22	22	9/29/09		1031	65 38.085	168 12.101	39	x	x				x

F. Acknowledgments: We would like to thank the many people who assisted with deck operations, including Stanislav Denisenko and Petr Strelkov (Zoological Institute, St. Petersburg, Russia), Alexander Bosin and Alexander Kolesnik of the Pacific Oceanology Institute in Vladivostok, Russia). We also thank Alexey Sherbinin, Sergey Yarosh , Evgeny Vekhov , and Vasily Strugov, all from FERHRI, Russia, for their very good winch operations and deck support. We also appreciate the time and effort of Dr. Terry Whitledge as Chief Scientist for the RUSALCA09 expedition as well as the CTD hydrography team. Financial support was provided by the NOAA Arctic Office to PIs Grebmeier and Cooper).

Fisheries Ecology of the Bering and Chukchi Seas

Submitted by Brenda Holladay, Institute of Marine Science/UAF and Morgan Busby, NOAA Alaska Fisheries Science Center

The fisheries ecology project objective has been the documentation of fishes in the Bering Strait and Chukchi Sea by gathering information about fish species presence, distribution, relative abundance, and association with the environment. Larval, juvenile and adult fishes were collected using a plankton net (bongo) and a small mesh bottom trawl (beam trawl). The bongo was towed at 31 stations, including all the sites sampled as RUSALCA biological stations and additional sites. The beam trawl was deployed at 22 biological stations. Bottom water was collected from the CTD rosette, and interstitial water was collected from sediment cores.

The bongo was a 60 cm diameter net with paired 0.505-mm mesh plankton nets, fished in an oblique tow from the surface to within 10 m of the bottom while the vessel steamed at approximately1.5- 2 knots. At deep stations the bongo was deployed to a maximum of 200 m. A depth recorder was attached to the net frame to determine gear depth. The target wire angle and deployment speed were 45°, 40 m/min during wire out, and 20 m/min during retrieval. An ichthyoplankton sample was preserved in 5% formalin for laboratory identification during the coming year.

The bottom trawl was a 3.05 m plumbstaff beam trawl of 7 mm mesh with a 4 mm mesh codend liner and an effective swath of 2.26 m. The vessel speed was approximately 1.5 kt during the 1-5 minute tow on the sea floor. Fishes were measured (total length of each fish), weighed (one weight per species), and frozen. Future laboratory analysis will assess ages using fish otoliths. Trace element content, e.g. magnesium/calcium ratios, will be examined of fish otoliths, bottom water and interstitial water.

The samples collected by bongo and beam trawl were integral to the research of three additional RUSALCA projects and contributed to several auxiliary projects. Half of the zooplankton collected in the bongo was provided to the Census of Arctic Zooplankton Communities project (Hopcroft and Kosobokova) to enable quantitative estimates of larger zooplankton than was caught in their gear. Epibenthic invertebrates caught by the beam trawl were quantified and utilized by the Arctic Epibenthic Community and Benthic Foodweb studies; fish tissues were also provided for the RUSALCA Benthic Foodweb study (Bluhm and Iken). Many fishes collected by the beam trawl were provided as voucher specimens for museum collection and taxonomic study by the Fish Diversity project (Mecklenburg and Chernova). Fish tissues were provided for genetics examination by the Fish BarCode of Life (Mecklenburg), Petr Strelkov (Zoological Institute, Russia), and John Nelson (University of Victoria, Canada). The ichthyoplankton samples contribute to the NOAA EcoFOCI (or AFSC) archive of larval fishes from the arctic.

We gratefully acknowledge the assistance of our fellow scientists in deploying gear and processing samples onboard, including Natalia Chernova, Christy Gleason, Sarah Hardy, Catherine Mecklenburg, Daria Petrova, Petr Strelkov, and Jared Weems. The captain and crew members of the R/V Professor Khromov and Chief Scientist Terry Whitledge provided excellent support to the operations. We thank John Calder and Kathy Crane of the Arctic Region Office/NOAA for developing the RUSALCA program jointly with the Russian Federation and for providing us with this opportunity to make important observations on the current state of fishes in the arctic ecosystem.

Table 1. Bongo trawl collections during RUSALCA 2009.

Station	Haul	GMT tow start	Duration (minutes)	Bottom depth (m)	Gear depth (max, m)	Latitude mid-tow	Longitude mid-tow
CS8	BON-01	4-Sep-09 22:54	7.8	51	49	67.44	-169.67
CS8	BON-02	4-Sep-09 23:31	7.6	51	40.3	67.43	-169.60
CEN5	BON-03	6-Sep-09 11:37	7.0	56	48.7	69.69	-174.91
CEN3	BON-04	7-Sep-09 00:32	6.3	61	55	70.26	-176.66
CEN1	BON-05	7-Sep-09 11:42	6.3	31	23.6	70.78	-178.71
LS3	BON-06	8-Sep-09 04:35	4.4	49	39	70.34	178.28
LS1	BON-07	8-Sep-09 14:25	8.7	44	37	69.81	177.93
SS5	BON-08	9-Sep-09 13:29	4.3	46	35	71.38	172.37
SS4	BON-09	9-Sep-09 23:26	2.5	42	30	71.89	173.14
SS3	BON-10	10-Sep-09 08:38	5.4	45	29	72.45	174.03
WN3	BON-11	11-Sep-09 01:31	11.7	83	64	72.67	177.70
WN2	BON-12	11-Sep-09 09:00	4.5	50	37	72.35	178.60
WN1	BON-13	11-Sep-09 21:29	2.3	31	17	71.67	179.56
HC49	BON-14	14-Sep-09 01:27	9.0	150	134	73.37	-175.66
HC55	BON-15	14-Sep-09 19:25	13.9	102	82	73.03	-174.08
HC60	BON-16	17-Sep-09 23:40	7.8	84	67	71.41	-174.79
GD7	BON-17	20-Sep-09 22:06	12.8	640	200	76.67	-164.11
GD6	BON-18	21-Sep-09 11:25	15.8	580	172	76.51	-164.43
SL1	BON-19	22-Sep-09 21:14	10.8	350	241	74.46	-165.99
SL2	BON-20	23-Sep-09 03:28	8.0	240	200	74.15	-166.04
CL1	BON-21	24-Sep-09 15:02	5.7	47	35	68.93	-166.94
CL3	BON-22	25-Sep-09 02:47	6.3	55	49	68.99	-168.92
CL6	BON-23	25-Sep-09 16:11	7.9	55	39	68.48	-171.51
CL8	BON-24	26-Sep-09 03:20	4.7	50	37	67.84	-172.59
CL10	BON-25	26-Sep-09 12:16	3.6	33	20	67.39	-173.63
CS4	BON-26	27-Sep-09 00:41	4.8	43	32	66.92	-170.97
CS8	BON-27	27-Sep-09 08:47	6.4	52	45	67.43	-169.56

CS12	BON-28	27-Sep-09 16:27	8.0	56	34	67.85	-168.33
CS17	BON-29	28-Sep-09 02:12	3.7	42	30	68.28	-167.06
BS2	BON-30	29-Sep-09 01:03	5.6	54	25	66.01	-169.57
BS8	BON-31	29-Sep-09 04:04	7.4	52	34	65.90	-169.15
BS14	BON-32	29-Sep-09 07:58	7.2	53	33	65.79	-168.72
BS22	BON-33	29-Sep-09 12:34	5.8	50	33	65.58	-168.35

Table 2. Beam trawl collections during RUSALCA 2009.

Station	Haul	GMT tow start	Duration (minutes)	Depth (m)	Latitude mid-tow	Longitude mid-tow
CS8	BT-01	5-Sep-09 01:30	2.5	51	67.45	-169.55
CEN3	BT-02	7-Sep-09 02:00	2.5	58-58.5	70.29	-176.75
LS3	BT-03	8-Sep-09 07:05	5.2	49	70.41	178.21
LS1	BT-04	8-Sep-09 17:15	1.8	43-44	69.79	177.98
SS5	BT-05	9-Sep-09 14:58	2.5	45	71.37	172.61
SS4	BT-06	10-Sep-09 16:51	2.5	42	71.88	173.13
SS3	BT-07	10-Sep-09 09:58	1.7	45	72.43	174.13
WN3	BT-08	11-Sep-09 14:57	1.7	73.5-75	72.65	177.60
WN1	BT-09	11-Sep-09 22:45	5	26-27	71.64	179.54
WN1	BT-10	12-Sep-09 12:26	2	32-33	71.67	179.48
HC49	BT-11	14-Sep-09 15:14	1.5	151-152	73.34	-175.69
HC55	BT-12	14-Sep-09 20:48	2.3	93-94	73.00	-174.08
HC60	BT-13	18-Sep-09 00:59	2.2	80	71.44	-174.86
CL1	BT-14	24-Sep-09 16:28	3.5	49	68.96	-166.87
CL3	BT-15	25-Sep-09 03:52	2.1	55-56	69.02	-168.92
CL6	BT-16	25-Sep-09 17:36	2.7	56-57	68.51	-171.56
CL8	BT-17	26-Sep-09 04:43	2.5	50	67.88	-172.59
CL10	BT-18	26-Sep-09 13:26	2.6	38	67.42	-173.61
CS4	BT-19	27-Sep-09 01:52	2.1	44-45	66.95	-170.93
CS12	BT-20	27-Sep-09 17:49	2.2	59	67.89	-168.36
CS17	BT-21	28-Sep-09 03:17	4.1	40	68.31	-167.05
BS8	BT-22	29-Sep-09 04:58	2	51	65.93	-169.08
BS22	BT-23	29-Sep-09 14:39	2.2	52	65.68	-168.29

Fish Diversity ("Adult Fish") Project

(submitted by Catherine W. Mecklenburg, PI, Research Associate, California Academy of Sciences)

The main cruise objectives of the fish diversity, or "Adult Fish", project were (1) to use an otter trawl to sample juvenile and adult benthic and demersal fishes at the same stations as in 2004, as well as additional stations as time and conditions permit; (2) to document the catch for fish identifications and presence by preserving examples of each species caught at each station and archiving them in permanent fish collections; (3) to obtain tissue samples and supporting documentation (photographs and the sampled fish specimens) for molecular genetic analyses; (4) to collect fishes of particular interest for taxonomic research; and (5) to photograph live and fresh specimens to record life colors and appearance of Arctic species. All the objectives were well met. The PI worked in collaboration with the Russian PI for fish diversity, Natalia Chernova. Our success depended greatly on the fishing ability and stamina of Brenda Holladay and the able assistance of all fishers and sorters.

The otter trawl net (9.14-m headrope, 1.9-cm-mesh liner in the codend) was deployed at 26 stations. One successful tow was made at most biological stations, and a second tow at a few stations where the first tow was not quantitative, at a towing speed of 2 knots and the net 20 minutes on the bottom. All captured individuals were sorted, measured for total length (except for a few tows where great quantities were caught and we subsampled), and identified, usually to genus and species. The otter trawl catch comprised 11,578 fish, with more than 46 species represented. A large proportion of the total catch was divided among researchers for analysis and documentation of the catch. More than 300 individual samples of 1 to 50 or more specimens were preserved and apportioned among the fish collections of the California Academy of Sciences, the University of Alaska Museum of the North (UAMN), the Zoological Institute of the Russian Academy of Sciences, and the University of Washington. Together, these collections contain examples of each species caught at each station. I extracted 192 muscle tissue samples from 1-5 fish of each species for DNA sequencing by for the Barcode of Life program of the Census of Marine Life and 100 samples for the UAMN tissue bank. We caught 29 of the 33 species caught on RUSALCA 2004, plus at least 17 other species. The additional species were found mostly at the new stations sampled farther north, especially at the high latitudes and deeper waters of the Chukchi Sea Slope and Chukchi Cap. Species caught in the East Siberian Sea and the northernmost sites provided valuable documentation of fish presence where such information was previously lacking. Several relatively rare and understudied species were collected, and will be studied during post-cruise analysis. The numerous photographs taken of fishes in fresh condition will provide an invaluable record to supplement the preserved samples and will be used in publications reporting new knowledge on the fishes in the RUSALCA study area and their distribution and relationships.

station	gear-haul	midLat	midLong	comment	local date	local time
CS8	ot-01	67.45728333	-169.51015	no catch; net did not touch bottom; no marks on shoes of doors	5-Sep	3:10
CEN5	ot-02	69.6968	-174.6195667	presence only (not CPUE); not consistently on bottom; added wire three times during tow; barely got this net aboard due to strong wind and >10 ft seas	7-Sep	4:09
CEN3	ot-03	70.27606667	-176.6946		7-Sep	17:04
LS3	ot-04	70.35691667	178.2643	fouled (FR over HR); collected fish	8-Sep	21:13:05
LS3	ot-05	70.38898333	178.23495		8-Sep	22:16:10
LS1	ot-06	69.8157	177.94145		9-Sep	8:18:20
SS5	ot-07	71.37063333	172.5322167	start position marked 2 min into tow, distance is 18 min of 20 min fished	10-Sep	6:04
SS4	ot-08	71.88595	173.0686333	catch included a lot of mud; volume not recorded -- check photo	10-Sep	15:00
SS3	ot-09	72.4403	174.05555		11-Sep	1:06:20
WN3	ot-10	72.66271667	177.6622833		11-Sep	18:02:15
WN2	ot-11	72.34086667	178.5952833		12-Sep	1:46
WN1	ot-12	71.65948333	179.5536833		12-Sep	13:56
HC49	ot-13	73.35735	-175.68265		14-Sep	17:58:49
HC55	ot-14	73.01865	-174.1277833		15-Sep	11:55
HC60	ot-15	71.41826667	-174.8140667		18-Sep	16:06:30
GD7	ot-16	76.70166667	-163.9930333		21-Sep	15:25:30
GD6	ot-17	76.5515	-164.4417		22-Sep	5:01:10
SL1	ot-18	74.48393333	-165.9670333		23-Sep	14:07:30
SL2	ot-19	74.12288333	-166.00855		23-Sep	18:27:44
CL1	ot-20	68.94545	-166.9111167		25-Sep	7:32:15
CL3	ot-21	68.99606667	-168.9216333		25-Sep	19:06:10
CL6	ot-22	68.491	-171.5054167		26-Sep	8:36:42
CL8	ot-23	67.85898333	-172.5844667		26-Sep	19:52:03
CL10	ot-24	67.39515	-173.6280167		27-Sep	4:34:44
CS4	ot-25	66.92776667	-170.9619167		27-Sep	17:05:14
CS12	ot-26	67.86576667	-168.3410333		28-Sep	8:56:37
CS17	ot-27	68.29335	-167.0565167		28-Sep	18:33:55
CS8	ot-28	65.90846667	-169.1236	rocky in grab - 10 min tow	29-Sep	20:24:20
BS22	ot-29	65.61296667	-168.3353333	not quantitative - strong current and wind; catch indicates net was rarely on bottom	30-Sep	4:55:45
BS22	ot-30	65.90846667	-169.1236	added 40 m scope; net on bottom throughout tow	30-Sep	5:48:40

RUSALCA 2009-Cruise Report: Marine Mammal Watch

Introduction

The 2009 RUSALCA cruise provided a rare opportunity to search for marine mammals in the East Siberian and western Chukchi Sea. Such an effort had not been undertaken since 1992 and 1993, when aggregations of bowhead whales (*Balaena mysticetus*) were seen along the Chukotka coast on visual watches conducted during oceanographic surveys (Moore et al. 1995). In 1993, bowheads were associated with a 5x 8 km patch of zooplankton, including the euphausiid *Thysanoess rachii*, a common bowhead prey species. A decade later, in the western Beaufort Sea, acoustic sampling showed that gray whales (*Eschrichtius robustus*) over-wintered in Arctic waters northeast of Barrow, Alaska in 2003-04 (Stafford et al. 2007). Combined with other evidence, it appears that gray whale numbers and residency time in arctic waters has increased in recent years coincident with the extreme seasonal retreats of sea ice in the Pacific Arctic region (Moore 2008). Finally, there is concern that populations of walrus (*Odobenus rosmarus*) and other ice-associated pinnipeds (e.g., bearded and ringed seals) may be stressed by the loss of haul-out habitat associated with the rapid and extreme retreats of sea ice evident in the Pacific Arctic over the past decade (Moore and Huntington 2008).

Including a visual watch on the 2009 RUSALCA cruise provided the means to obtain a 'snapshot' of marine mammal distribution along the cruise track. The four goals of the marine mammal watch were to obtain:

1. positions and associated environmental data for all marine mammals seen along the cruise track;
2. positions and descriptions of 'atypical' seabird sightings;
3. photographs of individual-whale diagnostic features (e.g., humpback whale flukes, killer whale dorsal fins/saddles), if possible; and
4. underwater recordings, if possible (only in US or international waters).

Sighting data from the RUSALCA cruise will complement information from the much more robust visual and acoustic surveys for marine mammals underway in the eastern Chukchi and Beaufort seas (http://noaa.nmml.gov/caep). Combined, the overall goal is to develop a more complete picture of marine mammal distribution, relative abundance and seasonal occupancy in the Pacific Arctic region.

Methods

A visual watch for marine mammals was conducted during daylight hours when the ship was in transit between sampling stations and during 10-20 minute scans each hour when the ship was on station. The watch was undertaken by a single observer using naked eye and handheld binoculars to view a 180º arc forward of the ship when underway, with 360º scans conducted when the ship was on station. The watch was conducted from the ship's bridge (*ca.* 9m height) and flying bridge (*ca*.12m height) depending on weather. The watch was curtailed when sea state exceeded Beaufort 05, or visibility was < 1 km.

All marine mammal sightings were noted by time, location, species and number of animals. Associated environmental conditions included an estimate of ice cover (percent), sea state (Beaufort scale), weather and approximate visibility range. Behavior and any other additional physical or biological features were noted as a comment linked to the sighting information. The primary observer was occasionally assisted by other scientific party personnel and the ship's crew. All ship's position and sighting data were combined to a common excel file. Ultimately, the marine mammal sightings will be incorporated in the NOAA Platform of Opportunity database and available via the NOAA Corp Officer at the National Marine Mammal Laboratory.

Results & Discussion

Marine mammal watch effort consisted of 145h of search while in transit and 102 scans while on station for a total of *ca.* 170h, from 3-29 September (Table MM-1). Viewing conditions were poor-fair on 14 days (52%), good-excellent on 13 days (48%), and there were no sightings of marine mammals on 10 days (37 %). There were no opportunities during the cruise to take individual-specific photographs of whales, nor to record underwater sounds.

Marine Mammals

Seven species of marine mammals were seen during the cruise, including bowhead, gray and humpback whales, walrus, ringed and bearded seals and one sighting of three polar bears – a sow and two cubs (Table MM-2). An aggregation of over 100 gray whales was observed on 4 September, with at least 21 humpback whales also in the area bounded by *ca.* 67-67°30'N, 169°20'-169°40'W. The gray whales were seen in loose groups of 5-20 animals, diving repeatedly with greenish-brown sediment evident at the surface indicating benthic feeding. The humpbacks were most often seen in small groups of 2-4 whales, with a possible cow-calf pair in the largest group numbering 9 whales. Overall, gray whales were seen on the shoreward (east) side of the ship, while most humpbacks were noted on the seaward (west) side. These whales were associated with a productive benthic 'hotspot', previously documented by Grebmeier. Many murres (*Uria* spp.) and rafts of shearwaters (*Puffinus* spp.) were also noted in the area.

Gray whales were next seen north of Wrangel Island on 10-11 September. Sediment plumes in the water indicative of feeding were noted near the seven whales seen on 10 September, but not the four seen on 11 September, which were swimming very 'low profile' (a behavior called snorkeling) towards the island. Although few in number, this may be a 'record' in distribution for this species, in part because waters north of Wrangel Island usually have been covered by sea ice until roughly the past decade. Gray whales may be 'prospecting' feeding areas near Wrangel Island, an area of documented declines in sea ice cover in September (Moore and Laidre 2006).

Three bowhead whales were seen at 72°54.7'N, 175°49.4'W on 13 September, roughly 18 km (10 nm) north of a 1-km ribbon of sea ice on which *ca.* 80 walruses were hauled out. Of note, three large whales were seen the evening of 12 September, roughly 2nm (3.5 km) south of 72°08.1'N, 175°57.5'W, but the ship (towing side-scan sonar at 3kts) turned back north before a positive identification could be made. From the size of the blows, these were large whales and from the location very likely bowheads. A few walrus and seals were the only marine mammals seen from 14-24 September, with six consecutive days (17-22 September) of no sightings at all. Then, on 25 September, 127 gray whales and 12 humpback whales were seen along the western half of the CL line in the south-central Chukchi Sea. Both species appeared to feeding, with numerous mud plumes seen near the gray whales. The area of highest density was the area roughly bounded by 68°20-68°N and 171°45-172°20W. Bowhead, gray and humpback whales, as well as walrus, were seen along the Chukotka coast on 26 September. Unfortunately, darkness constrained the survey of this productive coastline to only 3 hours before the sampling track turned northeast along the CS line. Humpback whales, walrus and many seabirds were seen on 27 September, but only through station CS12; thereafter sighting rates fell likely due to the transition out of Anadyr water and into less-productive Bering and Alaska coastal current water masses. The humpback whales seen near station CS12 (67°53'N, 168°17'W) appeared to be feeding by swimming slowly on their sides with the left ½ of their flukes exposed, then giving a quick 'flick' of their flukes followed by a fast roll briefly exposing their backs. This behavior was noted in two pairs of whales, with the second pair accompanied by a much smaller whale (possibly a calf) that seemed to lunge between the two larger whales. Of note, comparatively large arctic cod (*Boreogadus saida*) were sampled near the location of this feeding activity (see Holladay). Later that evening a small cetacean, likely a harbor porpoise (*Phocoena phocoena*) was seen passing the ship stationed offshore Pt. Hope, Alaska. A few humpback and gray whales were seen enroute to and near Cape Deshnev and Big Diomede island on 28 September, and a single pinniped was noted as the ship passed King Island on 29 September.

In brief, **highlights** of the marine mammal watch included:

1. Gray whales feeding north of Wrangel Island

2. Bowhead whales (and a sighting that was likely bowheads) in Herald Canyon

3. Humpback whales feeding in the south-central Chukchi Sea

4. Walrus on the very scant ribbon of sea ice in the otherwise open northern Chukchi Sea

5. Ringed and bearded seal sightings confined to the small portion of the cruise conducted near sea ice north and west of Wrangel Island; i.e. there appeared to be no sea ice suitable for haul out for walrus, ringed or bearded seals – even at the northern terminus (*ca.* 77°30'N, 166°30'W) of the transit on 21 September.

Seabirds

Atypical seabird sightings included two mega-flocks of short-tailed shearwaters in the central Chukchi Sea, two sightings of Pacific loons (a single and a pair) and two sightings of single northern fulmars in the far northern Chukchi Sea (Table MM-3). The first shearwater encounter was while on transit to stations X1 and CEN 5, with streams of birds noted nearly continuously for ~8h while the ship steamed northwest roughly 100km (60 nm) offshore between Cape Serdtse-Kamen and Cape Vankarem on 5 September. Viewing conditions were poor, with shearwaters displaying their characteristic acrobatic flight in seas running a 6-8'swell and Beaufort 04-06 sea state. By mid-afternoon, one long-tailed jaeger had joined the shearwaters and was seen through evening. The second mega-flock was noted east of Herald Island on 16 September. Multiple rafts of 100s of shearwaters were seen as the ship approached station HC25 in the low-light of pre-dawn. A disturbance at one large raft was caused by a walrus (likely male, from head and tusk size) that suddenly rose up under the raft apparently trying (unsuccessfully) to grab a shearwater. The shearwaters responded with vigorous wing flapping and running across the water's surface to escape, behaviors described as "flash expansion" for eiders when attacked by walrus (Lovvorn et al. 2009). Working closely-spaced stations westward toward Herald Island, the shearwaters seemed especially numerous near stations HC25-HC23, coincident with a 4-6° C thermal boundary (see Pickart Line 2). Large flocks of 1000s of birds took to the air later in the morning, flying in counterclockwise ellipses and spirals, with behaviors typical of feeding also noted. Two long-tailed jaegers flew counter-clockwise to the direction of flight of the shearwaters, with crested auklets noted scrambling away from the bow of the ship.

In addition to these atypical sighting, 'expected' seabirds seen included: Ross's and ivory gulls (*Hydrocoloeus rosea* and *Pagophila eburnea*) when the ship was near Wrangel Island/Herald Canyon; pelagic cormorants (*Phalacrocorax pelagicus*) near Herald Island (1 bird) and Cape Lisburne (2 birds) and 'many' near the Chukotka coast; many black-legged kittiwakes (*Rissa tridactyla*) and murres (*Uria spp.*), thousands as the ship passed the Diomedes northbound and in smaller numbers throughout south and central Chukchi Sea. Although not identified to species, both thick-billed and common murres were seen, the latter especially noted along the CS-line and south. Crested auklets (*Aethia cristatella*) were common in small numbers throughout the Chukchi Sea north to Herald Island, with a spectacular assemblage of 1000s of birds seen on the water near 70°07'N, 167°24'W, as the ship approached station X2 and again between stations CL2-CL3. Finally, a short eared owl *Asio flammeus*, rode along on the ship the morning of 12 September, soon after we'd passed Wrangel Island; the owl appeared to have left the ship by late afternoon that day.

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Table MM-1. Marine Mammal (MM) Watch Effort Summary: transit watch (h) and scans (10-20 min/h) while on station.

Date	Hours	Scans	Cruise Segment	MM Species	Conditions
9/3/09	5	0	Nome-Bering Strait	walrus	Excellent
9/4/09	3	7	To/from Station CS8; ~8h on station, 1st deployments	gray & humpback whales	Excellent
9/5/09	3	1	Heading to station CEN5; short sediment station X1 on crossing		Poor: low OC w/ 6-8' swell, & wind 25-30ts B05-06
9/6/09	4	2	Stations CEN 4, CEN 3		Poor: dark, low OC; 5-7' swell; 20-25kts wind, gusts to 30kt
9/7/09	6	9	Long Strait stations; short (water & geo) and full-biology	walrus in water; one FE-pup pair	Good: high OC; ~10-15 kts, B03
9/8/09	8	2	Chukotka coast, then NW to East Siberian Sea (SS5)	walrus in water; one FE-pup & one large male	Fair: partly cloudy to high OC; 15-20kts+ B04-05
9/9/09	3	5	East Siberian Sea SS4 & SS3	ringed seals near station SS3	Poor: 20-25 kts, 4-5' swell; fog, 5% ice
9/10/09	7	4	East Siberian Sea, north of Wrangel Island	polar bear (sow +2), bearded & ringed seals, gray whales w/ plumes	Good: 50% ice –to-open water w/ 3-4' swell
9/11/09	4	7	NE Wrangel; most of day near WN1 – WN0	gray whale, bearded & ringed seals	Fair-Good: fog in AM, then CVU PM
9/12/09	7	0	Herald Canyon slow-tow side scan sonar day	3 unidentified whales (ship turned)	Fair-Poor: OC, w/ fog patches
9/13/09	6	6	Herald Canyon: HC49 & 50; begin Hi-rez 50h run	bowhead whales and walrus	Good-Fair: 1-5% ice at start, then open water
9/14/09	1	7	Herald Canyon HC55-59; CTD breakdown/fix		Poor: open water @ 7320N, B05, precip. & fog

9/15/09	7	5	Herald Canyon HC43-34		Poor: open water, B03, precip, fog, OC
9/16/09	9	4	Herald Canyon HC25-14; pass Herald Island	walrus, ringed seals, five unidentified seals	Good-Fair: open water B0-03; precip, fog
9/17/09	2	5	Herald Canyon HC1 (end hi-rez) + HC58B bio-station		Poor: fog, precip. B03-05
9/18/09	9	0	All-day transit north to CD1		Good: OC & PC, B03, 4'swell PM
9/19/09	1	9	Slow-tow sonar grid all day CD1-CD8		Good: OC & PC, B03-02, 2-3' swell
9/20/09	0	4	Move among tightly-spaced CD stations all day		Poor: OC B04-05 4-5' swell
9/21/09	9	3	NW to ice, 2h of pancake ice, never find true 'edge'		Good; OC, ice 0-90%
9/22/09	3	4	N. Chukchi; 2 fishing stations, SL1 & SL2		Fair; OC B04 3-4' swell
9/23/09	4	3	Transit south to X2 station and CL line	PN @ dusk w/ 1000s auklets	Fair-Poor; OC to snow & fog in PM
9/24/09	6	4	Cape Lisburne line: CL1-3	PNs w/ s-t shearwater rafts & near fish trawl net	Good-Fair; OC, swell 3-5', snow squalls in PM
9/25/09	8	3	Central Chukchi: CL6-8;	GW & HW	Fair-Good; PC, B04 snow squalls
9/26/09	9	3	So.Central Chukchi CS1-6	BH, GW, HW, WS UnId whale	Fair-Good; PC, B04, snow squalls
9/27/09	8	3	So. Cent. Chukchi CS8-17	HW, WS	Good; B03-04
9/28/09	8	2	So. Chukchi & Bering Strait	GW, HW, PN	Fair-poor;B03-06
9/29/09	5		enroute Nome	PN next to ship	Fair; B03-05/glare
TOTAL	**145**	**102**			

Marine Mammal Species Abbreviations and Latin Names:

BH = bowhead whale (*Balaena mysticetus*)

GW = gray whale (*Eschrichtius robustus*)

HW = humpback whale (*Megaptera novaeangliae*)

CT = unidentified cetacean

WS = walrus (*Odobenus rosmarus*)

BS = bearded seal (*Erignathus barbatus*)

RS = ringed seal (*Pusa hispida*)

PN = unidentified pinniped

PB = polar bear (*Ursus maritimus*)

Table MM-2. Marine Mammal Sighting Summary (no. sightings/no. animals).

Date	BH	GW	HW	CT	WS	RS	BS	PN	PB	Comment
9/3/09					1/11					in water near King Island
9/4/09		8/101	5/21							CS8 So.Chukchi 'hotspot'
9/7/09					2/8					in water near Wrangel Island
9/8/09					2/10					in water near Wrangel Island
9/9/09						2/2				E. Siberian Sea
9/10/09		3/7				15/28	1/1		1/3	N. Wrangel Is.
9/11/09		2/4				10/24	4/6			NE Wrangel Is.
9/12/09				1/3						CT likely BH, ship turned (!)
9/13/09	1/3				8/99					BH 18km N of WS on 1km 'ribbon' of ice
9/16/09					1/1	3/3		3/5		WS & seals w/ shearwater mega-flock
9/23/09								1/1		Seal w/ 1000s crested auklets
9/24/09								2/2		Seals w/ s-t shearwater rafts & trawl net
9/25/09		21/127	3/12	1/2						CT likely humpback
9/26/09	1/2	11/45	1/7	1/2	5/22					CT poss. BH, or HW, w/ GW
9/27/09			2/5	1/1	1/3					CT ~ harbor porpoise
9/28/09		2/5	2/4					2/2		PN spotted?

9/29/09								1/1		PN spotted?
Totals	2/5	47/289	13/49	4/8	20/154	30/57	5/7	9/11	1/3	

Table MM-3. Atypical seabird sightings. Note that shearwaters and fulmars were seen elsewhere along the cruise track; the listings here are considered 'atypical' with regard to 'common' distributions shown in bird guide books.

Date	**Species**	**Location**	**Comments**
5 SEP	Short tailed shearwater *Puffinus tenuirostris* Long tailed jaeger *Sterorarius longicaudus*	6817.9N 17337.8W *-to-* 6904.2N 17430.2	'mega-flock' 1000s of birds around ship, 6-8'swell, B04-05; 10s of crested auklets near ship single jaeger flying high 'with' shearwaters
13 SEP	Pacific loon *Gavia pacifica*	7321.2 N 175 36.8W	Near HC 49; diving in mud brought up in grab
16 SEP	Short tailed shearwater Long tailed jaeger	7146.1N 17431.1W *-to-* 7143.6N 17446.6W	'mega-flock' – multiple 'rafts' of 100s; feeding; WS tries to grab one! E. Herald Island – HC25-23 2 jaegers, flying 'against flow' of spiraling shearwaters
21 SEP 22 SEP	Northern fulmar *Fulmarus glacialis* Northern fulmar	7708.8N 16557.1W *- to-* 7723.1N 16559.5W 7450.4N 16600.1W	One bird (dark phase); ship-follow north on 1.5h transit through pancake ice – not seen at station @ 77°29'N 166°22'W One bird (light phase); boat follow in morning
23 SEP	Pacific loon	7107.9N	2 loons off starboard bow, fast-

		16703.9W	sculling away from ship

Geology and geophysics

1. Geophysical investigations

Boris Smirnov, Alexey Sazonov, Dmitry Korshunov, Elizaveta Logvina

The main goals of the geophysics survey during the Russian-American Long-Term Centrus of the Arctic (RUSALCA) cruise aboard RV "Professor Khromov" in the Leg 2 (from 2 to 30 of September 2009) were to collect side scan sonar and sub bottom profiler images (along track lines) to investigate the possible methane releases from the sediments in the Pockmark field (*Reference*) on the Chukchi Plateau (at the water depth > 500 m) and to determine Herald canyon structure and topography at the water depth > 100 m (Fig. 1.1).

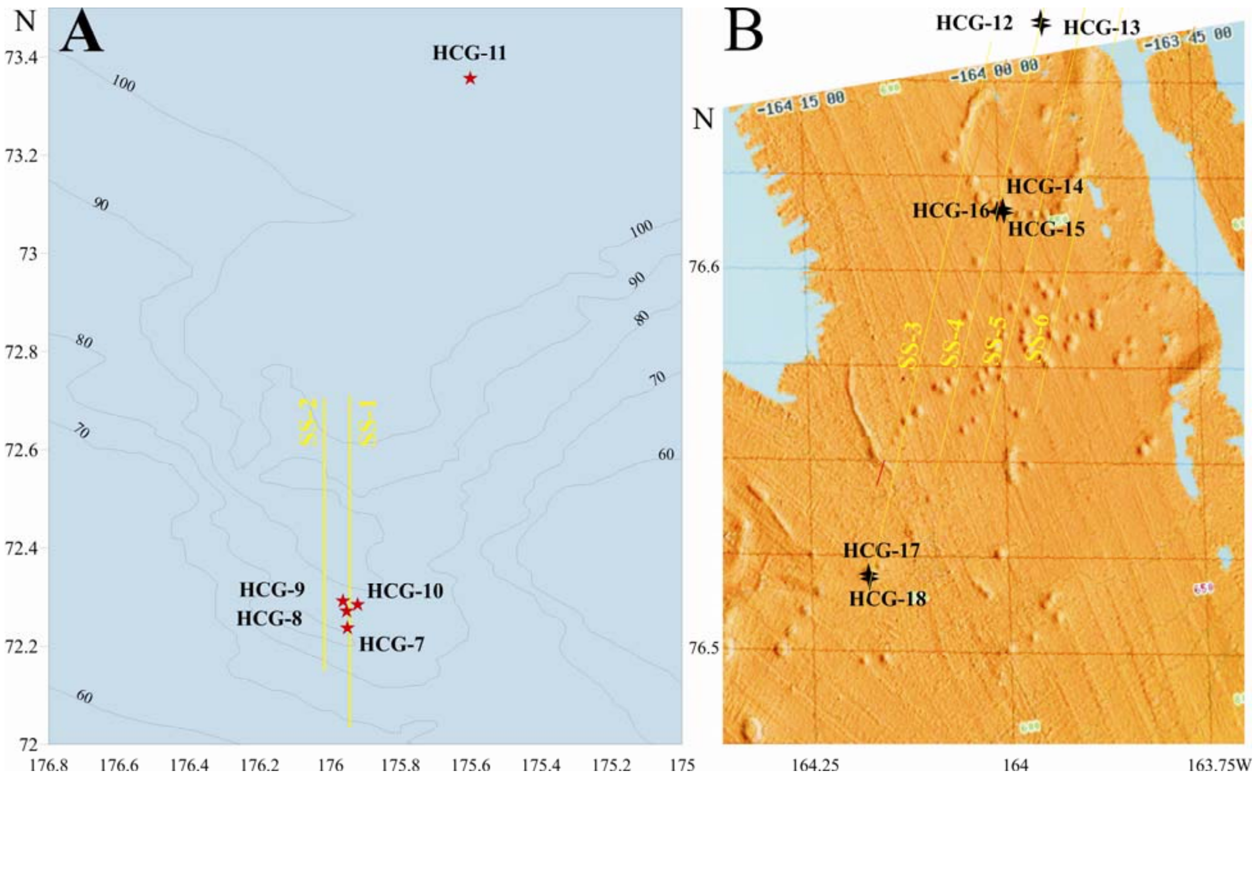


Figure 1.1. Scheme of the geophysics side scan sonar and sub bottom profiler track line (yellow lines) and geological core sampling stations (red and black stars) in tow investigation areas (A) Herald Canyon and (B) Pockmark field in the Chukchi Plateau.

Methods

SONIC-3M deep water Side-scan Sonar System was used for geological-geophysical survey, environmental and engineering research to investigate of bottom topography and the top part of sediment structure to discover natural resources, to resolve environmental pollution problems, to design, and accommodate underwater structures (e.g. pipelines, cables, etc.) as well as to look for submerged objects in shallow and deep water (> 100 m). The system is very mobile and can be transported by airplane, train and car and easily installed on vessels of any type. The preliminary geophysics results may be carrying on hard copies and in digitally aboard.

THE SYSTEM CONFIGURATION:

- 30 kHz Side Scan Sonar
- 5 kHz Sub bottom Profiler
- Fish Track Underwater Navigation System
- Pressure sensor

TECHNICAL DATA

Side Scan Sonar	
Operation frequency	30 kHz
Pulse Length	0,5 –2,0 ms
Width angle	2,5 x 50°
Pulse Power	2 x 2500 W
Width Range	800 - 3200 m
Best resolution	0.5m
Sub bottom profiler	
Operation frequency	5 kHz
Pulse Power	3500 W
Pulse Length	0,2 – 2 ms
Best resolution	0,4 m
Width angle	50 x 50°

Fish Track Navigation System	
Operation frequency	10.6 kHz
Pulse Length	1 – 10 ms
Width angle	45 x 45°
Pulse Power	5 kW
Pressure (Depth) sensor	
Accuracy	1%
Tow fish dimensions	3,15 x 0,67x0,35 m.
Weight in air	127 kg
Registration formats	SN2 / PRF / SEG-Y
Maximum operation depth optional	6000 - 10000 m
Tow cable	One wire coaxial KG1-30, KG1-55, KGP-1-150
Operation vessel speed	2 – 3 knots
Maximum (emergency) vessel speed	7 knots
AC Power (Without computer)	190-240V, 47-63 Hz up to 70 W

For towage “SONIC-3M” fish one wire cable KG1-1.5-55 (5000 m), winch and A-frame of RV “Professor Khromov” were used. Fish altitude above the seafloor was from 80 to 120 m, cable length over 1000-2000 m.

Registration Software package, operating in WINDOWS produces digital record of data on hard disk of the computer, visualisation of sonar data on the screen of the computer, registration of GPS and fish track’s navigation data, it may be connected to a graphic recorder, it allows also connect and register of different analogue and digital sensors. Dataloggings software can to work at several computers (first - master, other for slave).

The post-processing Software package makes possible correction of geometric and amplitude distortion of sonar images, building of the seabed mosaics in different map projection, making up of 3D mosaics images.

Results

Side-scan sonar (SSS) and sub bottom profiler (SBP) survey were carried out along two track lines in Herald Canyon (over 100 km long; Table 1.1) and four track lines in the “pockmark field” area on the Chukchi Plateau (over 50 km long; see Table 1.1) using a deep water hydroacoustic system “SONIC-3M”.

Table 1.1. List of side scan sonar and sub bottom profiler track-lines, Leg 2 of the RUSALCA cruise aboard RV “Professor Khromov” 2009

NN	Beginning of the track line		End of the track line		Date UTC	Time UTC
			The Herald Canyon			
SS-1	72º26.1929N	175º59.8765W			12.09.09	15:29
			72º07.9403N	175º57.5212W	13.09.09	04:50
SS-2	72º17.8926N	175º58.1702W			13.09.09	08:38
			72º40.1324N	175º58.0720W	13.09.09	16:10
			Pockmark field area on the Chukchi Plateau			
SS-3	75º39.8176N	164º00.3719W			19.09.09	18:02
			76º31.8182N	164º06.7374W	19.09.09	21:38
SS-4	76º40.3037N	163º56.3496W			19.09.09	22:32
			76º40.1271N	163º53.3606W	20.09.09	01:22
SS-5	76º3221.51N	164º02.5807W			20.09.09	02:00
			76º32.4161N	163º59.2021W	20.09.09	04:30
SS-6	76º39.6521N	163º50.5100W			20.09.09	04:46
			76º39.6094N	163º50.5491W	20.09.09	07:50

The Herald Canyon (see fig. 1.1(A)). During the SSS and SBP profiling furrows, crossing the slopes of the canyon in different directions were marked. These furrows are different in long, but much more than 1200 m (two track lines 600 m each) and different in wide, around 10 to 200 m (Fig. 1.2). It is difficult to analyze the nature of this furrows, it could be explained by icebergs movement, or by near-bottom dredging or may be vital functions of some mammal (whales ?).

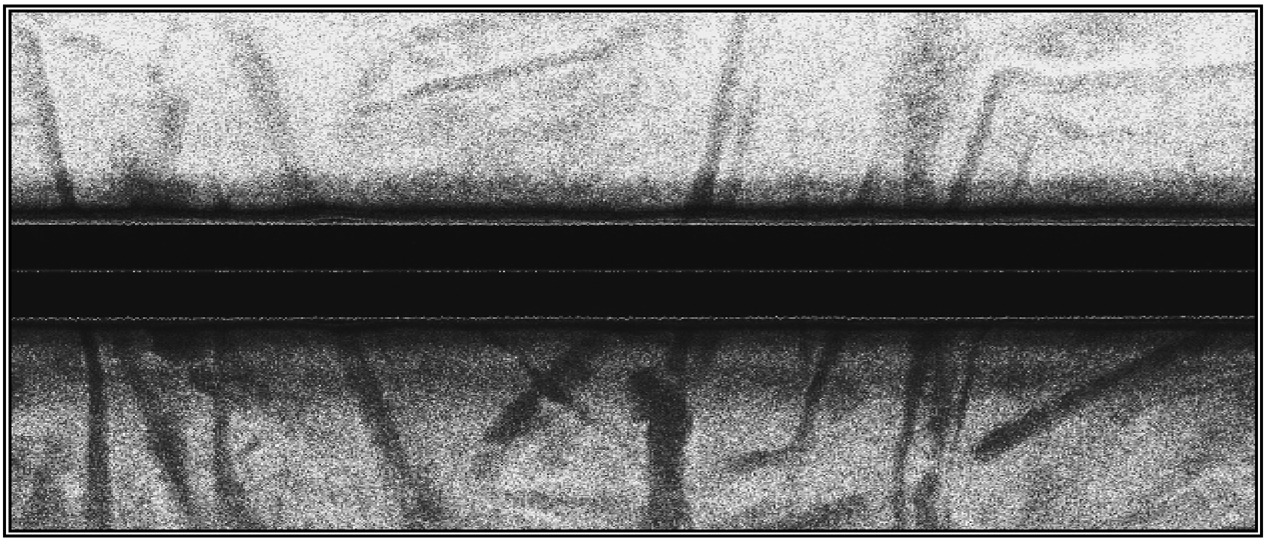


Figure 1.2. Inwrought fragment of the side scan sonar SS-1 track line in the Herald canyon area. Black lines - furrows, crossing the slopes of the canyon in different directions.

The Pockmark field (see fig. 1.1(B)). Based on different intensity of the backscattering, more than 20 rounded depression structures on the SSS images were revealing (Fig. 1.3). The dimensions of these depressions are rather different, from 150 to 850 m in diameter. The greatest distinction in the depth, in comparison with surrounded sea flour level, was observe in the central part of the structures – 40…50 m depth. These rounded depressions are the conical in the cross section.

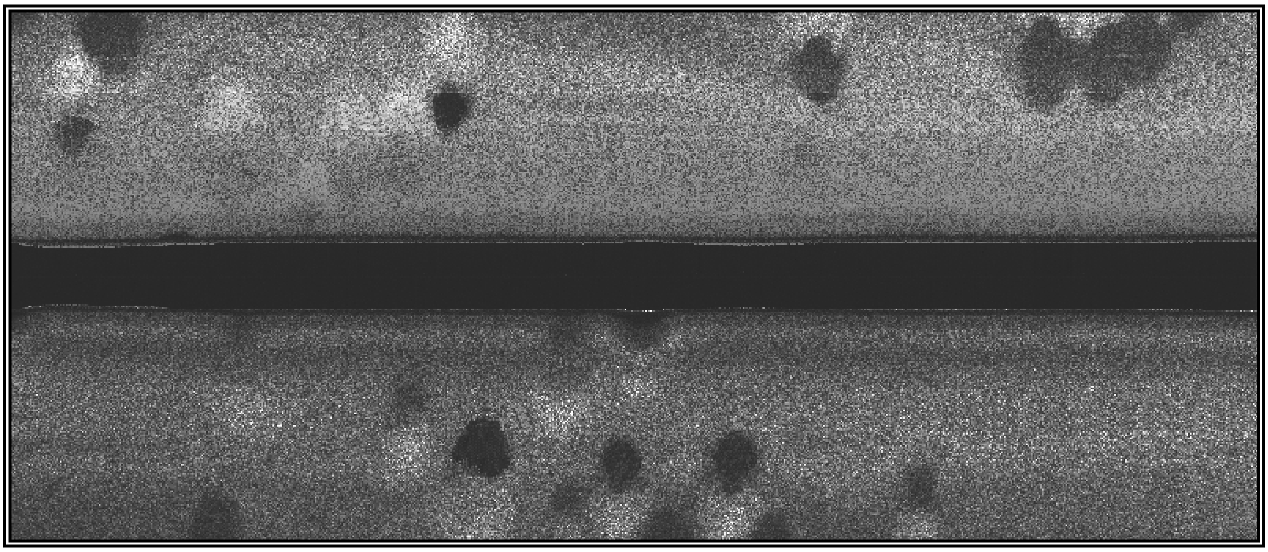


Figure 1.3. Inwrought fragment of the side scan sonar SS-5 track line in the Pockmark area.

Black and white - different intensity of backscattering - rounded depression structures.

There is no any evidence of gas both in the SSS and in the SBP images across the depressions. In this case, at present time, it is difficult to approve that the nature of these depressions connected with gas escapements from the sediments.

2. Geology investigations

Elizaveta Logvina, Alexander Bosin, Dmitry Korshunov, Alexander Kolesnik, Konstatin Kramchanin

The main goals of the geology investigations during the Russian-American Long-Term Centrus of the Arctic (RUSALCA) cruise aboard RV “Professor Khromov” in the Leg 2 (from 2 to 30 of September 2009) were to collect sediment cores and grabs in Herald Canyon area and in the “Pockmark field” area on the Chukchi Plateau (see fig. 1.1 and 2.1.). Furthermore geological/sediment sampling was emphasized for sampling on and occurred at the selected hydrographic stations in the Chukchi Cap and in the East-Siberian sea region (Fig. 2.1).

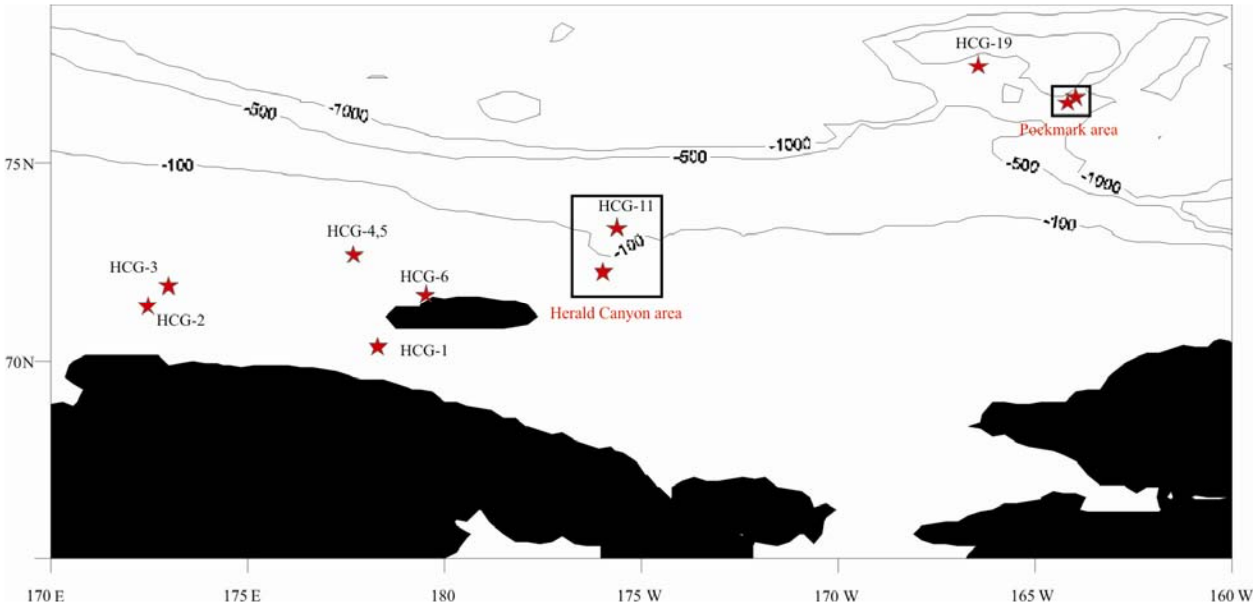


Figure 2.1. Sketch-map of the core sampling during the RUSALCA LEG 2 cruise in 2009.

Methods

Geological sampling during the RUSALCA cruise aboard RV “Professor Khomov” was carried out using by hydraulic corer (GSP-2) and two types of grabs – “Van Veen” and “Ocean”, which were prepared for surface sediment sampling.

During the cruise “Van Veen” grab was used mainly because it requires less time for taking of sediments. Grab “Ocean” was used only during Leg 1 of the cruise. Surface sediment samples were packed in plastic bags and stored with epy temperature about 4˚C.

The length of the stainless steel core barrels is 330 cm, with the inner diameters 90 cm. To speeds up the retrieval of sediments, the flexible polyethylene liner was put inside of the core barrel. These plastic liners were used because it requires much less time for taking of sediments. After recovery of the gravity corer to the deck, the liner with sediment core was cuted up on 1 m sections and than transferred to laboratory for further studies. Time interval from rise corer on the deck up to cutting of sediment in laboratory did not exceed 10-20 minutes.

The subsequent lithological documentation was done using the standard scheme including the description of a texture, color, structure, density, inclusions (debris, shells), character of contacts between layers.

Temperature of the sediment was measured immediately after recovering aboard (Appendix 1).

Samples for density and humidity analyses were taken with plastic syringes. Samples were taken every 20-30 cm by plastic syringes. Syringes with sediment are weighed. After full drying with temperature 105˚C, sediment will weighed again. Due to definite volume of sediment humidity and dry bulk density will be calculated.

Magnetic susceptibility (MS) was measured in seven cores after core description (Appendix 2). MS is one of the main stratigraphy proxies for marine sediments. This proxy indicates changes of magnetic sediment components, caused by increasing of terrigenic input during cold periods, volcanic pyroclastic materials or other sources.

Half of each core section was packed for the POI archive storage in the cold room with temperature about 4˚C; other part of the core was cuted for future geochemical and litholigical studies. Smear slides were made for following investigation under microscope with the aim of preliminary determination of sediment components.

Results

Fe-Mn concretions has been taken from 3 grabs (Table 2.1). A significant amount of concretions and crusts (about 10 kg) were raised on stations SL1 and SL2 by larval fish trawl (Fig. 2.2). All material packed for continued study in POI.

Table 2.1. Station list of the Fe-Mn concretion sampling during the RUSALCA cruise aboard RV "Professor Khromov" in the Leg 2 in 2009

№ station	Coordinates		Depth, m	Date and time (on the ship)
	Longitude	Latitude		
HC 40	176º 46.9’ W	72º 16.5’ N		
HC 14	175º 58’06.4W	70º58’43.9N	55	16.09.09 21.48
HC 60 (58B)	174º 47’31.3W	71º22’08.9N	85	17.09.09 13.05
SL 1-2	166º 00’00.0W	74º07’12.0N		

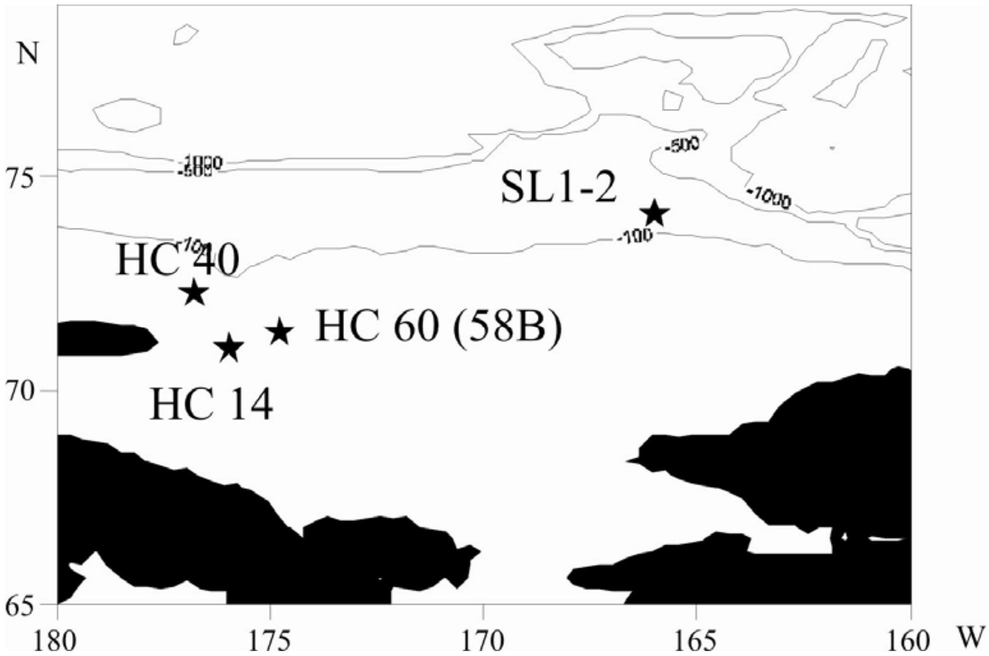


Figure 2.2. Sketch-map of the Fe-Mn concretion sampling during the RUSALCA cruise aboard RV “Professor Khromov” in the Leg 2 in 2009

Magnetic susceptibility (MS) was measured in seven cores (Appendix 2).

HCG-2. This core was taken near the eastern coast of East-Siberian sea. 0-75 cm – MS is high, probably due to input of terrigenic magnetic material by sea ice. 75-95 cm – decreasing of MS probably caused by restriction strong sea ice cover.

HCG-3. This core was taken not far from core HCG-2. MS in core HCG-3 is not so high like in core HCG-2, probably due to more distant situation from the coast.

HCG-4 and HCG 5. These cores were taken in eastern part of East-Siberian sea, NW from Wrangel Island very close to each other. MS in these cores very low, probably due to strong sea ice cover blocked sources of magnetic components. Sharp peaks probably caused by single pebbles.

HCG-8 and HCG-10. These cores were taken in northern part of Herald Canyon very close to each other. MS in these cores is very high. Increasing of magnetic components in this region probably caused by tectonic activity.

HCG-11. This core was taken on the shelf slope far from sources of magnetic components. MS in this core is very low. Sharp increasing probably caused by single pebble.

Surface sediment sampling by "Van Veen" and "Ocean" grabs has been done in 86 stations (Appendix 3). Sediment samples (0-40 cm sub bottom depth) and debris material different in size and rounded was collected. All grab sampling stations sampled during Leg 1 of the RUSALCA cruise aboard RV "Professor Khromov" are presented in the figure 2.3 and grab sampling stations sampled during Leg 2 in 2009 are presented in the figure 2.4.

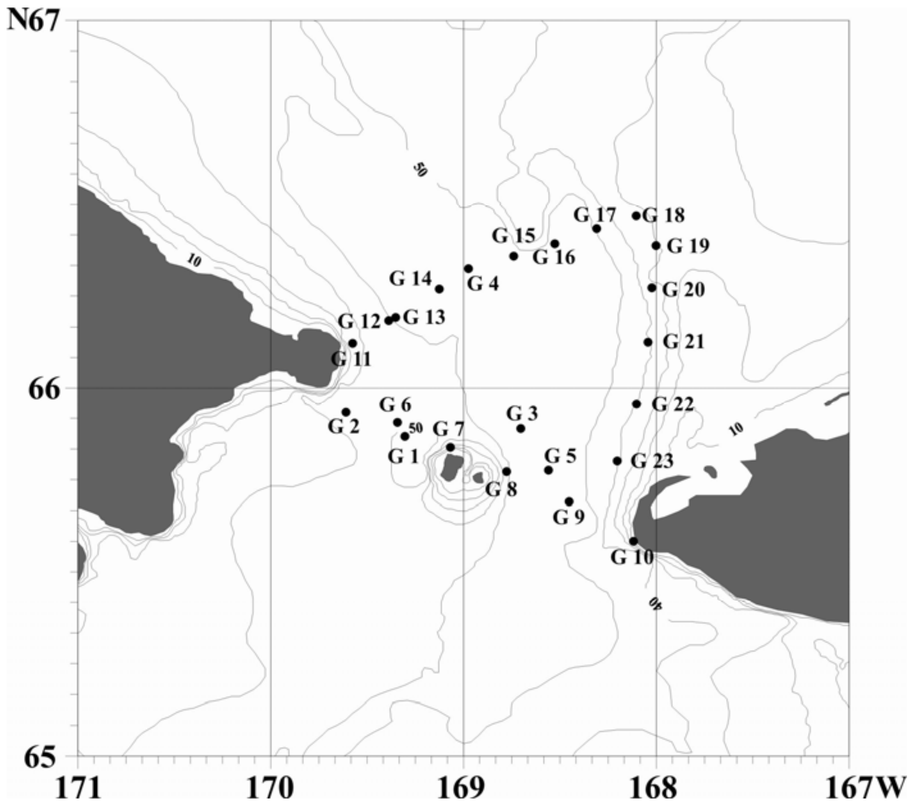


Figure 2.3. Grab sampling stations sampled during Leg 1 of the RUSALCA cruise aboard RV "Professor Khromov" 2009

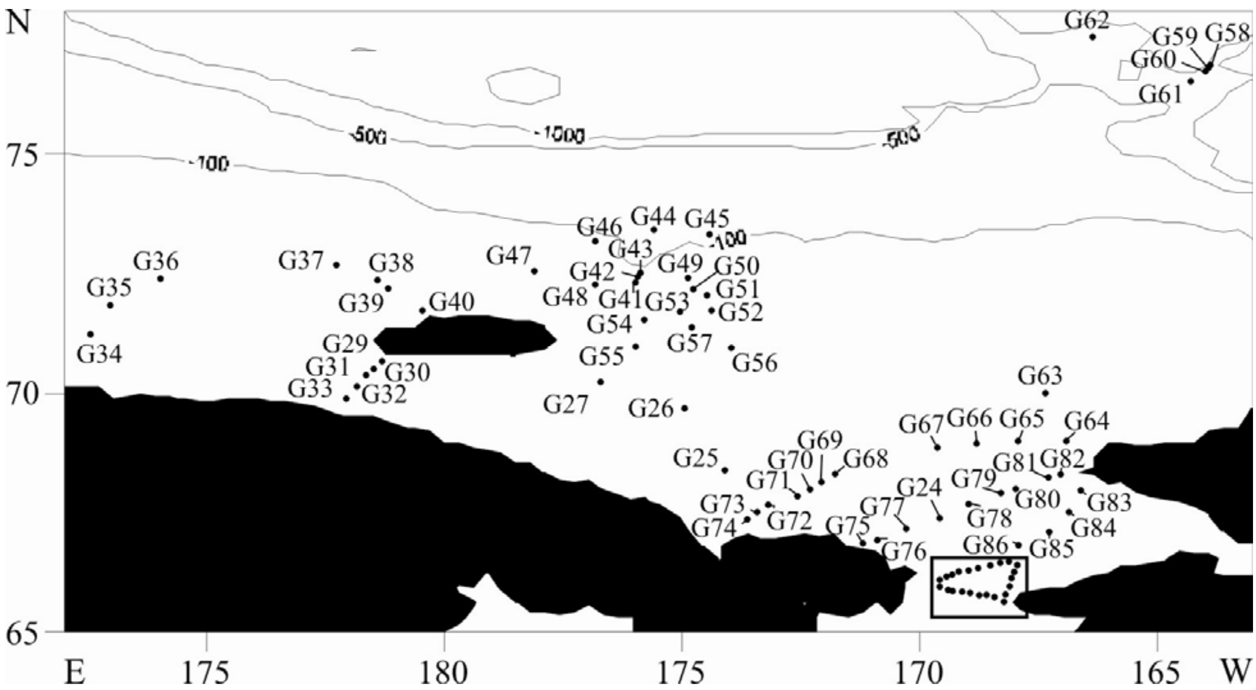


Figure 2.4. grab sampling stations sampled during Leg 2 of the RUSALCA cruise aboard RV “Professor Khromov” 2009

Core sampling. Nineteen coring stations were described and sampled during the Leg 2 of the RUSALCA expedition (Table 2.2): six of them in the Chukchi Cap and in the East-Siberian sea region, five - in Herald Canyon area, seven - in the Pockmark field area on the Chukchi Plateau and one in the far north area at the grates water depth - 672 m (see fig. 1.1 and 2.1). The length of the received sediments varies from 20 cm (Station HCG19) to 262 cm (Station HCG-17) (Appendix 3).

Table 2.2. Geological core sampling stations during the RUSALCA cruise aboard RV “Professor Khromov” in the Leg 2 in 2009

NN Coring station	NN hydrographic/biological station	Coordinates		Water depth (m)	Core length (cm)
The Chukchi Cap and the East-Siberian sea					
HCG-1		70º20,4609N	178º19,6062E	44	50

HCG-2	SS5	71º21,7610N	172º28,9304E	45	99
HCG-3	SS4	71º52,9567N	173º00,5286E	45	130
HCG-4	WN3	72º40,1310N	177º42,5907E	75	103
HCG-5	WN3	72º40,1310N	177º42,5907E	75	202
HCG-6	WN1	71º39,6647N	179º32,2485E	28	26,5
Herald Canyon area					
HCG-7		72º14,2154N	175º57,7404W	94,7	30
HCG-8		72º17,5962N	175º57,3095W	98	193
HCG-9		72º16,9104N	175º57,3058W	98	33
HCG-10		72º16,9104N	175º57,3058W	98	149
HCG-11	HC49	73º21,1437N	175º36,5817W	150	119
Pockmark field area on the Chukchi Plateau					
HCG-12	GD-7	76º39,6737N	163º57,3024W	565	179
HCG-13	GD-7	76º39,6322N	163º57,2107W	565	147
HCG-14	GD-1	76º37,0312N	163º59,7328W	595	200
HCG-15	GD-1	76º36,9925N	163º59,9947W	570	86
HCG-16	GD-1	76º36,9886N	163º59,8308W	602	180
HCG-17	GD-6	76º31,1538N	164º10,7253W	635	262
HCG-18	GD-6	76º31,0995N	164º10,9742W	685	140
HCG-19		77º27,1742N	166º26,1633W	672	20

The Chukchi Cap and in the East-Siberian sea region (see fig. 2.1). Six geological stations in common with hydrographic and biological stations were carrying-out (see Table 2.2, Appendix 4). Coring and grab stations are situated relatively close to each other at the water depths ranged from 28 to 75 m, except the HCG-11 station, sampled in the far north in East-Siberian sea region – 150 m. Therefore, the structural and mineral compositions of the recovered sediment are reasonably similar.

The sediments in general are represented by silty-clay and clayey silt with minor admixture of sandy fraction, and composed mostly of siliceous organic debris with addition of terrigenious material. Major colors of deposits are generally dark gray or grayish-green. The structure is homogeneous or banded and spotty due to black hydrotroilite laminas. Different in size and rounded debris were observed in the different sub bottom depth in most of the cores.

The upper 0-5 cm of the sediments some time strongly disturbed by coring operation. In case of good preservation the top part of sediments is usually differed from the underlying. The youngest layers at the cores HCG-1, HCG-2, HCG-3, HCG-4 and HCG-6 are represented by strongly reduced and water-encroached light gray mud with thickness up to 5 cm. On the other hand, in the core HCG-5 such type of sediments was absence.

The Herald Canyon (see fig. 1.1 and 2.1). The lithological outlook of five sedimentary cores taken within the both Herald Canyon and in the Chukchi Cap and in the East-Siberian sea region (see above) in general is similar (Appendix 4). Dense sediment with some admixture of sandy fraction (mainly in upper part) was recovered from all stations in this region (see Table 2.2). Tube worms was observed in the upper 0-20 cm sub bottom depth on the stations HCG-7, HCG-8 and HCG-10. The hydrotroilite geode over 4 cm in diameter was marked in the 91-95 cm sub bottom depth on the stations HCG-8. In most of the cores in the different sub bottom depth different in size and rounded debris was found.

The Pockmark field (see fig. 1.1. and 2.1). Based on side scan sonar and sub bottom profiler records (see above), three rounded depression structures has been chosen for geology investigations. Collected seven cores were rather different from each other (Appendix 4). All cores characterized by brown oxidized aleuric sediments with sand admixture in the upper 0-15 cm layer. Furthermore, the oxidized layers observed in the different sub bottom depth in all collected cores, right up to 233 cm of sub bottom depth.

The main component of sampled cores was miry, sticky pelite different in colors from beige, light brown, brown, olive-gray, dark gray to black (in hydrotroilite laminas).

Breccia-like structure, characterized by brownish-gray clay with dark-gray thick clay inclusions (up to 0.5cm in diameter), has been marked in the cores HCG-14 and HCG-15, sampled in the central part of the “GD-1” structure (see fig. 1.1), thickness of these layers was 25 and 50 cm, accordingly. Similar in structure, but different in color (dark gray, light brown and dark brown) and inclusions size (up to 0.2 cm in diameter) layer observed in the 35-45 cm of sub bottom depth in the station HCG-12 (“GD-7”; see fig.1.1). In the HCG-13 station such type of structure (breccia-like) but just dark gray in color, was marked in the 33-37 cm of sub bottom depth.

In one core HCG-18, sampled from the slope of depression structure, located in the southern part of the studied area (“GD-6”; see fig. 1.1), sand layer with debris up to 5 cm thickness, has been marked.

There is on any evidence of gas presence in the recovered sediments.

The core HCG-19, sampled in the far north in the studied region yielded just 20 cm of sediments and consist of similar first layers already described in all other cores collected in the water depth more than 500 m in the Chukchi Plateau.

Sediments, obtained within the investigated region were formed during Holocene mainly. Period of accumulation of recovered sediments from the sites with water depth less than 150 m water depth (the Chukchi Cap and in the East-Siberian sea, the Herald Canyon) are perhaps extended and partly occupy the Pleistocene time. The Wrangelya Island and Chukotka peninsula are the main sources for terrigene material for all investigated region.

3. Remotely Operated Video Operations

Boris Smirnov, Alexey Sazonov, Dmitry Korshunov

A Remotely Operated Video (ROV) was an integral part of the RUSALCA cruise aboard RV “Professor Khromov”. The main goal of the ROV investigations during the Leg 2 (from 2 to 30 of September 2009) was to provide color video in Chukchi and East Siberian seas and Longa strait, transmitted over 150 m of coaxial cable up to the ship. Images was captured on computer and transferred directly into MPEG 4 files for hard drive and CD storage. At most of the stations shallower than 60 meters, the ship requewted to anchor. At other stations (e.g. Herald Trough), the ROV operations was took place while the ship is drifting with the currents. It was planned to spend television observation of a bottom in those points, where it was spent in RUSALCA-2004 cruise (stations number: 14, 15, 18, 20, 23, 25, 62b, 73b, 85b, 106 and 107) and in other interesting places potentially interesting for bottom sediments.

Methods

For maintenance of works has been prepared the same ROV “Intershelf-105”, as in 2004, but in addition equipped additionally by the block of smooth brightness control, laser pointers for definition of the sizes of objects at the bottom and is completed by another, softer Kevlar armored cable.

Video via a cable connecting the device with a vessel was transmitted to a vessel where amplified in the onboard block and recorded by a digital media recorder AV500 ARCHOS in format AVI DivX 6.8.5 with data rate 2000 kb/s, that provides studio quality of the image 720 x 576 pixels at 25 frame/s. Simultaneously viewing the image on the monitor of a computer by means of “AVerMedia Hybrid + FM Volar”. tuner TV

The ROV «Intershelf-105M» (Fig. 3.1) characteristics:

Maximum water depth	130 m
Cable length	200 m
Number of propellers	3 (2 horizontal 1 vertical)
Recommended vessel’s speed	3 knots
Lighters	2 * 100W
TV camera	0,1 Lux PAL 720 x 576
Image dimension measuring	2 lasers
Video recording	Digital on AV500 “ARCHOS”
Power	2kW, 220V, 50Hz
Weight on air/water	18/0,3 kg

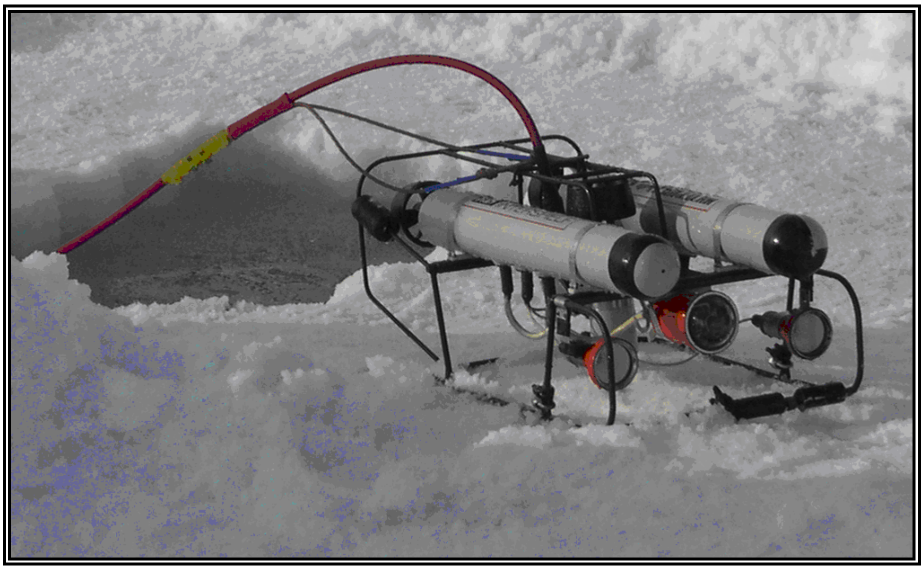


Figure 3.1 .***The ROV «Intershelf-105» used in the RUSALCA cruise aboard RV "Professor Khromov" in the Leg 2 in 2009.***

Results

In the second leg of RUSALCA 2009 cruise television survey of a sea bottom was made at stations LS-3 and LS-1 in Longa strait; the SS-3 and SS-5 stations in East-Siberian sea; the WN-3, WN-2, WN-1 and WN-0 stations at northern coast of. Wrangelya island (Table 3). Only in one case (station WN-0) the vessel became on an anchor that has allowed to make good video recording of a bottom within 20 minutes. In other cases strong current or a wind led to drift of a vessel 2,5 - 3 knots that did not allow, not only in detail to consider bottom and to define a fauna available there, but also to operate the device.

In the second part of the second leg of cruise it was planned to repeat survey at stations of RUSALCA-2004. Television observation of a bottom at stations 23 (CL-1) and 25 (CL-3) have been made. Survey were made at statement of a vessel on an anchor, but bad weather conditions (height of a wave 2 - 2,5 m) have not allowed to receive high quality of a material as the device on everyone to rolling of a vessel ran into a bottom, that could bring (and has brought}) in its damage. It was necessary to refuse the further attempts of work.

In total it has been executed television supervision at 10 stations but only two of them repeated stations RUSALCA-2004г. (CL-1 and CL-3). On each station there are the brief description with photos of a typical condition of a bottom and the most interesting objects and alive organisms. Video data are grouped in two folders "Full" and "Short". In the first folder video files were not edited (except for time of down and up ROV to the deck), in the second folder from video files not informative places have been cut out and they are more suitable for viewing and presentations. In each folder there are same names .srt file of external subtitles of Date, time and coordinates.

Table 3.1. R.O.V. station list during the during the Russian-American Long-Term Centrus of the Arctic (RUSALCA) cruise aboard RV "Professor Khromov" in the Leg 2 in 2009

NN Station File name	Date/Time (UTC)	Coordinates	Comments
Station 121 (LS-3.) Full -121(LS-3).avi Short(8 min)- 121.avi	08.09.09/04:31:35 - 04:53:16	70º 20'25,16 "N 178 º19'18,12"E	Longa strait. 48 m depth. Strong current but low waves.
Station 119 (LS-1.) Full -119(LS-1).avi Short(9 min.) - 119.avi	08.09.09/18:14:20 - 18:32:40	69º50'11,11"N; 178º01'5,93"E	Longa strait. 45 m depth. Strong current, medium waves.
Station 145 (SS-5) Full -145(SS-5).avi Short(15 s) - 145.avi	09.09.09/16:03:50 - 16:16:44	71º20'6,21"N; 172º29'50,77"E	East Siberian sea. 45m. depth. Very strong current, medium waves.
Station 143 (SS-3) Full -143(SS-3).avi Short(9 min.) - 143.avi	10.09.09/07:46:40 - 08:10:48	72º26'40,86"N; 174º01'20,34"E	East Siberian sea. 45m. depth Strong current, medium waves.
Station 138 (WN-3) Full -143(SS-3).avi Short(9 min.) - 143.avi	11.09.09/0:15:30 - 0:42:30	72º40'16,09"N; 177º42'58,75"E	North from Wrangelya isl. 76,2m.depth. Medium current, medium wave
Station 137 (WN-2.) Full -137(WN-2).avi Short(33 s) - 137.avi	11.09.09/08:31:03 - 08:48:18	72º20'59,45"N; 178º33'50,39"E	North from Wrangelya isl. 50m.depth Very strong current, medium waves.
Station 136 (WN-1.) Full -136(WN-1).avi Short(5 min) - 136.avi	11.09.09/20:26:05 - 20:44:44	71º40'12,31"N; 179º30'53,34"E	North from Wrangelya isl. 45m.depth Very strong current, medium waves.
Station 136-0(WN-0)	12.09.09/01:36:52	71º35'56,71"N;	North from Wrangelya isl 35m.depth On

Full -136(WN-1).avi Short(18 min.)– WN-0	- 02:00:00	179º34’4,92”E	an anchor. Good weather (wave 0,5 m)
Station 23 (CL-1.) Full -23(CL-1).avi Short(2,5min.)– CL-1	24.09.09/18:05:04 - 18:18:26	68º35’56,57”N; 166º54’45,27”W	south of Chukchi sea near Alaska coast, on anchor, 55м depth, bad weather (a wave more than 2 m)
Station 25 (CL-3.) Full -23(CL-1).avi Short(2,5min.)– CL-1	25.09.09/04:15:10-04:28:33	69º01’16,41”N; 168º54’46,10”W	south of Chukchi sea, on anchor depth - 55м, bad weather (a wave more than 2 m)

Station 121 (LS-3) (Fig. 3.2) ROV observation in a middle part of Longa strait have begun08/09/2009 with 04:31:35 UTC in a point 70º20’25,16N 178º19’18,12E on depth 48m. Also have finished in 04:53:16 UTC in a point 70º20’22,64N 178º18’50,16E.

The original of video on AV500 - VID0003.

From 25 minute video recordings, having removed not informative staff, it was possible to mount 8 minute film on which it is possible to describe, how geomorphological structure of a sea bottom, and to give the description of flora and fauna.

Figure 3.2. From the left site - bottom in this place oozy in holes and hummocks. From living creatures prevail *Brittle stars* and soft corals (*Gersemia, Actiniaria, Pagurus*) from the right site.

Station 119 (LS-1) (Fig. 3.3) ROV observation in the South-east part of Long strait at Chukchi coast have begun 08/09/2009 of18:14:20 UTC in a point 69º50’11,11N; 178º01’5,93E on depth 45m. Also have finished in 18:32:40 UTC in a point 60º50’18,62N; 178º01’0,66E.

The original of video on AV500 - VID0004.

From the 18 min video record, after editing we have a 9 min film on which basis it is possible to tell that concentration of a plankton in this place of passage above, than in point LS-3 has turned out, the transparency of water is less, the bottom is more equal also more oozy, density of a covering of a bottom.

Figure 3.3. From the left - the *Brittle stars* in some times above, than at the previous station and except for soft corals there are any spherical organisms. From the right – many young fishes.

Station 145 (SS-5) (Fig. 3.4) ROV observation in northeast part of the East-Siberian sea have begun 09/09/2009 in 16:03:50 UTC in a point 71º20’6,21N 172 º29’50,77E on the water depth 45m. Also have finished in 16:16:44 UTC in a point 71º20’32,17N 172º29’33,14E.

The original video on AV500 - VID0005.

From the 13 minutes video record it was possible to mount one15 second informative episode.

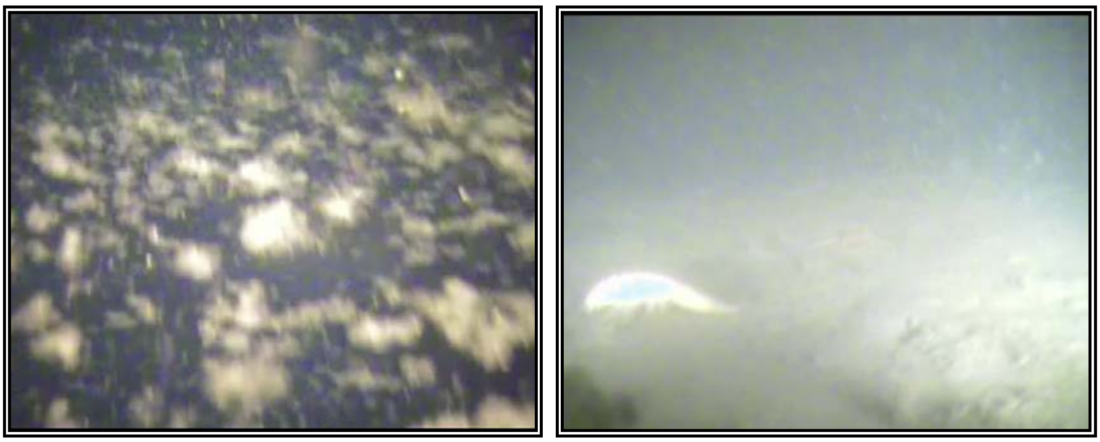


Figure 3.4. From the left site - very strong turbidity of water in a benthonic layer and very strong current. From the right - the shrimp *Saduria sp.(?)*

Station 143 (SS-3) (Fig. 3.5) ROV observation in northeast part of the East Siberian sea have begun 10/09/2009 in 07:46:40 UTC in a point 72º26’40,86N 174º01’20,34E on depth 45m. Also have finished in 08:10:48 UTC in a point 72º27’1,52N 174º01’49,08E.

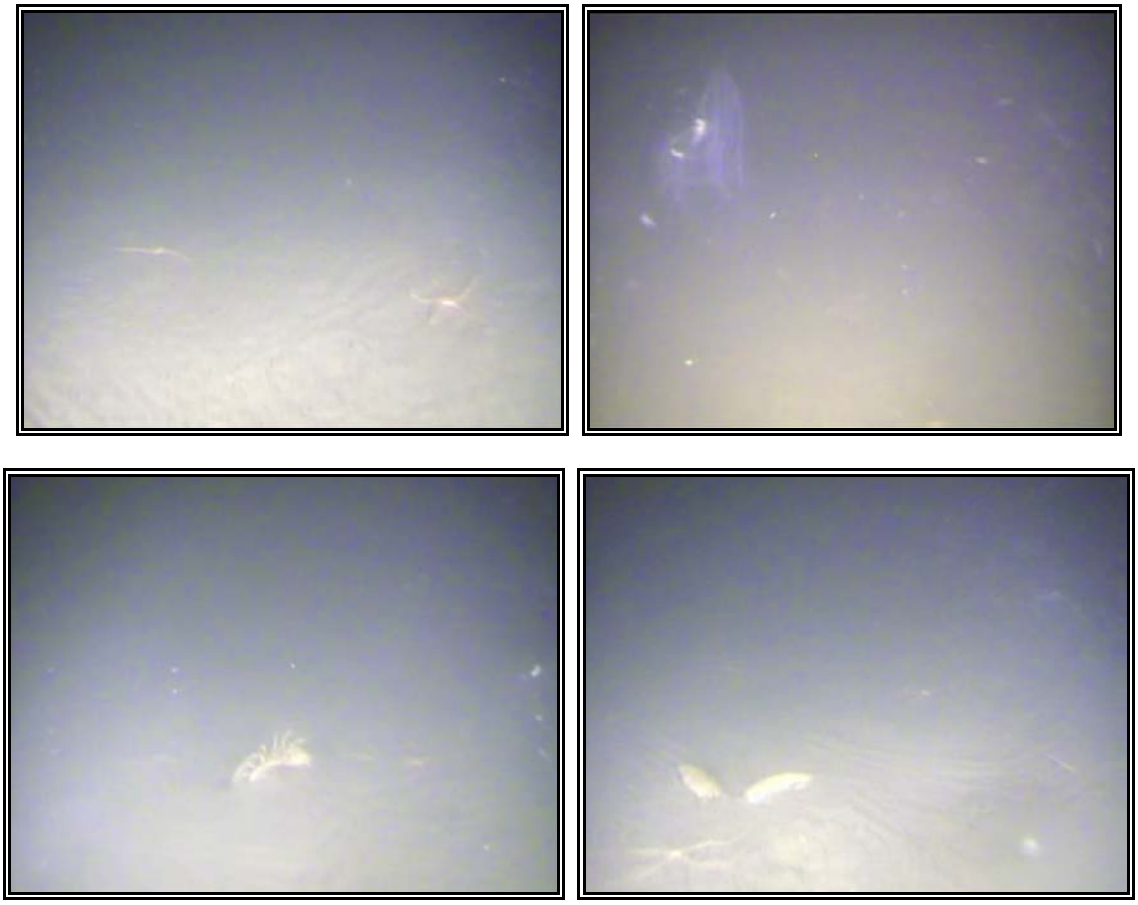


Figure 3.5. From the top left- the Brittle stars at this station meet less often, than on previous. From the top right- a lot of jelly-fishes and any others organisms below.

The original of record on AV500 - VID0006.

From 25 minutes of video was made 9 minutes film which viewing enables is mounted to note some differences from the previous stations:

Station 138 (WN-3) (Fig. 3.6) ROV observation to the north from Wrangelya island have begun 11/09/2009 in 0:15:30 UTC in a point 72º40’16,09N; 177º42’58,75E on depth 76,2m. Also have finished in 0:42:30 UTC in a point 72º40’22,84N; 177º43’0,30E.

The original video on AV500 - VID0007.

From 28 minutes records it was possible to mount 9 minute film.

Figure 3.6. From the top right and left in the below – Crab(?)

From the right below -*Gerianthus sp*.

Station 137 (WN-2) (Fig. 3.7) ROV observation to the north from Wrangelya isl. have begun 11/09/2009 in 08:31:03 UTC in a point 72º20’59,45N; 178º3350,39E on depth 50m. Also have finished in 08:48:18 UTC in a point 72º21’9,25N; 178º34’38,99E.

The original of record on AV500 - VID0008.

Because of strong drift of a vessel the device could reach a bottom only once, and from 17 minute records it was possible to allocate 33 second episode of contact to a bottom on which it is possible to describe hardly structure of a bottom and character of fauna. An oozy bottom, and from alive organisms prevail Brittle stars

Figure 3.7.

Station 136-1 (WN-1) (Fig. 3.8) ROV observation to the north from Wrangel island have begun 9/11/2009 in 20:26:05 UTC in a point 71º40'12,31N 179º30'53,34E on depth 45m. Also have finished in 20:44:44 UTC in a point 71º40'20,62N 179º31'44,69E.

The original of record on AV500 - VID0009.

Very strong current and the big drift of a vessel. From 17 minutes video after editing we made a 5 minutes film on the basis of which nevertheless it is possible to give the characteristic of a bottom surface and to note a greater variety of fauna at this station. A bottom oozy, high turbidity of water, beside *Brittle stars* s (*Opheura*) meet starfishes (see fig.3.8) and shrimps.

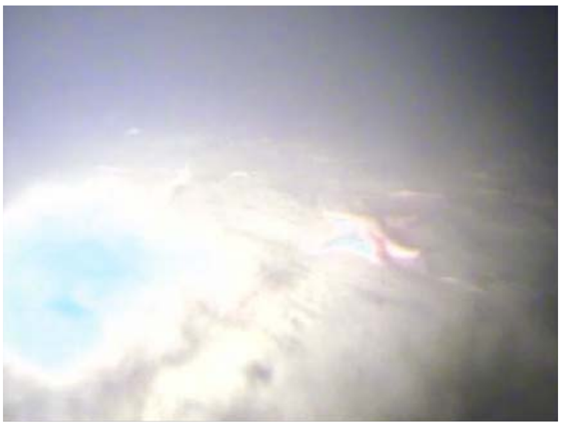


Figure 3.8. From the left in the top – *Brittle stars (Opheura),* meet starfishes (?); from the top in the left - *Saduria sp.* and below from the right- *Saduria sp.* + shrimp.

Station 136-0 (WN-0) (Fig. 3.9) ROV observation to the north from Wrangel island have begun on anchor parking of 9/12/2009 in 01:36:52 UTC in a point 71º35'56,71N 179º34'4,92E on depth 35m. Also have finished in 02:00:00 UTC in a point 71º35'56,15N 179º34'4,58E.

The original of record on AV500 - VID0010.

Statement on an anchor and good weather (wave no more than 0.5 m) gave the best results from the stations done till now –have allowed to receive (a 18 minute film from 23 minutes of video-recording.)

Equal oozy bottom, abundance of plankton, very poor fauna - full absence *Brittle stars* (*Opheura)*, the organisms similar to seaweed (see fig. 3.9, top left), two cockleshells (see fig. 3.9 top right, left middle), two "cockroaches" (see fig. 3.9 middle right and left below), one shrimp? (see fig. 3.9 from the right below) and something similar to a worm is everything, that it is possible to see for 18 minutes of film.

Figure 3.9. From the top right and left in the below to seaweed, two cockleshell two “cockroaches”, one shrimp?

Station 23 (CL-1) (Fig. 3.10) ROV observation on south of Chukchi sea near Alaska coast on anchor have begun 24/09/2009 in 18:05:04 UTC in a point 68º35’56,57N 166º54’45,27W on depth 55m. Also have finished in 18:18:26 UTC in a point 68º56’57,58N 166º54’46,16W.

The original of record on AV500 - VID0011.

Statement on an anchor, but bad weather (a wave more than 2 m) have not allowed to receive satisfactory results. 2.5 minutes film was made from 12.5 minutes record after editing turned out. On everyone to rolling of a vessel, the device ran into a bottom. Under the received image, it is possible to give the characteristic of a ground surface and to note poverty of fauna at this station. A bottom oozy, high turbidity of water, meet fishes (see fig. 3.10 top left) crabs (see fig. 3.10 top right and left below) prevail.

Figure 3.10. From the top left: fish, crabs

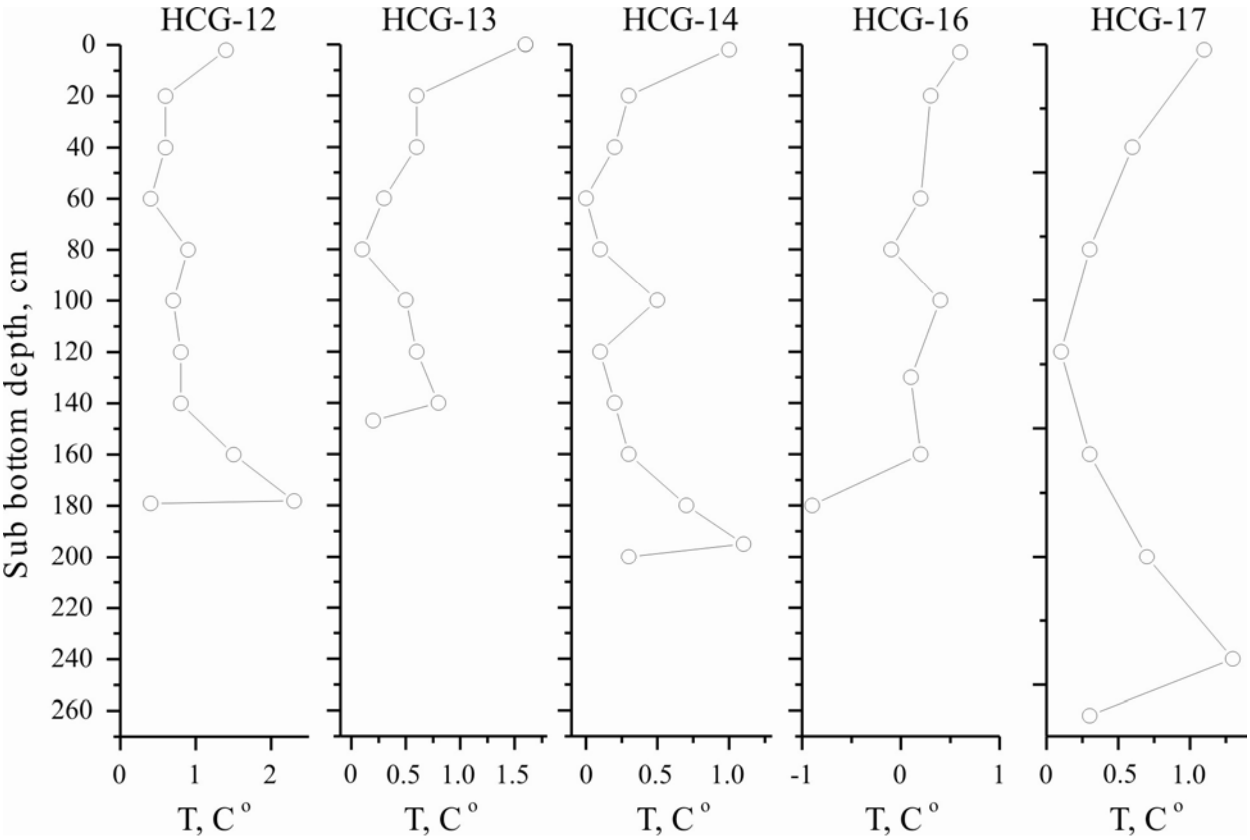
Station 25 (CL-3) (Fig. 3.11) ROV observation in the south of Chukchi sea have begun on anchor statement of 25/09/2009 in 4:15:10 AM UTC in a point 69º01'16,41N 168º54'46,10W on depth 55m. Also have finished in 4:28:33 AM UTC in a point 69º01'13,69N 166º54'46,76W.

The original of record on AV500 - VID0012.

As well as at the previous station, statement on an anchor at bad weather (a wave more than 2 m) have not allowed to receive satisfactory results. From 13.5 minutes video-recordings after editing 2.5 minutes film has turned out. Under the received image, it is possible to give the characteristic of a ground surface and to note poverty of fauna at this station. A bottom oozy. It is a lot of jellyfishes (see fig. 3.11 top left and right). There are crabs and cancers - eremites (see fig. 3.11 below left and right).

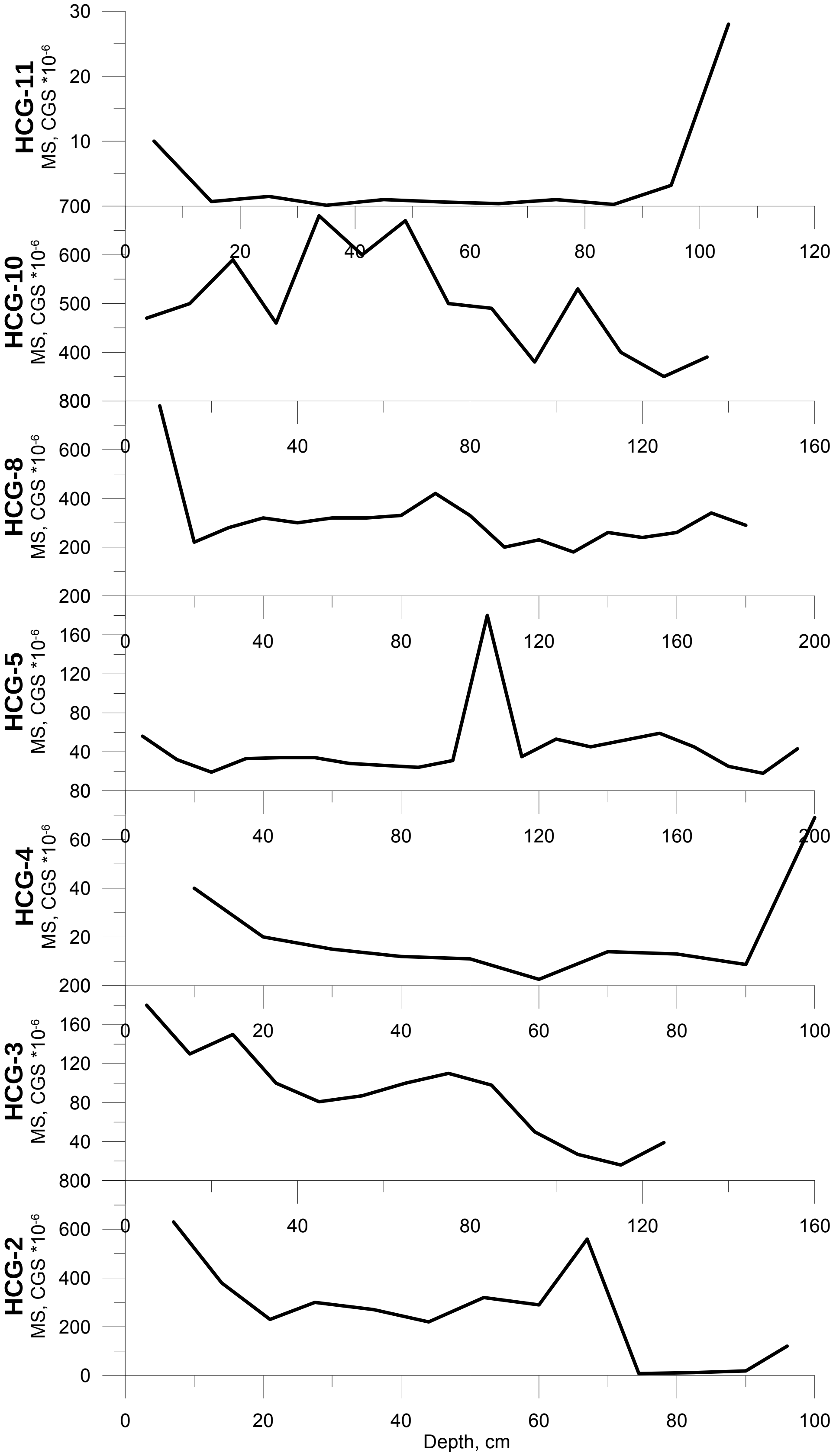
Figure 3.11. From the top left and right – jellyfishes, crabs and cancers - eremites below from left and right.

Appendix 1



HCG-12
HCG-13
HCG-14
HCG-16
HCG-17
Sub bottom depth, cm
0
20
40
60
80
100
120
140
160
180
200
220
240
260
0 1 2
0 0.5 1.0 1.5
0 0.5 1.0
-1 0 1
0 0.5 1.0
T, C°
T, C°
T, C°
T, C°
T, C°

Appendix 2



HCG-11
MS, CGS *10-6
HCG-10
MS, CGS *10-6
HCG-8
MS, CGS *10-6
HCG-5
MS, CGS *10-6
HCG-4
MS, CGS *10-6
HCG-3
MS, CGS *10-6
HCG-2
MS, CGS *10-6
Depth, cm

Appendix 3

NN	Station	Coordinates		Depth, m	Date and time (ship)
		Longitude	Latitude		
Leg 1 the RUSALCA cruise aboard RV “Professor Khromov” 2009					
G1	A1-3	W 169^{0} 18’23.6”	N 65^{0} 52’05.4”	48	
G2	A1-2	W 169^{0} 36’57.3”	N 65^{0} 56’01.3”	49	
G3	A2W	W 168^{0} 42’18.4”	N 65^{0} 53’34.2”	53	
G4	A3	W 168^{0} 58’45.2”	N 66^{0} 19’46.4”	57	
G5	A2	W 168^{0} 33’55.7”	N 65^{0} 46’53.6”	54	
G6	BS5	W 169^{0} 20’55.1”	N 65^{0} 54’33.9”	48	
G7	BS9	W 169^{0} 04’07.7”	N 65^{0} 50’26.2”	47	
G8	BS13	W 168^{0} 46’59.3”	N 65^{0} 46’30.6”	57	
G9	BS18	W 168^{0} 27’14.3”	N 65^{0} 41’42.5”	53	28.08.09, 00.01
G10	BS24	W 168^{0} 07’11.2”	N 65^{0} 35’01.4”	38	29.08.09, 06.03
G11	AL1	W 169^{0} 34’50.8”	N 66^{0} 07’33.2”	38	29.08.09, 11.56
G12	AL4	W 169^{0} 23’27.2”	N 66^{0} 11’05.2”	42	29.08.09, 13.53
G13	AL5	W 169^{0} 21’11.3”	N 66^{0} 11’57.8”	57	29.08.09, 14.28
G14	AL9	W 169^{0} 07’53.4”	N 66^{0} 16’12.5”	54	29.08.09, 17.11
G15	AL15	W 168^{0} 44’38.1”	N 66^{0} 21’51.4”	50	29.08.09, 21.17

NN	Station	Coordinates		Depth, m	Date and time (ship)
		Longitude	Latitude		
G 16	AL18	W 168^0 31’59.4”	N 66^0 23’54.2”	55	29.08.09, 23.35
G 17	AL21	W 168^0 18’56.3”	N 66^0 26’02.6”	49	30.08.09, 01.50
G 18	AL24	W 168^0 06’25.6”	N 66^0 28’12.2”	29	30.08.09, 03.49
G 19		W 168^0 00’09.4”	N 66^0 23’24.3”	26	30.08.09, 04.46
G 20		W 168^0 01’38.7”	N 66^0 16’33.1”	34	30.08.09, 05.47
G 21		W 168^0 02’59.2”	N 66^0 07’51.6”	42	30.08.09, 07.11
G 22		W 168^0 06’16.4”	N 65^0 57’36.8”	47	30.08.09, 09.24
G 23		W 168^0 12’17.0”	N 65^0 48’03.9”	45	30.08.09, 11.32
Leg 2 the RUSALCA cruise aboard RV “Professor Khromov” 2009					
G 24	CS8	W 169^0 34’24.1”	N 67^0 26’27,0”	47	04.09.09, 10.54
G 25		W 174^0 09’04.0”	N 68^0 24’02.1”	49	05.09.09, 12.45
G 26	CEN5	W 174^0 51’47.0”	N 69^0 41’36,5”	56	06.09.09, 01.40
G 27	CEN3	W 176^0 40’24.8”	N 70^0 17’15.3”	56	06.09.09, 14.52
G 28	CEN1	W 178^0 33’37.1”	N 70^0 47’56.5”		07.09.09, 02.30
G 29		E 178^0 37’33.5”	N 70^0 37’38.2”	43	07.09.09, 12.10
G 30	LongS4	E 178^0 32’00.5”	N 70^0 31’31.8”		07.09.09, 13.56
G 31	LongS3	E 178^0 18’46.5”	N 70^0 19’40.8”	49	07.09.09, 17.21

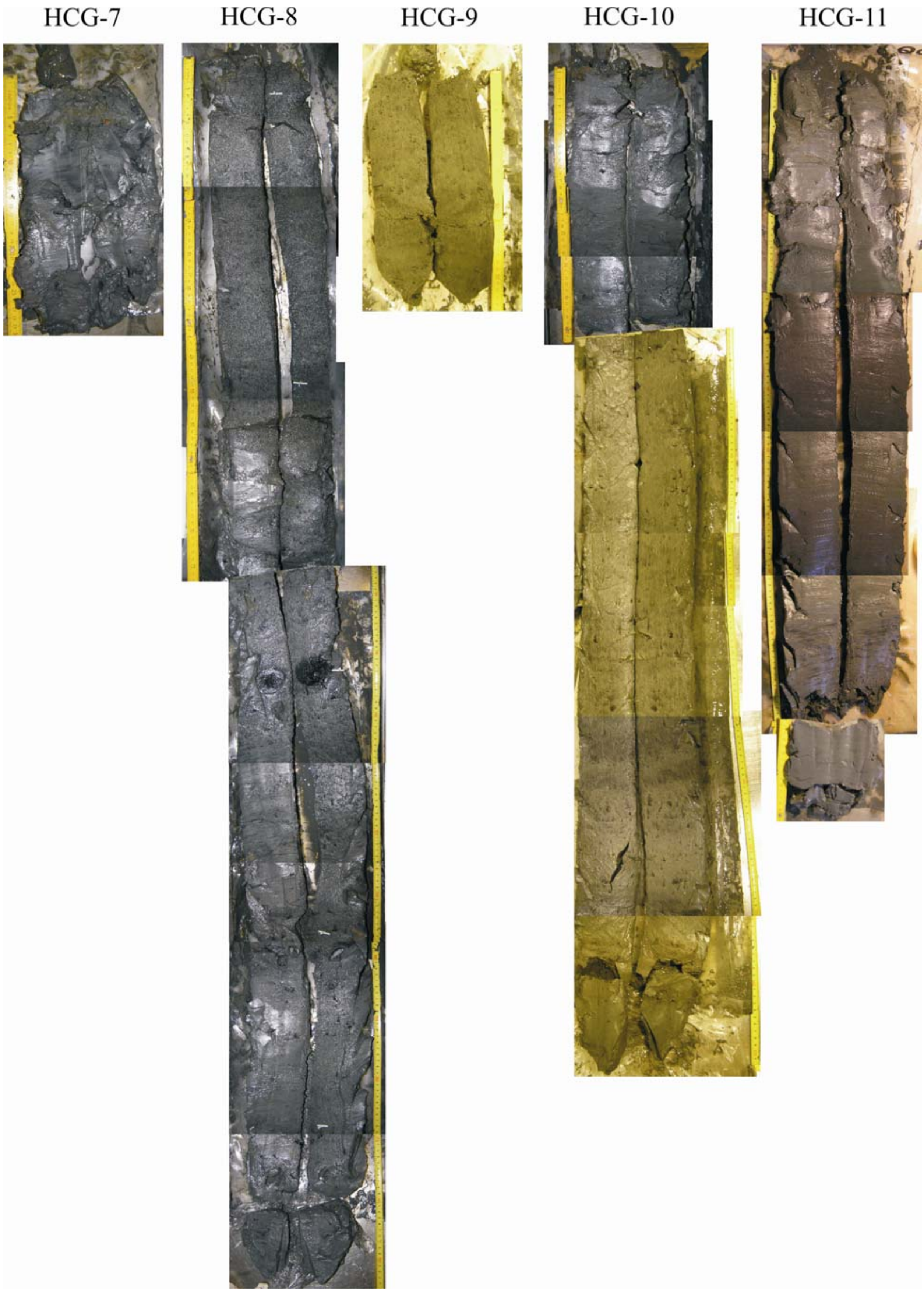
NN	Station	Coordinates		Depth, m	Date and time (ship)
		Longitude	Latitude		
G32	LongS2	E 178^0 11’53.3”	N 70^0 06’51.5”	49	08.09.09, 02.22
G33	LongS1	E 177^0 59’40.8”	N 69^0 49’29.5”	45	08.09.09, 05.27
G34	SS5	E 172^0 32’30.7”	N 71^0 19’58.7”	45	09.09.09, 03.39
G35	SS4	E 173^0 00’20.4”	N 71^0 51’25.8”	42	09.09.09, 13.28
G36	SS3	E 174^0 00’41.3”	N 72^0 25’47.0”	45	09.09.09, 22.50
G37	WN3	E 177^0 41’18.2”	N 72^0 40’03.8”	75	10.09.09, 14.28
G38	WN2	E 178^0 32’48.6”	N 72^0 20’46.3”	49	11.09.09, 00.08
G39		E 178^0 48’57.4”	N 72^0 07’10.4”		11.09.09, 04.28
G40	WN1	E 179^0 30’14.6”	N 71^0 39’44.9”	30	11.09.09, 10.30
G41	GG07	W 175^0 57’57.1”	N 72^0 13’55.3”	99	12.09.09, 22.05
G42	GG07	W 175^0 57’40.1”	N 72^0 16’35.3”	98	12.09.09, 22.57
G43	GG07	W 175^0 56’31.0”	N 72^0 17’32.8”	98	12.09.09, 23.44
G44	HC49	W 175^0 34’21.6”	N 73^0 20’40.2”	149	13.09.09, 14.44
G45	HC52	W 174^0 26’18.9”	N 73^0 16’38.7”		14.09.09, 01.28
G46	HC46	W 176^0 40’02.6”	N 73^0 08’19.5”	124	15.09.09, 03.59
G47	HC41	W 178^0 04’40.5”	N 72^0 36’41.2”	64	15.09.09, 12.16
G	HC40	W 176^0	N 72^0	68	15.09.0

NN		Station	Coordinates: Longitude	Coordinates: Latitude	Depth, m	Date and time (ship)
48			47’31.2”	16’18.4”		9, 16.35
49	G	HC27	W 174^0 58’25.4”	N 72^0 22’26.9”	55	16.09.09, 02.48
50	G		W 174^0 49’48.3”	N 72^0 10’54.7”	51	16.09.09, 04.50
51	G		W 174^0 33’10.4”	N 71^0 57’17.9”	54	16.09.09, 06.47
52	G	HC26	W 174^0 23’39.4”	N 71^0 47’18.1”	52	16.09.09, 08.48
53	G	HC21	W 175^0 02’56.5”	N 71^0 40’55.6”	73	16.09.09, 12.54
54	G	HC15	W 175^0 47’49.1”	N 71^0 33’10.0”	37	16.09.09, 17.27
55	G	HC14	W 175^0 58’06.4”	N 70^0 58’43.9”	55	16.09.09, 21.48
56	G	HC1	W 174^0 02’18.9”	N 70^0 55’35.2”	44	17.09.09, 08.13
57	G	HC60(58B)	W 174^0 47’31.3”	N 71^0 22’08.9”	85	17.09.09, 13.05
58	G	GD1	W 164^0 03’09.6”	N 76^0 39’13.4”	568	20.09.09, 08.17
59	G	GD1	W 164^0 00’04.8”	N 76^0 39’29.2”	582	20.09.09, 09.41
60	G	GD1	W 164^0 02’06.6”	N 76^0 36’49.8”	555	20.09.09, 21.48
61	G	GD6	W 164^0 13’33.3”	N 76^0 31’00.0”	600	20.09.09, 23.44
62	G		W 166^0 25’17.2”	N 77^0 27’39.4”	645	21.09.09, 15.07
63	G		W 167^0 25’36.1”	N 69^0 59’47.4”	50	23.09.09, 21.41
64	G	CL1	W 166^0 56’05.9”	N 68^0 56’22.3”	47	24.09.09, 05.38

NN	Station	Coordinates		Depth, m	Date and time (ship)
		Longitude	Latitude		
G65	CL2	W 167^0 55’01.9”	N 69^0 01’15.6”	50	24.09.09, 13.55
G66	CL3	W 168^0 54’04.5”	N 68^0 59’51.4”	55	24.09.09, 17.24
G67	CL4	W 169^0 36’58.7”	N 68^0 52’05.1”	57	24.09.09, 23.31
G68	CL6A	W 171^0 44’54.6”	N 68^0 19’13.3”	54	25.09.09, 12.50
G69	CL7	W 172^0 03’09.0”	N 68^0 08’51.5”	52	25.09.09, 14.54
G70	CL7A	W 172^0 18’09.8”	N 68^0 00’17.1”	48	25.09.09, 16.24
G71	CL8	W 172^0 33’29.8”	N 67^0 51’29.7”	49	25.09.09, 18.14
G72	CL9	W 173^0 11’36.4”	N 67^0 40’12.8”	51	26.09.09, 00.02
G73	CL9A	W 173^0 24’01.7”	N 67^0 32’35.2”	48	26.09.09, 01.46
G74	CL10	W 173^0 37.9’	N 67^0 23.4732’		
G75	CS1	W 171^0 16’08.7”	N 66^0 49’08.6”	25	26.09.09, 13.03
G76	CS4	W 170^0 58’31.0”	N 66^0 55’22.7”	37	26.09.09, 15.27
G77	CS6	W 170^0 17’28.2”	N 67^0 11’18.8”	50	26.09.09, 20.51
G78	CS10	W 169^0 01’41.8”	N 67^0 37’28.7”	53	27.09.09, 03.43
G79	CS12	W 168^0 19’15.7”	N 67^0 51’53.5”	58	27.09.09, 07.14
G80	CS13	W 167^0 59’55.2”	N 67^0 59’19.3”	57	27.09.09, 12.16
G	CS16	W 167^0	N 68^0	47	27.09.0

NN Station		Coordinates		Depth, m	Date and time (ship)
		Longitude	Latitude		
81		13’03.6”	14’36.6”		9, 15.42
G 82	CS17	W 167^0 02’45.2”	N 68^0 17’18.3”	40	27.09.09, 17.32
G 83		W 166^0 37’04.3”	N 67^0 56’56.7”	58	27.09.09, 22.14
G 84		W 166^0 53’37.0”	N 67^0 30’11.5”	49	28.09.09, 01.23
G 85		W 167^0 20’05.2”	N 67^0 07’22.7”	42	28.09.09, 04.19
G 86		W 167^0 55’38.4”	N 66^0 49’01.9”	33	28.09.09, 07.11

Appendix 4


HCG-7
HCG-8
HCG-9
HCG-10
HCG-11


HCG-12
HCG-13
HCG-14
HCG-15
HCG-16
HCG-17
HCG-18
HCG-19

Sedimentology core description

Station HCG-1

The core length is 50 cm.

0-5 cm - zero level is very conventional, because top was destroyed at injection of the core sampler, the 1-2 cm grey pelite, homogeneous, diluted.

5-40 cm – homogeneous dark green restored pelite with an insignificant siltstone admixture. Soft viscous sediments, condensed with increase in sub bottom depth; interleaved with thin hydrotroilite interlayers up to 1 cm thick. 10, 17 cm - shell fragments up to 0.3 cm. 32-34 and 25 cm - hydrotroilite lenses. 40 cm – debris fragments.

40-50 cm - dense dark grey clay with siltstone and sandy admixture.

Station HCG-2

The core length is 99 cm

0-70 cm - dark grey restored pelite with hydrotroilite interlayers, dense, sticky, viscous.

70-73 cm - siltstone and pelite drowned lens olive in color about 4 cm in diameter.

73-99 cm - dark grey pelite with silddstone admixture and thin hydrotroilite interlayers. Sediments are homogeneous sticky viscous condensed to catch corer. 96-99 cm - pebbles 2см in the size.

Station HCG-3

The core length is 130 cm

0-5 cm - the zero level is very conventional, because top was destroyed at injection of the sampler, brown-grey pelite, diluted.

5-30 cm - pelite dark grey in color with hydrotroilite interlayers, sticky viscous. 11-14 cm – a hydrotroilite lens3 cm in diameter.

30-40 cm - a slanting interlayer of pelite with the high hydrotroilite content, diluted.

40-74 cm – grayish brown condensed viscous homogeneous pelite with hydrotroilite interliyers.

74-102 cm - grey pelite dense condensed with inclusions, lenses (up to 1 cm in diameter) and interlayers (up to 3 mm) of beige pelite.

102-109 cm - grey dense homogeneous pelite with hydrotroilite interlayer's.

109-130 cm - condensed massive pelite with a slanting hydrotroilite interlayer (up to 2 cm).

Station HCG-4

The core length is 103 cm

0-3 cm - zero level is very conventional, because top was destroyed at injection of the sampler, silty clay with siltstone admixture, diluted.

3-103 cm - grey dense massive pelite with in regular distributed hydrotoilite interlayer's (up to 2 mm).

Station HCG-5

The core length is 202 cm

0-202 cm - dark grey homogeneous condensed pelite. Hydrotrolilte interlayer's on all length of a column. 55-60 cm – high hydrotrilite content. 87-90 cm – lenses with high hydrotroilite content. 103, 143 cm - lenses of olive pelite, diluted with siltstone admixture. 162-166 cm – hydrotroilite interlayers. 170-202 cm - condensed pelite hydrotroilite free.

Station HCG-6

The core length is 26.5 cm

0-3 cm – zero level is very conventional, because top was destroyed at injection of the sampler, silty clay, diluted.

3-26.5 cm - homogeneous condensed dark grey pelite. Hydrotroilite interlayers are traced on all length of a column. 12 cm - lenses of olive pelite, diluted, with a sandy admixture. Debris fragments different in size and rounded in catch corer.

Station HCG-7

The core length is 30 cm

0-2 cm - Zero level is very conventional, because top was destroyed at injection of the sampler, greenish grey silty clay with high sandy admixture, diluted.

2-30 cm - darkly grey sticky viscous pelite with hydrotroilite interlayers (1-2 mm). 2-6 cm - a course of a worm in oxidized olive peliteовом a deposit and a worm. 16 cm - a worm hole (0,5 cm) enriched in hydrotroilite.

Station HCG-8

The core length is 193 cm

0-2 cm - zero level is very conventional, because top was destroyed at injection of the sampler, olive silty clay with worm (up to 20 cm long) hole, diluted.

2-193 cm - darkly grey condensed pelite with thin hydrotroilite interlayers. 77-80 cm - diluted lens filled in olive pelite (courses of worms). 93 cm – hydrotroilite geode about 5 cm in diameter. 134-140 cm - debris fragments different in size and rounded in catch corer.

Station HCG-9

The core length is 33 cm

0-2 cm - zero level is very conventional, because top was destroyed at injection of the sampler, olive pelite, diluted.

2-33 cm - darkly grey condensed pelite with thin hydrotroilite interlayers. 21-22.5 cm - diluted layer with high sand admixture.

Station HCG-10

The core length is 149 cm

0-2 cm - zero level is very conventional, because top was destroyed at injection of the sampler, olive silty clay, diluted with worm holes.

2-149 cm - darkly grey condensed pelite with thin hydrotroilite interlayers and inclusions. Up to 20 cm of sub bottom depth holes of worms in olive diluted pelite and alive worm. 44, 53, 79, 110, 125 cm – sell debris. 134-142 cm - condensed pelite brown in color. In catch corer condensed grey pelite with debris varied in size and rounded.

Station HCG-11

The core length is 119 cm

0-2 cm - zero level is very conventional, because top was destroyed at injection of the sampler, grey silty clay, diluted.

2-119 cm - darkly grey viscous sticky pelite. Up to 20 cm of sub bottom depth holes of worms in olive diluted pelite and alive worms. 90-100 cm - thin hydrotroilite interlayers and inclusions. 53 cm – sell debris.

Station HCG-12

The core length is 179 cm

0-10 cm – brown oxidized (Fe, Mn?) condensed dense viscous pelite with detrital rocks different rounded up to 1.5 cm in diameter.

10-18 cm - light brown beige condensed viscous pelite.

18-27 cm - condensed viscous light brown siltstone interleaved with grey siltstone with the same characteristics.

27-30 cm - condensed viscous grey siltstone.

30-35 cm - condensed viscous light brown siltstone.

Border between layers is sharp.

35-39 cm - friable brecciated diluted dark grey pelite with fragments of loams up to 0.3 cm in diameter.

39-42 cm - friable brecciated diluted beige pelite with fragments of loams up to 0.5 cm in diameter.

42-45 cm - friable brecciated condensed darkly brown pelite with fragments of loams up to 0.1 cm in diameter.

Border between layers is clear.

45-85 cm - sticky viscous grey, on sub bottom depth over 65-75 cm, passing in beige pelite. Border between layers not clear, layers smoothly pass one in another.

85-108 cm - condensed sticky siltstone with sandy admixture, from beige up to dark brown in color (result of oxidation (?)).Fragmental debris gravel dimension.

108 166 cm - light brown beige viscous sticky pelite, with hydrotroilite interlayers.

166-179 cm - grey viscous sticky pelite.

2, 38, 87 cm - fragmental debris various in size and rounded.

Station HCG-13

The core length is 147 cm

0-13 cm - zero level is very conventional, because top was destroyed at injection of the sampler, degraded. Brown in color, the oxidations caused by process (Fe, Mn?) condensed silty clay.

13-22 cm - light brown beige condensed viscous pelite.

22-33 cm - condensed viscous light brown siltstone interstratifyed with grey siltstone, with the same characteristics.

33-37 cm - friable brecciated diluted dark grey pelite with fragments of loams up to 0.3 cm in diameter.

37-62 cm - sticky viscous grey, on sub bottom interval 65-75 cm, the transitive zone described interstratifyed pelite grey and beige in colors and forming beige pelite layer. Border between layers not precise.

62-73 cm - condensed sticky siltstone with a sandy admixture, from beige up to dark brown in color (result of oxidation (?)). Fragmental debris various in size and rounded. 63 cm - a pebble 6 cm in size.

73-77 cm - condensed viscous siltstone with a sandy admixture and fragments 0.3 cm in size.

77-123 cm - light brown beige viscous sticky pelite with hydrotroilite interlayers. 120 cm - orange pelite layer.

123-147 cm - grey viscous sticky pelite.

Station HCG-14

The core length is 200 cm

0-10 cm - zero level is very conventional, because top was destroyed at injection of the sampler, degraded. Brown (oxidized Fe, Mn?) condensed silty clay.

10-14 cm – interstratified dark brown and grey viscous sticky pelite.

14-28 cm - olive sticky viscous pelite.

28-45 cm - grey with interlayers of olive and brown condensed massive pelite.

Precise border between the layers, presented by the brown oxidized interlayers.

45-49 cm - brown oxidized passing to more light brown dense massive pelite.

49-74 cm - friable brecciated diluted dark grey pelite with fragments of loams up to 0.6 cm in diameter. 54-55 cm – light-grey interlayer of the same structure.

Border between layers is clear.

74-152 cm - sticky viscous grey pelite, on sub bottom interval 127-139 cm the transitive zone between pelite layers grey and beige in color. 139-152 cm - Beige dense pelite with brown and seldom grey pelite interlayers. Border between layers not precise.

152-153 cm - pelite with thigh content of fragmental debris 3-5 cm in size.

153-169 cm - condensed sticky siltstone with a sandy admixture from beige up to dark brown in color (oxidized (?)).Fragmental debris various in size and rounded.

169-192 cm - dense viscous beige siltstone with grey and darkly brown interlayers.

192-200 cm – interstratified siltstone layers dark brown, beige and grey in color dense viscous with sandy admixture, 0.2-0.6 cm thick.

Station HCG-15

The core length is 86 cm

0-4 cm - surface and first centimeters of sub bottom depth are broken because of the core operation, degraded. Brown (oxidized Fe, Mn?) condensed silty clay.

4-15 cm - olive sticky viscous pelite interstratified in the top of interval with dark brown pelite with the same characteristics.

15-30 cm - condensed massive grey with light brown siltstone interlayers with a sandy admixture.

30-86 cm - friable brecciated diluted in an interval of 30-33 cm, dark grey pelite with fragments of loams up to 1 cm in diameter. 71-74 cm - dense sticky light grey pelite lens.

Station HCG-16

The core length is 180 cm

0-16 cm - the first centimeters of sediments are broken because of core operation, degraded. Brown (oxidized Fe, Mn?) condensed silty clay interstratify and passes in grey dense viscous pelite.

16-25 cm - brown dense massive siltstone with the high content of debris material various in round and dimension.

25-44 cm - sticky viscous grey pelite, on sub bottom interval 36-39 cm the transitive zone between grey and beige in colors pelite layers. 42-44 cm - Beige dense pelite. Border between layers not precise.

44-48 cm - condensed sticky dark brown (oxidized ?) siltstone with sandy admixture and loams.

48-138 cm - sticky viscous grey, light brown and beige interstratified pelite, thickness of interlayers up to 1 mm.

138-148 cm - condensed sticky siltstone from beige up to dark brown (oxidized ?) in color, interstratified.

148-155 cm - condensed massive siltstone light-beige - white color. Fragments of clay particles.

155-164 cm - condensed massive beige, light brown siltstone. With fragments of clay particles.

164-168 cm - condensed massive siltstone from light-beige up to white color. Fragments of clay particles are noted.

168-180 cm - sticky viscous grey pelite.

Station HCG-17

The core length 262 cm

0-11 cm – brown (oxidized Fe, Mn?) silty clay. 3-5 cm - soft viscous grey pelite lens.

11-19 cm - viscous sticky olive pelite-siltstone adjournment.

19-31 cm - condensed viscous light grey siltstone with debris inclusions up to 1 cm in size. 28-29 cm – brecciated dark grey clay with debris inclusions and loams lens.

31-33 cm - condensed viscous light-beige up to white siltstone.

33-36 cm - condensed viscous light grey siltstone.

36-150 cm - sticky viscous pelite interstratified layers of various color - dark brown (oxidized), beige and grey. Thickness of interlayers up to 1mm. 54-56 cm - dense dark brown siltstone lens. 92-94, 101-103 cm - dense siltstonea brown lenses. 104-114 cm - vertical dark brown lens. 150 cm - dark brown pelite lens.

150-152 cm - beige, up to white color slanting layer consist of condensed massive pelite with sandy admixture.

152-164 cm - condensed sticky olive pelite. 155, 159-161 cm - dark brown condensed sticky pelite lenses.

164-210 cm - sticky viscous grey pelite. 200, 203 cm - condensed beige color siltstone interlayers with sandy admixture.

210-214 cm - condensed massive light brown siltstone.

214-222 cm - condensed massive beige-grey siltstone. 222 cm - light-beige pelite thin interlayes.

222-230 cm - condensed sticky siltstone from beige up to dark brown (oxidized) in color, interstratified.

230-262 cm - condensed viscous beige siltstone.

Station HCG-18

The core length is 140 cm

0-10 cm - diluted brown (oxidized Fe, Mn?) condensed silty clay with siltstone damixture.

10-33 cm - condensed sticky viscous light grey with olive pelite. 23, 25, 28, 30 cm - brown siltstone with a sandy admixture.

33-35 cm - friable brecciated diluted dark grey pelite with fragments of loams up to 0.3 cm in diameter.

35-42 cm - the dim interval - sand with debris different in size and rounded.

42-52 cm - sticky viscous olive-grey pelite.

52-63 cm - sticky viscous beige-grey pelite. A pebble 5 cm in diameter.

63-65 cm - condensed massive viscous beige-grey pelite.

65-85 cm - condensed massive viscous dark brown, beige siltstone.

85-140 cm - condensed massive viscous olive-grey pelite with thin hydrotroilite and rare brown interlayers (83, 93 cm).

Station HCG-19

The core length is 20 cm

0-10 cm - diluted brown, (oxidized Fe, Mn?) condensed silty clay.

10-20 cm - condensed viscous sticky olive-grey pelite with hydrotroilite interlayers (1-2 mm).

2009 RUSALCA Cruise Report

September 30, 2009

Christine Patrick

Public Affairs Specialist, NOAA's Office of Ocean Exploration and Research

The goal of my participation on the 2009 RUSALCA expedition was to help chronicle and publicize the RUSALCA project. I planned to feed the NOAA Ocean Explorer website (oceanexplorer.noaa.gov), which is the official website of NOAA's Office of Ocean Exploration and Research, which funded RUSALCA in part. This website receives roughly 6 million individual visitors each year (see more background information below).

In the first few days of the mission, I met with Kevin Wood, Gus Anning, Terry Whitledge, Vladimir Bakhmutov and Aleksey Ostrovskiy to discuss how we would proceed with press interactions if we had a reason to issue a press release about something (for instance, a scientific discovery) that occurred aboard. I spoke with leaders of the science teams to gauge the likelihood of this. During our meeting, we agreed we would meet again and discuss the path forward, keeping in mind that we would like to create equal access for both American and Russian media outlets to cover the news, in the event there was news. We did not have a second meeting, as one was not called for. I did, however, prepare notes and photos for Kevin Wood to use in his correspondence with Reuters reporter Jeffrey Jones about halfway through the second leg of the mission.

During the 28-day mission, I wrote five logs from sea, which were read and approved by the Chief Scientist Terry Whitledge and the Chief of Expedition Vladimir Bakhmutov, before they were emailed to colleagues at NOAA. I also facilitated seven science teams or individuals writing logs about their research or roles. The logs were:

Sent on	Title	Author
9/8	The Things They Hauled	Christine Patrick
9/8	The Motion of the Ocean and Its Discontents	Christine Patrick
9/8	Power of Interpreter	Aleksey Ostrovskiy
9/10	Where's the ice?	Christine Patrick
9/13	Beyond Operator Error	Christine Patrick
9/16	Standing Watch	Sue Moore
9/17	Heading North	Christine Patrick
9/23	Awaiting the Beam Trawl's Surprises	Sarah Mincks Hardy

9/24	Examining CO2 Changes in the Arctic	Marlene Jeffries
9/27	Arctic Drifters	Russ Hopcroft
9/27	Phytoplankton Productivity in the Chukchi Sea	Sang Lee
9/28	Where is This Water From, and Where Is It Going?	Daniel Torres

I am expecting two more logs: one from the fish team headed by Brenda Holladay, and one from the benthic processes team headed by Jackie Grebmeier. The two teams not represented – Geology and Geophysics, and Methane and Microbiology, have both agreed that I may use their cruise reports to fashion a log (with their approval before it is final).

All the logs and photos can be found at www.oceanexplorer.noaa.gov/explorations/09arctic. This page also links to logs written by Betty Carvellas, articles written by Reuters reporter Jeffrey Jones, and previous NOAA web content maintained by Program Director Kathy Crane, including an electronic version of the Memorandum of Understanding between NOAA and RAS.

Each time I sent a log, whether written by myself or others, I also emailed the latitude and longitudes we visited since my last email. This allowed the NOAA webmaster to create an online map of our path. That is also available at the above website.

With each email I also included one photo, under 300KB in size. Once shoreside, I will furnish higher-resolution photos for the website. All photos on the website are in the public domain, meaning they can be used and published by anyone, including news media, without requesting permission or paying for them. The only request for public domain images is that the proper credit line be given. For this mission, the credit line is: 2009 RUSALCA expedition, RAS-NOAA.

Additionally, I spent most of my time onboard capturing still and video imagery of scientific operations, and making audio recordings explaining these techniques. Since the email system did not allow me to send large files, as mentioned above, the high-resolution still images, videos, and audio recordings will be turned over to the NOAA webmaster during the first week of October. My equipment was as follows: a Macintosh PowerBook G4 laptop, with iPhoto and Photoshop software; a Nikon D70 digital SLR camera; a Panasonic Digital Video Camcorder, model PV-GS250; a Flipvideo High-definition video camera and still image camera; and an Olympus Digital Voice Recorder, model WS-311M. All this equipment belongs to NOAA and is for official use.

My final task onboard was to collect images from others on a voluntary basis, and create an image highlights CD. I customized and copied these for everyone aboard who expressed interest. There are 260 highlight images (about 550KB total), out of approximately 1500 photos taken.

Below is text I prepared and posted on the main bulletin board about the NOAA Ocean Explorer website:

LOGS FROM SEA: BACKGROUND

- Ocean Explorer is one of NOAA's most popular websites: it has won awards for the best government website of the year and is often looked at as an example for educational government websites. It has over 5,000 pages of content and receives 6 million unique visitors a year. It has a Twitter feed and a presence on YouTube.
- The web coverage tells the story of the mission. It is an opportunity to tell readers about what occurred during the mission: achievements, highs, and lows. Logs are available 24/7, 365 days a year to anyone around the world with an Internet connection.
- Logs are meant to be written by those closest to the story, while the mission is ongoing (whether or not they are posted while the mission is ongoing). Logs are meant to focus on the events and activities, rather than the programs.
- There are two primary types of logs: planned logs and logs of opportunity. Planned logs explain aspects of science on the mission and frame them in a larger context – so a person in Indiana, for instance, can see why the research is important. Logs of opportunity are written when a discovery or unusual event occurs and likewise puts it in context.
- Logs are meant to be about 500 words in length, but can be a little less or more as needed.
- Logs are written for an interested, generally educated reader, but not an expert: think of explaining the meaning of your work to a sibling or family member
- Logs are accompanied by photos or videos; additional products like an audio or video podcasts are great. This could be an overlay of voice on a video clip or a still-image slideshow, or could be an interview. Christine will gather this imagery but is happy to use images others have taken, and suggestions for what images would work best with a log are much appreciated. All imagery that goes on Ocean Explorer is in the public domain, meaning that anyone can use the imagery in a newspaper or a publication or on their website. We ask that proper credit be given when the imagery is used. Credits for all of these will be, if all agree to it: *Courtesy of 2009 RUSALCA expedition, RAS-NOAA.*

WRITING A LOG FROM SEA:

- Describe what you do, how you do it, and why (larger context)
- When describing how you do it, discuss what your gear is, how it is deployed, and how you analyze the findings
- What about this mission or your research is a "first"?
- What makes the research area unique?
- What is known about your subject from this research area?
- What challenges do you face in conducting this mission (i.e. gear issues, weather – avoid politically sensitive answers)
- Write one mission fact when you are finished with your log – a one-sentence fact about the mission, research topic, area of study, or featured technology. Example: Did you know that chemosynthetic ecosystems, based on chemicals rather than the sunlight as an energy source, were discovered around hydrothermal vents in 1977?