North Pacific Research Board

National Science Foundation

Cruise Report - USCGC Polar Sea

7 March-7 April 2010 - Bering Sea

Report Editor:

Lee W. Cooper, Chesapeake Biological Laboratory, University of Maryland Center for Environmental Sciences, PO Box 38, Solomons, MD 20688, USA **T** +1 410.326.7359 **E** cooper@umces.edu **URL** http://arctic.cbl.umces.edu

Cover Photos of USCGC Polar Sea and flying spectacled eiders by Matt Sexson, US Geological Survey and University of Alaska Fairbanks

Science Team, Marine Science Technicians, Deck Force, and Science/ Operations Officers, Polar Sea 10-01

Photo courtesy of Steve Shelton http://www.stevesheltonimages.com

Editor's Note:

- **All data and summaries provided herein are subject to revision or correction and should be treated as unpublished data with intellectual property reserved to the scientist contributing to the report.**
  - **Please contact the individuals listed as having responsibility for each report section for additional information or Lee Cooper.**
  - **Report edited April 2010, Kodiak, Alaska and Solomons, Maryland.**

Acknowledgements

We thank the US Coast Guard crew, officers and commanding officer onboard Polar Sea for well-executed hard work and flexibility under cold and often difficult conditions. We wish to specifically thank the entire Marine Science Technician team, and the Marine Science Officer, Lt. Chris Verlinden who assisted us aboard the ship during the research operations. Maritime Helicopters (Bill Springer and Al Hall), and the Aviation Management Directorate of the Department of the Interior (Doug Kraus) also contributed significantly to completing successfully the science mission objectives. The Earth Observations Laboratory of the University Corporation provided very effective geographical information (mapserver) system support that was critical in planning shipboard sampling and we also had excellent IT support from Mike Merchant. Finally, the Scripps Institution of Oceanography team onboard (Scott HIller and Ben Gire) provided excellent support for operation and data collection from the ship's CTD system.

We also thank the Native Village of Savoonga and the Native Village of Gambell for their cooperation and assistance while the ship was operating in the vicinity of Saint Lawrence Island and for facilitating two personnel transfers by helicopter from ship to shore.

Financial support for the research was provided primarily by the US National Science Foundation and the North Pacific Research Board as part of their coordinated Bering Sea Research Program.

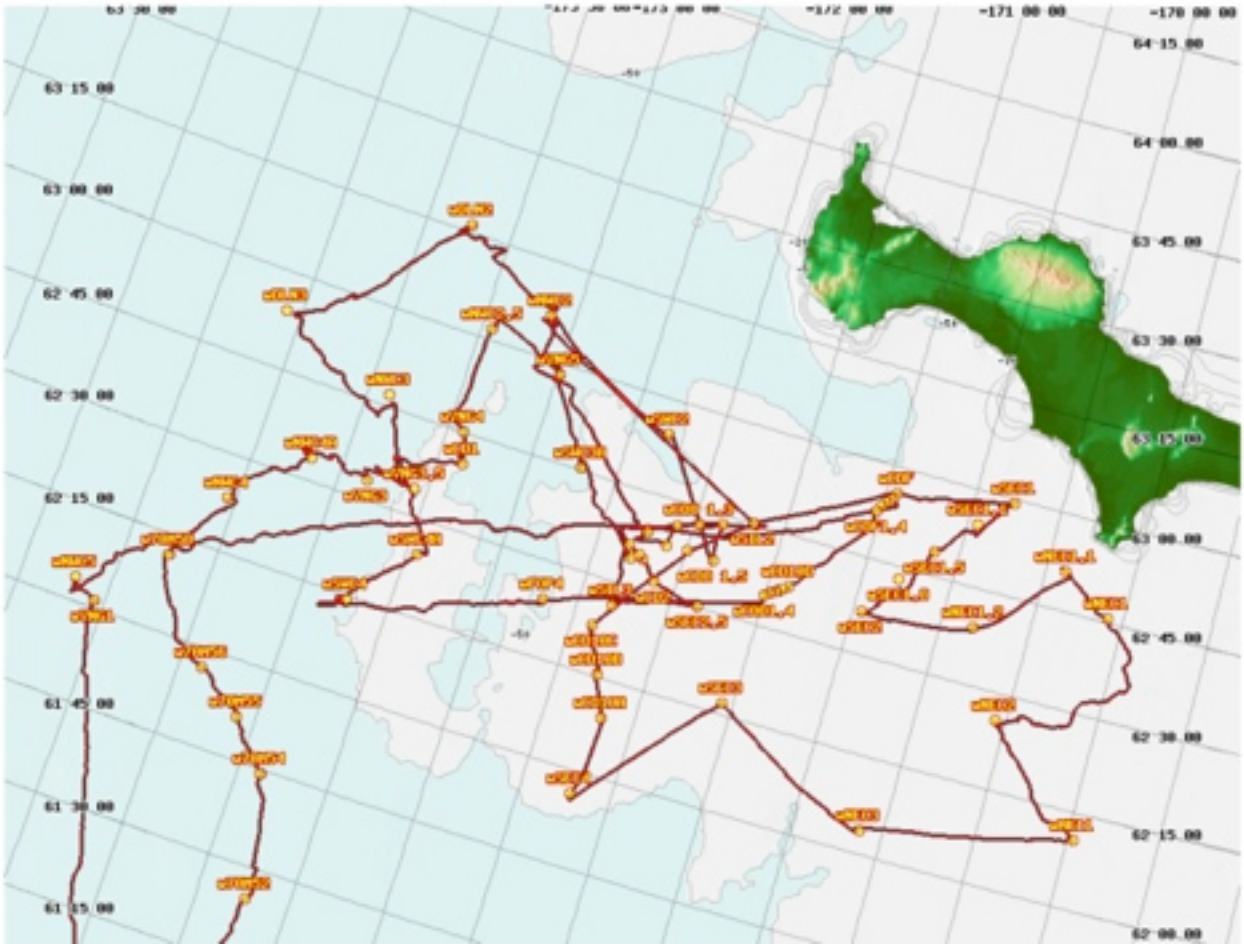
Summary

USCGC Polar Sea Cruise 10-01: March 7-April 7, 2010

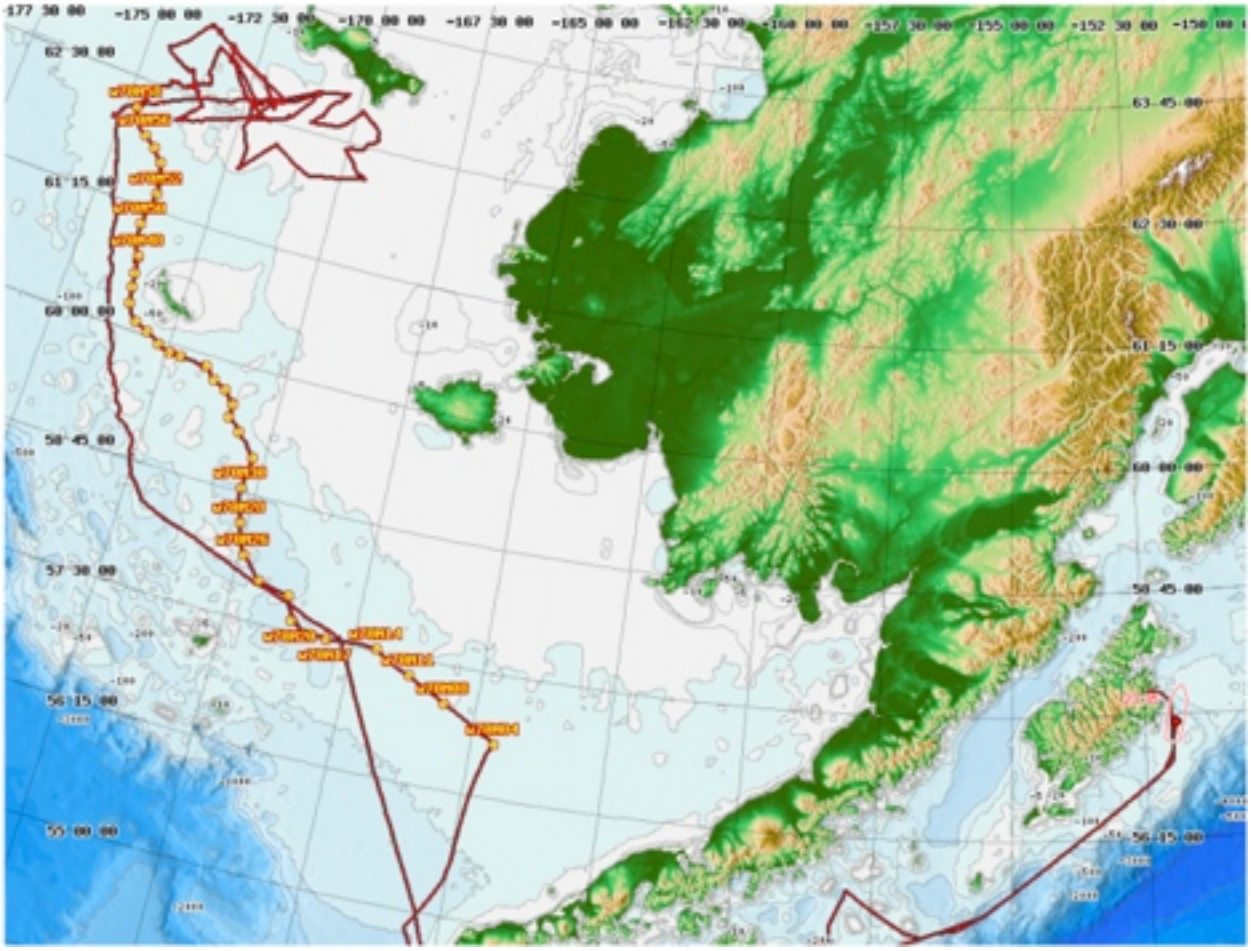
Polar Sea Cruise 10-01 departed Kodiak, Alaska on March 7, 2010 and returned to Kodiak on April 7, 2010. With funding provided by the National Science Foundation (NSF) and additional support from the North Pacific Research Board (NPRB), a major aim of the cruise was to investigate patch dynamics of apex predators in relation to the distribution of food supplies on the sea floor. This was the third of a three-year series of cruises to the northern Bering Sea prior to the spring bloom that is providing new insights on late winter foraging and ecosystem dynamics in a biologically rich sub-polar setting. The research effort was jointly coordinated by the Bering Sea Integrated Ecosystem Research Program (BSIERP) and the Bering Sea Ecosystem Study (BEST), with support from the NPRB and the NSF, respectively. Research programs accommodated included studies of benthic macrofaunal populations and sediment metabolism, sea ice biology, mesozooplankton grazing and diet composition using molecular approaches, the late winter distribution of the world population of spectacled eiders in relation to sea ice and food supplies, surveys of marine birds and mammals while the ship was transiting, nitrogen cycling in ice, water and sediments, and a hydrographic survey of the water column over a large area of the Bering Sea. Use of a helicopter onboard the ship extended science operations to include sea ice collections, and bird and mammals surveys distant from the ship.

In part because of the relatively small science team that could be accommodated, public outreach efforts about the research activities were more limited than what was achieved during cruises in March 2008 and March 2009. However, a print journalist, Ms. Sandy Doughton, and a professional photographer, Mr. Steve Shelton were aboard the ship for about a week while it operated near St. Lawrence Island, and several scientists onboard communicated activities onboard using new internet-based media forms such as Twitter and blogs. One ship-based blog on research activities was featured by the NPRB on their Bering Sea research webpage. Outreach prior to the cruise also resulted in short pieces picked up by the Associated Press and several media outlets in Seattle, as the ship left port, and a front page article on the ship's visit to Kodiak was also published in the Kodiak Daily Mirror that outlined the scientific research program the ship was supporting. Com-

munication efforts were also made with the two Saint Lawrence Island Yupik communities, the Native Village of Gambell and the Native Village of Savoonga, to advise local stakeholders about the position and route of the ship, as well as wildlife and ice conditions observed. The latest satellite imagery of ice conditions was also provided to both communities electronically from the ship. These efforts followed face-to-face meetings Lee Cooper and Jackie Grebmeier had in both villages in January 2010 with support from NPRB to communicate prior research results and to listen to potential concerns about ship sampling impacts on subsistence hunting. Finally a satellite conference call was placed to an arctic climate change course being taught by Dr. Karen Frey of Clark University on March 25 with presentation of preliminary results by several of the lead researchers on the ship.



Core sampling area. Map courtesy of shipboard map server provided by the UCAR team onboard.



Map of cruise track including 70 m isobath stations

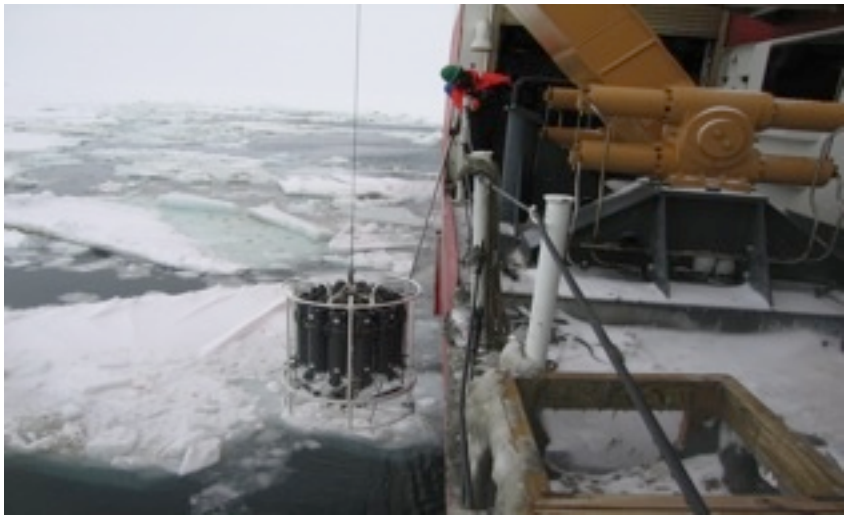
Science Team

Name	Institution	Role on Ship	email address
Lee Cooper	University of Maryland Center for Environmental Science	Chief Scientist, benthos, chlorophyll, $\partial^{18}O$ of seawater	cooper@umces.edu
Jackie Grebmeier	University of Maryland Center for Environmental Science	Co-Chief Scientist, lead benthic studies	jgrebmei@umces.edu
Marisa Guarinello	University of Maryland Center for Environmental Science	benthos, data complilations and coordination	guarinel@cbl.umces.edu
Linton Beaven	University of Maryland Center for Environmental Science	benthic biology	beaven@cbl.umces.edu
Regan Simpson	University of Maryland Center for Environmental Science	benthic biology	simpson@cbl.umces.edu
Steve Fenske	University of Maryland Center for Environmental Science	benthic biology	steven_fenske@yahoo.com
Matt Sexson	US Geological Survey, University of Alaska Fairbanks	benthic biology, spectacled eider telemetry, surveys	msexson@usgs.gov
Jim Lovvorn	Southern Illinois University	spectacled eider surveys, small-scale benthic food surveys	lovvorn@siu.edu
Dawn Sechler	Southern Illinois University	spectacled eider surveys, benthic biology	dsechler@siu.edu
Rolf Gradinger	University of Alaska Fairbanks	lead, sea ice biology	rgradinger@ims.uaf.edu
Martin Schuster	University of Alaska Fairbanks	sea ice biology	mdschuster@alaska.edu
Jared Weems	University of Alaska Fairbanks	benthic biology	j.weems@sfos.uaf.edu
Kathy Kuletz	US Fish and Wildlife Service	lead, underway seabird and marine mammal surveys	Kathy_Kuletz@fws.gov
Aaron Lang	US Fish and Wildlife Service	underway seabird and marine mammal surveys	birdingak@gmail.com
Scott Hiller	Scripps Institution of Oceanography	Lead, CTD operations	shiller@ucsd.edu
Ben Gire	Scripps Institution of Oceanography	CTD operations	bgire@ucsd.edu
Ted Durbin	University of Rhode Island	Lead, Mesozooplankton	edurbin@gso.uri.edu
Maria Casas	University of Rhode Island	Mesozooplankton	mcasas@gso.uri.edu
Sigrid Salo	NOAA PMEL	Water column chemistry	sigrid.a.salo@noaa.gov
Peter Proctor	NOAA PMEL and University of Washington	Water column chemistry	peter.proctor@noaa.gov
Didier Burloff	Lamont-Doherty Earth Observatory	Nitrogen cycling in ice, water and sediments	burdloff@ldeo.columbia.edu
Mark Bradford	University Corporation for Atmospheric Research	Data catalog	mark@ucar.edu
John Allison	University Corporation for Atmospheric Research	Data catalog	jja@ucar.edu

CTD / MET System
Summary of Support
Scripps Institution of Oceanography
USCGC Polar Sea – PSEA1001
February 25 – April 7, 2010

CTD Data Set overview

85 CTD Casts on 81 stations were completed. Cast depth ranged from 40-80 meters and water samples were taken from each cast. See Table 1 for Station-Cast log



Instrumentation

CTD casts were performed with a rosette system consisting of a 12-place Seabird rosette frame with 30 liter OceanTest bottles and a 24-place SBE-32 carousel. CTD system electronic components consisted of:

- CTD, Seabird 911plus, dual conductivity and temperature sensors
- Carousel, Seabird 24 position latch assembly
- Oxygen sensor, Seabird SBE-43
- Transmissometer, Wetlabs 25cm 660nm wavelength
- Fluorometer, Chelsea Aquatrack III
- PAR sensor, Bioshperical QSP-2300
- Altimeter, Benthos PSA-916 100 meter
- Surface PAR sensor, Biospherical QSP-2200
- CTD deck unit, SBE-11 version II
- SIO CTD computer, 2U rack mount, 9 serial ports, 1 GPIB port

The CTD utilized redundant temperature and conductivity sensors with a SBE-43 dissolved oxygen sensor plumbed to the primary temperature and conductivity sensors. The PAR sensor was located on top of the rosette and a Surface PAR sensor was located on top of the Flying Bridge (fwd stbd side). The Surface PAR sensor fed data to the SBE-11 CTD Deck unit, as well as the MET computer. Surface PAR data was logged continuously for the cruise.

The CTD package also provided fluorometric signals (chlorophyll-a) and light transmissivity data from the fluorometer and transmissometer. A 100 meter altimeter was mounted on the rosette frame giving the CTD console operator an indication of how far off the bottom the rosette was during a cast.

The niskin bottles on the rosette were OceanTest 30 liter bottles. The bottles were equipped with internal nylon coated springs and silicone o-rings. Bottle numbering was 1-12 with bottle no.1 tripped first at the deepest part of the cast and bottle no.12 tripped at the surface. The rosette frame was suspended from a standard UNOLS 3 conductor 0.322 electromechanical cable. The .322 winch utilized a set of IEC 4-conductor slip rings for data telemetry through the winch.

Procedures

There were very few problems encountered during the cruise with the CTD/Rosette system. A few bottles developed leaks at glue joints and were repaired immediately with new glue. A few bottle mistrips were noted during the cruise, primarily due to bottles being cocked/prepared wrong prior to a cast. On several occasions freezing water would prevent the pumps and conductivity sensors from operating properly at the beginning of a cast. When this occurred the rosette would be hauled back inside and thawed. Keeping the CTD sensors out of the wind prior to a cast helped in preventing frozen sensors (old mustang suit wrapped around the end of the CTD and pulled off just before lowering the rosette in the water.) Deployment and recovery operations required quick transitions between the Outer Wet Lab (CTD hangar) and on deck. The rosette could not sit on deck for any length of time without causing sensor problems on the CTD. The conductivity/temperature sensors were left dry between casts to prevent frozen water in the plumbing system of the CTD.

The same set of sensors were utilized for the entire cruise with no changes in sensor configuration. Sensor serial numbers used for the CTD system were as follows:

Sensor	Serial number
CTD 911plus	416 (pressure # 57473)
T1, Primary Temperature	2498
T2, Secondary Temperature	4353
C1, Primary Conductivity	2361
C2, Secondary Conductivity	2863
Dissolved Oxygen	501
Fluorometer	088234
Transmissometer	CST-436DR
PAR	70112

Surface PAR	20153
Altimeter	1062
Primary Pump	3679
Secondary Pump	2074

CTD Data Acquisition and Processing

The CTD 911plus was operated generally as suggested in the Sea-Bird CTD Operating and Repair Manual. The Sea-Bird software "Seasave" (version 7.20b) was used to acquire the data and the Sea-Bird software "SBE Data Processing" (version 7.20b) was used to process the raw data upon completion of each cast. A CTD Station Sheet was filled out for each cast (by NOAA PMEL personnel) and a .pdf copy of each Station Sheet can be found with the archived data. Water samples taken from the rosette after the cast were also logged on the CTD Station Sheet. The Seasave acquisition program, as described in the CTD Data Acquisition Software Manual, provided a real-time graphical display of selected parameters adequate to monitor CTD performance and information for the selection of bottle-tripping depths. Raw data from the CTD were archived on the computer's hard disk at the full 24 Hz sampling rate.

Raw CTD data from each cast was copied over the intranet to a science server located in the Dry Lab. Immediately following each CTD cast, the raw data was processed into ASCII files that included bottle trip information and .5 meter depth averaged data. Plots were also produced and saved as .jpg files.

Salinity check samples were taken from the rosette and used to verify the stability of the two conductivity sensors on the CTD. The shipboard salinometer was used to run these samples and produce comparison salinity data for bottle minus ctd conductivity differences. The salinometer on the ship was a Guildline Autosal, model 8400B and was in good condition. The ship also provided standard seawater for salinometer standardization.

The conductivity sensors on the CTD showed a difference on average of 0.010 mS/cm between each other and maintained this stable difference throughout the cruise. The two temperature sensors on the CTD tracked well during the cruise, exhibiting no more than 0.001 difference. After running check samples on the salinometer, the secondary conductivity sensor showed better salinity data over the primary conductivity sensor. The secondary conductivity showed an average of 0.0030 difference between bottle check samples, whereas the primary conductivity sensor differences were much greater. The temperature and conductivity sensors were calibrated by Sea-Bird in February 2010 (just prior to this cruise) and a post-cruise calibration will be preformed on both sets of sensors. This post-cruise calibration data will be available for anyone who needs to back-calculate conductivity offsets for more precise salinity data. As with all other BEST cruises, UCAR will be archiving this CTD data to their catalog website (http://www.eol.ucar.edu).

Table 1

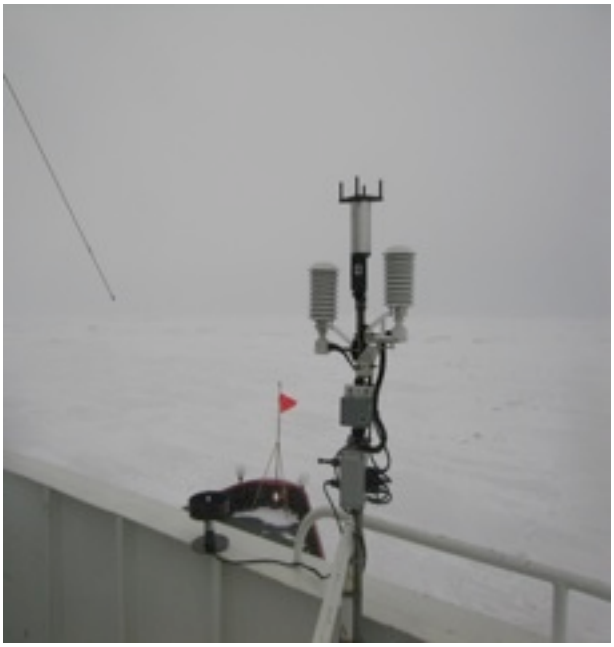
PSEA1001 – CTD Station/Cast Log

Column Headers
1 - Station Name
2 - Station Number
3 - CTD Cast Number
4 - Date
5 - UTC Time
6 - Latitude
7 - Longitude
8 - Max CTD Depth
9 - Knudsen Bottom Depth
10 - CTD Data Beginning Scan Number

VNG1	001	001	Mar 13 2010	14:54:32	62 01.09 N	175 02.99 W	69.500	83	1777
NWC5	002	002	Mar 13 2010	20:36:19	62 03.08 N	175 11.98 W	72.000	84	2425
NWC5	002	003	Mar 13 2010	21:20:07	62 02.82 N	175 11.78 W	73.500	84	3889
NWC4	003	004	Mar 14 2010	22:33:30	62 24.05 N	174 31.64 W	63.000	74	625
NWC4A	004	005	Mar 15 2010	10:52:27	62 33.69 N	174 12.58 W	82.829	73	1873
VNG3	005	006	Mar 15 2010	17:54:53	62 33.29 N	173 50.45 W	60.000	71	1945
VNG35	006	007	Mar 16 2010	02:18:58	62 34.62 N	173 37.42 W	60.500	70	1300
CD1	007	008	Mar 16 2010	14:47:32	62 40.58 N	173 22.00 W	63.159	70	2257
VNG4	008	009	Mar 16 2010	19:43:01	62 45.33 N	173 24.59 W	70.000	78	1537
VNG4	008	010	Mar 16 2010	22:52:22	62 45.70 N	173 26.08 W	61.000	71	500
NWC2.5	009	011	Mar 17 2010	06:55:10	63 01.99 N	173 25.35 W	64.500	75	240
VNG5	010	012	Mar 17 2010	14:58:44	62 58.10 N	172 59.18 W	65.000	70	2617
SWC3A	011	013	Mar 17 2010	21:05:02	62 45.71 N	172 42.59 W	54.000	65	400
POP3A	012	014	Mar 18 2010	02:50:00	62 34.54 N	172 18.57 W	41.500	85	420
SIL3	013	015	Mar 18 2010	06:24:36	62 26.50 N	172 18.73 W	46.000	55	690
SEC2.5	014	016	Mar 18 2010	11:13:37	62 29.77 N	171 51.15 W	43.000	50	2209
CD2	015	017	Mar 18 2010	14:18:49	62 31.88 N	172 07.12 W	42.500	50	1345
CD2	015	018	Mar 18 2010	18:34:04	62 33.61 N	172 10.74 W	44.000	50	529
CD08	016	019	Mar 19 2010	07:34:55	62 39.20 N	172 14.14 W	43.500	56	400
SIL2	017	020	Mar 19 2010	14:33:02	62 45.07 N	171 39.81 W	44.500	50	385
SIL2.5	018	021	Mar 19 2010	18:35:22	62 37.81 N	171 59.20 W	45.000	50	385
CD10C	019	022	Mar 20 2010	00:13:14	62 22.23 N	172 22.99 W	47.000	56	800
CD10B	020	023	Mar 20 2010	05:08:58	62 15.50 N	172 16.92 W	45.500	56	460
CD10A	021	024	Mar 20 2010	08:31:18	62 09.05 N	172 10.68 W	46.500	55	457
SEC4	022	025	Mar 20 2010	12:01:24	61 55.41 N	172 13.06 W	51.000	60	265
SEC3	023	026	Mar 20 2010	19:14:51	62 16.86 N	171 33.77 W	41.500	52	433
NEC3	024	027	Mar 21 2010	06:21:44	62 03.51 N	170 38.99 W	40.500	55	200
MK11	025	028	Mar 21 2010	15:17:18	62 10.69 N	169 27.88 W	34.500	40	217
NEC2	026	029	Mar 21 2010	21:19:18	62 25.71 N	170 03.42 W	30.000	40	720
NEC1	027	030	Mar 22 2010	07:05:16	62 45.52 N	169 35.51 W	33.500	44	1000
NEC1.1	028	031	Mar 22 2010	10:42:12	62 51.16 N	169 53.24 W	39.500	46	889
NEC1.2	029	032	Mar 22 2010	15:06:49	62 38.88 N	170 18.81 W	37.000	45	601
SEC2	030	033	Mar 22 2010	20:30:12	62 36.34 N	170 57.28 W	37.500	47	1400
SEC1.8	031	034	Mar 22 2010	23:43:02	62 41.51 N	170 45.84 W	35.000	46	300
SEC1.5	032	035	Mar 23 2010	02:34:06	62 48.56 N	170 38.76 W	36.000	45	400
SEC1.1	033	036	Mar 23 2010	05:10:25	62 53.23 N	170 25.83 W	35.500	45	600
SEC1	034	037	Mar 23 2010	07:44:12	62 59.58 N	170 16.03 W	33.000	42	450
CDF	035	038	Mar 23 2010	12:38:37	62 56.06 N	170 55.69 W	38.000	46	649
CDF1.4	036	039	Mar 23 2010	15:22:10	62 51.60 N	171 01.80 W	40.000	47	529
CD10D	037	040	Mar 23 2010	22:16:03	62 36.83 N	171 23.12 W	40.000	50	600
POP4	038	041	Mar 24 2010	11:20:36	62 23.95 N	172 41.13 W	52.500	46	601
SWC4	039	042	Mar 24 2010	21:23:39	62 13.53 N	173 46.10 W	55.500	46	360
SWC4	039	043	Mar 24 2010	22:01:17	62 13.43 N	173 46.56 W	55.000	65	260
SWC4A	040	044	Mar 25 2010	14:26:31	62 25.09 N	173 24.68 W	57.000	65	577
NWC3	041	045	Mar 26 2010	01:03:27	62 44.86 N	173 52.25 W	65.500	74	930
DLN3	042	046	Mar 26 2010	10:33:22	62 53.64 N	174 30.89 W	71.500	80	553
DLN2	043	047	Mar 27 2010	00:11:46	63 15.83 N	173 44.10 W	67.000	82	600
CD81.1	044	048	Mar 27 2010	23:57:27	62 37.93 N	172 15.93 W	43.500	55	720
CD81.5	045	049	Mar 28 2010	06:05:31	62 43.15 N	171 50.33 W	43.000	54	180
SWC2	046	050	Mar 28 2010	12:33:11	62 54.50 N	172 16.47 W	51.500	60	649
NWC2	047	051	Mar 28 2010	22:03:18	63 07.84 N	173 07.35 W	60.500	72	500
CDF	048	052	Mar 29 2010	19:13:04	62 55.19 N	170 56.81 W	39.000	46	1009

70M58	049	053	Mar 30 2010	23:17:26	62 11.93 N	174 45.11 W	66.500	79	600
70M56	050	054	Mar 31 2010	05:00:34	61 56.97 N	174 22.29 W	66.000	77	980
70M55	051	055	Mar 31 2010	07:40:05	61 51.59 N	174 06.14 W	65.000	77	300
70M54	052	056	Mar 31 2010	10:18:03	61 44.29 N	173 52.41 W	66.500	77	529
70M52	053	057	Mar 31 2010	14:39:48	61 25.16 N	173 44.04 W	70.000	79	365
70M50	054	058	Mar 31 2010	19:13:57	61 04.44 N	173 50.59 W	73.500	84	529
70M48	055	059	Apr 01 2010	01:43:29	60 44.94 N	173 40.22 W	64.500	76	380
70M47	056	060	Apr 01 2010	07:17:38	60 34.23 N	173 38.00 W	60.000	72	360
70M46	057	061	Apr 01 2010	09:34:51	60 25.71 N	173 35.57 W	60.000	70	745
70M45	058	062	Apr 01 2010	11:41:37	60 15.92 N	173 31.88 W	64.500	73	865
70M44	059	063	Apr 01 2010	15:13:21	60 06.08 N	173 17.79 W	65.500	75	385
70M43	060	064	Apr 01 2010	18:03:08	60 02.53 N	173 00.23 W	62.500	71	145
70M42	061	065	Apr 01 2010	21:10:38	59 57.72 N	172 43.36 W	61.500	73	300
70M41	062	066	Apr 02 2010	00:24:21	59 54.67 N	172 26.14 W	64.500	78	280
70M40	063	067	Apr 02 2010	02:34:18	59 54.26 N	172 12.17 W	64.000	76	260
70M39	064	068	Apr 02 2010	06:29:18	59 53.04 N	171 39.27 W	62.500	76	300
70M38	065	069	Apr 02 2010	09:45:52	59 46.71 N	171 25.65 W	67.500	77	841
70M37	066	070	Apr 02 2010	12:25:27	59 42.55 N	171 08.22 W	66.500	76	553
70M36	067	071	Apr 02 2010	15:14:56	59 35.48 N	170 55.04 W	65.500	75	961
70M35	068	072	Apr 02 2010	17:08:22	59 27.00 N	170 54.92 W	66.500	76	313
70M34	069	073	Apr 02 2010	20:56:58	59 20.11 N	170 38.88 W	60.000	73	400
70M32	070	074	Apr 03 2010	00:28:27	59 06.78 N	170 15.57 W	61.000	70	200
70M30	071	075	Apr 03 2010	04:48:26	58 47.31 N	170 18.04 W	61.500	75	320
70M28	072	076	Apr 03 2010	09:34:12	58 26.91 N	170 09.15 W	67.000	77	337
70M26	073	077	Apr 03 2010	13:43:17	58 08.74 N	169 55.00 W	65.500	77	505
70M24	074	078	Apr 03 2010	18:24:18	57 55.09 N	169 30.72 W	64.000	73	457
70M22	075	079	Apr 03 2010	22:31:47	57 50.85 N	168 53.95 W	64.000	75	200
70M20	076	080	Apr 04 2010	01:33:55	57 36.83 N	168 43.71 W	61.500	74	190
70M17	077	081	Apr 04 2010	06:00:45	57 30.27 N	168 00.56 W	63.500	75	180
70M14	078	082	Apr 04 2010	11:19:30	57 31.17 N	167 02.93 W	65.000	75	337
70M11	079	083	Apr 04 2010	16:50:52	57 19.65 N	166 21.06 W	64.000	74	793
70M08	080	084	Apr 04 2010	21:00:43	57 06.62 N	165 36.67 W	63.500	75	750
70M04	081	085	Apr 05 2010	01:43:36	56 47.76 N	164 34.93 W	65.500	77	210

MET System Overview



In August 2009 a new Meteorological and Science Seawater system was installed on the ship while moored at Todd Shipyard in Seattle. A new 19" equipment rack was installed in the Wet Lab and a Science Information System consisting of 9 junction boxes were also installed during this time period. The SIS junction boxes were installed in all the science spaces to allow easy wiring of data signals from lab to lab.

MET instrumentation for this cruise is as follows:

Meteorological sensors
- Air Temperature, RM Young 41342LC
- Humidity, RM Young 41382V
- Barometric Pressure, RM Young 61202V
- Wind speed/direction, RM Young Heated Ultrasonic Anemometer 85004
- Surface PAR, Biospherical QSR-2200
- GPS Receiver, Furuno GP-32

Science Seawater sensors
- Thermosalinograph, Sea-Bird SBE-21
- Fluorometer, Turner SCUFA
- Dissovled Oxygen, Sea-Bird SBE-43
- Flowmeters (for TSG and O2)
- Vortex Debubbler
- Surface Seawater Temperature, Sea-Bird SBE-3S

The MET sensors were located on a mast mounted on the forward starboard side of the Flying Bridge and the Science Seawater sensors were located in the Wet Lab plumbed to the uncontaminated seawater system. A temperature sensor was also located in the engine room bilge next to the seawater hull intake valve. The seawater pump for this system is controlled in the Wet Lab. The uncontaminated seawater system on this ship has no method of removing ice from the hull intake, therefore the system was only used when stopped on station and when operating in open water.

The MET sensors and Science Seawater sensors were wired to a computer with 16 serial ports located in the 19" rack in the Wet Lab. This MET computer acquired the data, applied correction coefficients and combined the data into one serial data stream. This NMEA formatted serial stream was sent to the SCS computer in the Dry Lab where the data was archived and available for viewing on the science intranet. The MET data was also sent to SAMOS every 24 hours in a zipped one minute averaged file via email. SAMOS (Shipboard Automated Meteorological and Oceanographic System) is a program that provides routine access to accurate, high-quality marine meteorological and near-surface oceanographic observations from research ships. MET data from this cruise will be available by SAMOS at http://samos.coaps.fsu.edu

Nutrient and Chlorophyll Sampling during PS1001

Dr. Peter Proctor, PhD, lead

Nutrient sampling

Nutrient samples were collect from all CTD casts during the cruise. 30-liter Niskin bottles were tripped at selected depths during the upcast, usually 0, 10, 20, 30, 40 and 50 meters below the surface and a final bottom bottle that was tripped 5 – 10 meters above the sea floor as determined by an altimeter installed on the CTD.

During the CTD casts for productivity experiments, trip depths were determined during the downcast. These were nominally 0, 5, 10, 15, 20 and 25 meters, although the CTD cast went to within 5 – 10 meters of the sea floor. There was no bottom bottle tripped during these casts.

Nutrient samples were collected from the Niskin bottles into a 60 ml syringe after three complete seawater rinses. The samples were then filtered through a 20µm cellulose acetate filter directly into acid washed 25-ml linear polyethylene bottles that had been completely rinsed three times with the unfiltered seawater from the Niskin. The samples were then frozen at -80°C for shipment to Seattle and analysis. In Seattle, nutrient samples will be analyzed in accordance with the protocols of Gordon, 1994. A total of 543 nutrient samples were collected.

Chlorophyll sampling

Chlorophyll samples were collected from all non-productivity CTD casts subsequent to the sampling for nutrients. Samples were collected from the top six bottles, normally 0, 10, 20, 30, 40 and 50 meters. On some casts there was an additional bottle tripped at 15 meters for plankton identification samples, this bottle was not sampled for chlorophyll.

Chlorophyll samples were collected in brown Nalgene bottles after three complete seawater rinses. The bottles were filled completely to the top and the lids put on. These bottles had been previously calibrated so their exact volumes were known and the bottle ID and Niskin number were recorded on the log sheets for each cast to allow for calculation of chlorophyll concentration after analysis of chlorophyll content.

Total chlorophyll samples were filtered through 0.7 µm GE glass fiber filters. The filters were then placed into 1.5 ml microcentrifuge tubes and stored at -80°C for transport to Seattle for analysis. A total of 447 samples were collected and preserved.

Analysis of chlorophyll concentration will be accomplished in Seattle at the PMEL laboratory by fluorometric determination (acidification method, Lorenzen, 1966).

Oxygen sampling

The CTD in use for PS1001 had an SBE43 oxygen sensor from Seabird Electronics installed. Oxygen samples were collected from selected Niskins during selected casts for determination of oxygen concentration.

Oxygen samples were collected as the first sample drawn from the Niskin to prevent contamination by atmospheric oxygen. Samples were drawn into 125 ml glass iodine flasks and fixed with $MnCl_2$ and NaI in 8M NaOH. Subsequent to sample collection the flasks were sealed by pouring a small amount of seawater into the rim of the flask and sealing the flask with a rubber diaphragm. The samples will be analyzed in Seattle at the PMEL laboratory via the Winkler method (Carpenter 1965) in accordance with the protocol by Culberson, 1991.

There were a total of 49 oxygen samples taken.

Total samples taken

Total CTD casts	84
Nutrient samples	543
Chlorophyll samples	447
Oxygen samples	49

References

Carpenter, J. H., 1965. The Chesapeake Bay Institute technique for the Winkler dissolved oxygen method. Limnol, Oceanogr. 10, 141-143.

Culberson, C. H. (1991) Dissolved Oxygen, WHP Operations and Methods, July 1991

Gordon, L. I., J. C. Jennings Jr., A. A. Ross, and J. M. Krest. (1994). A suggested protocol for continuous flow automated analysis of seawater nutrients (phosphate, nitrate, nitrite and silicic acid) in the WOCE Hydrographic Program and the Joint Global Ocean Fluxes Study. WHP Operations and Methods. WOCE Hydrographic Program Office, Methods Manual 91-1, November 1994.

Lorenzen, C. J. 1966. A method for the continuous measurement of *in vivo* chlorophyll concentration. Deep-Sea Res. 13:223-227. (5)

Cruise report Polar Sea 10-01 Benthic and rosette sampling

Jackie Grebmeier and Lee Cooper, University of Maryland Center for Environmental Science (UMCES)

Sampling at each station included water sampling from the CTD deployment for $^{18}O/^{16}O$ ratios and water column chlorophyll. Typically samples for $^{18}O/^{16}O$ ratios were collected at three depths (near surface, mid-depth, and bottom water) based upon observations that the water column was well mixed as a result of sea ice formation and resulting mixing from brine injection. We also collected select snow and ice samples provided by Rolf Gradinger for $^{18}O/^{16}O$ ratios. Chlorophyll was measured typically at 6 depths, with filtering on the ship of 250mL water at measured depths through Whatman GF/F filters, flash freezing to fracture cell membranes on the filter surface and incubation in the dark at 4°C for 24 hours prior to measurement on a Turner Designs AU-40 without acidification (Welschmeyer method). Samples were also collected at selected stations to document algal species in the water column for Dr. Evelyn Sherr (Oregon State University) at 15m depth or the chorophyll maximum if one was observed during the CTD cast. These samples were preserved in Lugol's solution, packaged in the dark, and left on board to be shipped to Corvallis at the end of April.

Benthic sediments collections included measurement of sediment characteristics of infaunal populations through deployment of multiple van Veen grabs. An initial van Veen grab was deployed to allow for the collection of surface sediments from the screened top of the van Veen grab before it was opened. These sediments were collected for total organic carbon, sediment chlorophyll, and for ostracod population analysis (Laura Gemery, USGS & UMCES). Four additional van Veen grabs were collected for quantitative studies of infaunal benthic communities by sieving through 1-mm stainless steel screen and preservation of recovered organisms in buffered formalin. At select stations we collected an additional grab to provide reference food web samples for future analyses related to spectacled eider distributions (see Sexson report). In addition to numbered stations where a CTD was deployed (see Scripps section), we also sampled some stations in a tighter cluster around SEC1 to help address fine-scale patchiness of food supplies for apex predators such as walrus and spectacled eiders. In addition, we undertook fine scale sampling along 4 transects in an area where spectacled eiders were known from telemetry and observations to have been recently feeding. The locations of these fine scale sampling efforts, which were not given station numbers because no CTD was deployed, are tabulated in a second table at the end of this section. At these fine-scale sampling sites, we collected 2 grabs each at a spacing of 1 nautical mile from the initial station on each transect. These data will help resolve questions regarding patchiness of eider prey base (see Lovvorn report for more details). Overall, we collected a total of 218 grab samples that will be analyzed over the next 1-2 years in the laboratory for species identification and biomass.

At selected stations, a HAPS corer was used to obtain undisturbed cores from the sea floor for use in shipboard respiration incubations undertaken to simulate seafloor exchange conditions between the sediments and overlying seawater. Comparisons were also made of oxygen respiration

and nutrient exchange rates between sediments and the overlying water column at manipulated temperatures. At some stations we were able to recover 4 cores and ran experiments on 2 cores each at -1 Celsius and +3 Celsius. We collected a total of 54 core samples at 22 stations. At select stations we collected cores for additional science teams (see Burdloff and Gradinger/Weems reports).

Additional specifics on the collections made are documented in the following table. Number of van Veen grabs is equal to the number of quantitative biological grabs taken for taxonomic identification (2 for some stations with small-scale sampling grids, or in most cases, 4). Additional grabs were collected at sites with 4 van Veens for surface sediments and food web samples. HAPS core numbers also reflect the number of cores collected.

Stn_#	Stn_Name	Date_ mm/ dd/10 UTC	Water -Chla	Water-O18	Water-Sherr (phyto-plankton)	Sed-Chla	TOC	SurfSed-Laura (ostracods)	van Veens	HAPS cores
1	VNG1	03/13/10	x	x	x	x	x	x	4	4
2	NWC5	03/13/10	x	x	x	x	x	x	4	4
3	NWC4	03/14/10	x	x	x	x	x	x	4	4
4	NWC3A	03/15/10	x	x	x	x	x	x	4	2
5	VNG3	03/15/10	x	x	x	x	x	x	4	2
6	VNG3.5	03/16/10	x	x	x	x	x	x	4	4
7	CD1	03/16/10	x	x	x	x	x	x	4	2
8	VNG4	03/16/10	x	x	x	x	x	x	4	2
9	NWC2.5	03/17/10	x	x	x	x	x	x	4	4
10	VNG5	03/17/10	x	x	x	x	x	x	4	2
11	SWC3A	03/17/10	x	x	x	x	x	x	4	2
12	POP3A	03/17/10	x	x	x	x	x	x	4	

Stn_#	Stn_Name	Date_ mm/ dd/10 UTC	Water -Chla	Water-O18	Water-Sherr (phyto-plankton)	Sed-Chla	TOC	SurfSed-Laura (ostracods)	van Veens	HAPS cores
13	SIL3	03/17/10	x	x	x	x	x	x	4	
14	SEC2.5	03/18/10	x	x	x	x	x	x	4	
15	CD2	03/18/10	x	x	x	x	x	x	4	
15.1	CD2.1								2	
15.2	CD2.2								2	
15.3	CD2.3								2	
15.4	CD2.4								2	
15.5	CD2.5								2	
16	CD08	03/19/10	x	x	x	x	x	x	4	
17	SIL2	03/19/10	x	x	x	x	x	x	4	
18	SIL2.5	03/19/10	x	x	x	x	x	x	4	2
19	CD10C	03/20/10	x	x	x	x	x	x	4	2
20	CD10B	03/20/10	x	x	x	x	x	x	4	
21	CD10A	03/20/10	x	x	x	x	x	x	4	2
22	SEC4	03/20/10	x	x	x	x	x	x	4	1
23	SEC3	03/20/10	x	x	x	x	x	x	4	
24	NEC3	03/21/10	x	x	x	x	x	x	4	2
25	MK11	03/21/10	x	x	x	x	x	x	4	
26	NEC1	03/21/10	x	x	x	x	x	x	4	
27	NEC1	03/22/10	x	x	x	x	x	x	4	

Stn_#	Stn_Name	Date_ mm/ dd/10 UTC	Water -Chla	Water-O18	Water-Sherr (phyto-plankton)	Sed-Chla	TOC	SurfSed-Laura (ostracods)	van Veens	HAPS cores
28	NEC1.1	03/22/10	x	x	x	x	x	x	4	
29	NEC1.2	03/22/10	x	x	x	x	x	x	4	
30	SEC2	03/22/10	x	x	x	x	x	x	4	
31	SEC1.8	03/22/10	x	x	x	x	x	x	4	
32	SEC1.5	03/23/10	x	x	x	x	x	x	4	
33	SEC1.1	03/23/10	x	x	x	x	x	x	4	
34	SEC1	03/23/10	x	x	x	x	x	x	4	
35	CDF	03/23/10	x	x	x	x	x	x	4	
35.1	CDF1.1								2	
35.2	CDF1.2								2	
35.3	CDF1.3								2	
36	CD1.4	03/23/10	x	x	x	x	x	x	2	
37	CD10D	03/23/10	x	x	x	x	x	x	4	
37.1	CDD1.1								2	
37.2	CDD1.2								2	
37.3	CDD1.3								2	
37.4	CDD1.4								2	
38	POP4	03/24/10	x	x	x	x	x	x	4	2
39	SWC4	03/24/10	x	x	x	x	x	x	4	2
40	SWC4A	03/25/10	x	x	x	x	x	x	4	2

Stn_#	Stn_Name	Date_ mm/ dd/10 UTC	Water -Chla	Water-O18	Water-Sherr (phyto-plankton)	Sed-Chla	TOC	SurfSed-Laura (ostracods)	van Veens	HAPS cores
41	NWC3	03/25/10	x	x	x	x	x	x	4	4
42	DLN3	03/26/10	x	x	x	x	x	x	4	2
43	DLN2	03/27/10	x	x	x	x	x	x	4	2
44	CD8 1.1	03/28/10	x	x		x	x		4	
44.1	CD8 1.2								2	
44.2	CD8 1.3								2	
44.3	CD8 1.4								2	
45	CD8 1.5	03/28/10	x	x		x	x		4	
45.1	CD8 1.6								2	
46	SWC2	03/28/10	x	x		x	x		4	
47	NWC2	03/29/10	x	x		x	x		4	

Coordinates of station where collections were made but no CTD was deployed (no station integer number assigned)

Station Number	Station Name	Date_UTC	Lat (N) (degrees, decimal minutes)	Lon (W) (degrees, decimal minutes)
15.1	CD2.1	3/18/10	no bridge log recorded	
15.2	CD2.2	3/18/10	62 34.4947	172 13.1859
15.3	CD2.3	3/18/10	62 35.1011	172 14.8059
15.4	CD2.4	3/19/10	62 35.1766	172 15.0947
15.5	CD2.5	3/19/10	62 35.1532	172 14.9952
35.1	CDF1.1	3/23/10	62 55.1263	170 57.0019
35.2	CDF1.2	3/23/10	62 54.1951	170 58.6223
35.3	CDF1.3	3/23/10	62 53.3327	170 59.911
37.1	CDD1.1	3/23/10	62 36.2412	171 24.3058
37.2	CDD1.2	3/23/10	62 35.9271	171 26.2568
37.3	CDD1.3	3/24/10	62 35.1751	171 27.6339
37.4	CDD1.4	3/24/10	62 34.1891	171 29.9785
44.1	CD8 1.2	3/28/10	62 37.8065	172 7.6195

Station Number	Station Name	Date_UTC	Lat (N) (degrees, decimal minutes)	Lon (W) (degrees, decimal minutes)
44.2	CD8 1.3	3/28/10	62 41.1485	172 5.5018
44.3	CD8 1.4	3/28/10	62 42.2954	171 47.9371
45.1	CD8 1.6	3/28/10	62 37.5771	171 50.1734

Spectacled Eider satellite telemetry truthing and diet item sampling on the USCGC Polar Sea 10-01 science cruise; 7 March to 7 April, 2010 in the northern Bering Sea

Contact
Matt Sexson
USGS Alaska Science Center, Anchorage
msexson@usgs.gov
907-786-7177

Introduction

Spectacled Eiders (*Somateria fischeri*) are large sea ducks that spend 9 to 12 months of the year in marine environments. From late October through early April, the entire world population (> 350,000) winters in the northern Bering Sea, south of St. Lawrence Island, Alaska (Petersen et al. 1999). In 1993, the Alaska breeding populations (northern and western) were listed as threatened under the Endangered Species Act in response to rapid population decline (> 90% in western Alaska, Federal Register 1993). The breeding biology of the species has been relatively well studied (Petersen et al. 2000). However, the marine habitat requirements of Spectacled Eiders have not been adequately investigated, and the timing and route of spring migration is unknown.

Between 2008 and 2009, the U.S. Geological Survey has captured and marked 66 adult Spectacled Eiders with implantable satellite transmitters (PTT-100, Microwave Telemetry, Inc.) at coastal nesting areas in western and northern Alaska. We will mark 40 more eiders in 2010. Marked birds provide location data to the Argos satellite system every 4 to 5 days, and transmitters are programmed to operate continuously for approximately 20 months. In spring 2012, we expect to finish data collection with approximately 4 years of continuous location data. The proximate goal of this project is to investigate the distribution and migratory timing of eiders breeding in Alaska. Ultimate goals include modeling individual home ranges and habitat use in light of variables such as benthic prey abundance, sea ice dynamics and weather, and investigating the frequency of site fidelity to core use areas including the wintering area in the northern Bering Sea.

The Spectacled Eider wintering area is difficult to access due to sea ice, remoteness, and weather conditions. The USCGC Polar Sea 10-01 science cruise provided an opportunity to achieve multiple objectives in this area; benthic sampling for future habitat use modeling, aerial truthing of satellite telemetry data, and sample collection for future Spectacled Eider diet studies. USGS Spectacled Eider research activities on board the USCGC Polar Sea 10-01 science cruise included:

1. Truthing of satellite telemetry data through helicopter searches for eider flocks in areas where satellite telemetry indicated the presence of marked eiders.

2. Providing near real-time Spectacled Eider locations to guide benthic sampling in core use areas (Lee Cooper and Jackie Grebmeier, U. Maryland), guide helicopter enabled observations of eider flocks and sea ice conditions (Jim Lovvorn, Southern Illinois U.), and guide helicopter enabled photography of wintering eiders (North Pacific Research Board, Anchorage).

3. Assisting with benthic sampling at annually sampled stations and newly established stations based on telemetry indicated wintering areas, and collecting samples of potential Spectacled Eider diet items to be used for future diet studies (Alaska Sea Life Center, Seward).

Results

On 23, 24, and 29 March, large flocks (> 50,000 individuals) of Spectacled Eiders were observed by helicopter in areas where telemetry data had indicated the presence of marked birds. Between the 3 days where large flocks were found, the main concentrations were located within an area approximately 40 km^2 in size with a centroid at N 62.214, W 172.262. Smaller flocks (< 1,000) were observed at variable distances and vectors from the main flocks. In general, the telemetry data matched the location of the largest concentrations of Spectacled Eiders on those days (Figure 1).

Van Veen grabs were taken at 62 stations in the northern Bering Sea sampling area. Potential Spectacled Eider diet items including clams, mussels, snails, amphipods, polychaete worms, and tunicates were collected at 40 of those stations (Figure 1). Those samples will be archived at the Alaska SeaLife Center (Seward).

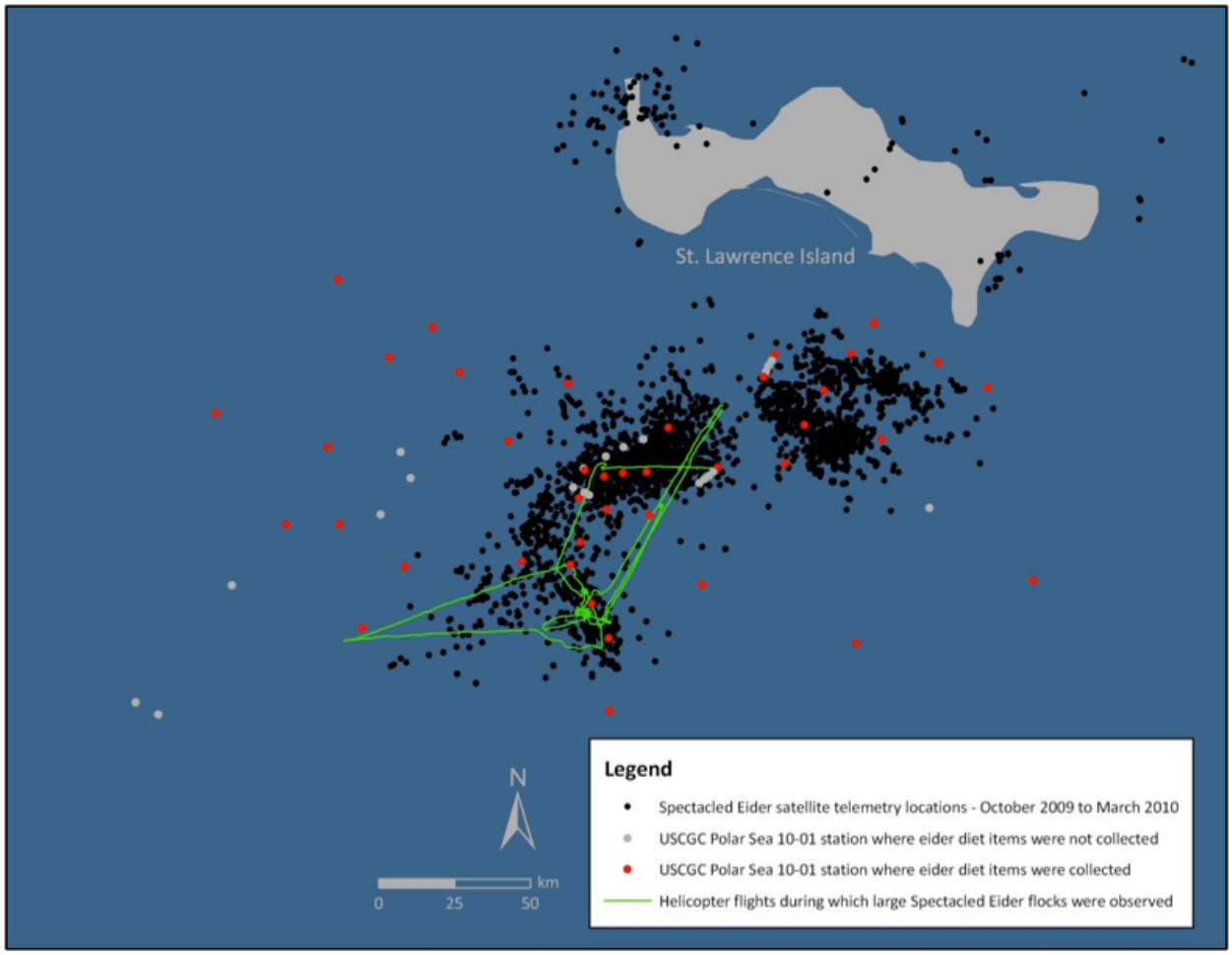


Figure 1. Spectacled Eider satellite telemetry locations south of St. Lawrence Island, Alaska from October 2009 - March 2010. USCGC Polar Sea 10-01 benthic sampling stations (gray and red) and helicopter flights (green) where large concentrations of Spectacled Eiders were observed are shown.

Literature

Federal Register. 1993. Final rule to list the Spectacled Eider as threatened. Federal Register 58(88):27374-27480.

Petersen, M.R., W.W. Larned, and D.C. Douglas. 1999. At-sea distribution of Spectacled Eiders: a 120-year-old mystery resolved. Auk 116:1009-1020.

Petersen, M.R., J.B. Grand, and C.P. Dau. 2000. Spectacled Eider (*Somateria fischeri*). *In* The Birds of North America, No. 547 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Effects of environmental change on foraging areas of Spectacled Eiders – Jim Lovvorn

A major goal of our work on Spectacled Eiders over the last decade has been to develop a simulation model that will predict where the eiders can meet their energy demands based on benthic sampling. During the *Healy* cruise in March 2009, heavy ice conditions in their usual wintering area had forced the eiders into a region in which densities of their benthic prey were much lower than in the area they had occupied in the late 1990s and early 2000s. Nevertheless, the body mass of eiders collected in 2009 was similar to that of eiders collected in much "better" habitat in 2001. To understand this unexpected result, we had three main goals on this cruise:

1. To locate the eiders and characterize ice conditions in both used and unused areas, to confirm that they really were being discouraged from using their former area by heavy ice.
2. To sample the benthos in used and unused areas as a means of inferring what their prey might be in the new area
3. To sample the benthos at higher spatial resolution (0 to 10 n mi) than our usual sampling grid (10 to 20 n mi), to determine if there might be patches of high prey density in the new area at smaller scales than we can detect with our standard sampling.

I. Locating the eiders was greatly aided by the fact that a number of eiders were fitted with satellite transmitters on the Yukon-Kuskokwim Delta in summer 2008 and on the North Slope in summer 2009 by Matt Sexson. In our helicopter flights throughout the area, we saw few eiders outside of the region used by the instrumented birds. As in 2008 and 2009, this year the eiders were again outside of the area that they used from 1996 through 2001, where prey densities are still higher. Also as in 2009, the ice pack in that former area was quite dense, with few leads adequate for the eiders. However, in March 2010, ice conditions in the former area were not much different from those in the new area where most of the eiders were found. These impressions will be followed up by analyzing the chronology of development of ice conditions through the entire winters of 1996–2001 and 2008–2010, to

investigate how ice conditions near the beginning of winter may shape the spatial use patterns of eiders later in winter, as well as between years.

During this 2010 cruise, helicopter flights for surveying ice conditions and eider dispersion had the following dates, times, and starting locations:

14 March 2010, 10:10-11:57, 62° 26', 174° 30'
16 March 2010, 10:31-12:15, 62° 48', 173° 26'
16 March 2010, 17:22-18:38, 62° 46', 173° 27'
17 March 2010, 10:15-11:00, 62° 46', 172° 41'
20 March 2010, 15:19-17:01, 62° 13', 171° 22'
22 March 2010, 13:20-14:42, 62° 40', 170° 50'
24 March 2010, 18:25-19:55, 62° 12', 173° 50'
25 March 2010, 10:15-11:13, 62° 34', 173° 39'
29 March 2010, 15:02-16:26, 62° 48', 171° 19'

II. Benthic sampling throughout the new area being used by eiders did not offer clear or simple indications of what they might be eating, as in most cases no taxa were consistently abundant or dominant across more than a few stations. Since the early 2000s, the bivalve *Nucula belloti* has increased in abundance relative to the formerly abundant and dominant *Nuculana radiata*, and *N. belloti* is perhaps the most consistently abundant prey available at present. However, most *N. belloti* sampled on this cruise were small, and our laboratory measurements have shown that this species' shell is substantially thicker and harder to crush than that of either *N. radiata* or *Macoma balthica*. We will try to address the question of whether *N. belloti* is an important food for eiders in this region by examining shell fragments in the intestines of eiders collected last year. We will also use stable isotope and fatty acid biomarkers to try to determine those eiders' diet (none contained food in their esophagi), but these biomarkers may be of minimal help in distinguishing deposit-feeding prey that feed largely on the same detrital pool.

III. At two locations, benthic samples were taken at 1-mile intervals over 4 n mi to look for patch structure in potential eider prey at a resolution of 1 n mi. At various locations within

the study area, we can also look for patch structure at a resolution of 4 n mi over 7 stations, a resolution of 7.5 n mi over 5 stations at each of two locations, and a resolution of 13 n mi over 7 stations. The numbers of stations per line are marginal for definitive analyses of patch structure. However, these initial samples should provide insights into the need for and design of further studies.

The stations proposed for analyzing each scale of resolution are

1 n mi: (a) CDF, CDF1.1, CDF1.2, CDF1.3, CDF1.4
(b) CD10D, CDD1.1, CDD1.2, CDD1.3, CDD1.4

4 n mi: CD2 1.4, CD2 1.1, CD8, CD8 1.2, CD8 1.3, CD8 1.4, SIL2

7.5 n mi: CD10A, CD10B, CD10C, SIL3, either POP3A or CD2

7.5 n mi: SEC1, SEC1.1, SEC1.5, SEC1.8, SEC2

13 n mi: POP4, SIL3, SEC2.5, CD01.1, SEC2, SEC1.5, SEC1

Cruise report:
Relevance of sea ice derived organic matter for pelagic and benthic herbivores
(Gradinger, Weems, Schuster)

Our research project focuses on the quality and quantity of organic matter produced by ice algal communities and its relevance for pelagic and benthic herbivores. During the early spring 2010 Polar Sea expedition we collected sea ice (19 stations), plankton (12 stations) and benthic (13 stations) samples (Table 1).

Table 1: Overview of sampling events

Date	Station	Sea ice samping	Under-ice CTD	Plankton	Benthos
3/11/10		X(helicopter)			
3/12/10		X(helicopter)			
3/13/10	VNG-1 NWC-5	 X	 X	X X	X X
3/14/10	NWC-4	X	X	X	X
3/15/10	VNG-3.5			X	X
3/16/10	VNG-4	X	X	X	X
3/18/10	CD-2 CD-2.2	X	X		 X
3/20/10	SEC-3	X(helicopter)	X	X	X
3/21/10	NEC-2	X(helicopter)	X	X	X
3/22/10		X(helicopter)	X		
3/23/10	CD10-D	X(helicopter)	X	X	X
3/24/10	SWC-4	X(helicopter)	X	X	X
3/25/10	NWC-3	X	X	X	X
3/26/10	DLN-2	X	X	X	X
3/28/10	NWC-2	X	X	X	X
3/30/10		X(helicopter)	X		
3/31/10		X(helicopter)	X		
4/1/10a		X(helicopter)	X		
4/1/10b		X(helicopter)	X		
4/2/10		X(helicopter)	X		

Under-ice CTD

Under-ice CTD measurements were conducted with a Seabird 19plus equipped with additional PAR and algal fluorescence sensors. The instrument was deployed at 17 stations- deployment at two stations failed due to freezing of the CTD pump system.

The under-ice CTD measurements (Fig. 1) agree with the ship's CTD data showing a well mixed and homogenous water column structure with the exception of increased bottom water salinities, likely due to brine drainage from growing sea ice.

The light data indicate substantial reduction of available PAR for phytoplankton in relation to ice thickness and snow depth.

Sea ice sampling

Ice cores for algal pigment, species composition and stable isotope ratios were collected at 19 stations (Table 2; 8 from ship, 11 by helicopter). Helicopter sampling turned out to be an extremely efficient tool for sampling sea ice whenever longer ice stations could not be scheduled. However on-ice time was not sufficient for primary productivity and sediment trap deployments during helicopter stations- those data sets are therefore only available for the eight ship based stations.
Ice thickness varied between 25 and 113 cm. Ice cores were sectioned into 1 to 10cm long sections and melted in the dark. After complete melt, samples were filtered onto GF/F filters and frozen (-80deg C) for further analysis in the home lab.

Table 2: Location of ice sampling during the spring 2010 expedition (BHS: helicopter stations)

Date	Station	Latitude (N)	Longitude (W)	Start time on ice	Ice thickness (cm)
3/11/10	BHS1	58deg41.563N	172deg35.595W	2pm	93
3/12/10	BHS2	60deg38.348N	174deg26.717W	2.30pm	72
3/13/10		62deg02.503N	175deg11.361W	1pm	53
3/14/10	NWC4/13	62deg23.706N	174deg31.924W	11am	80
3/16/10		62deg45.621	173deg25.159	12pm	51
3/18/10		62deg34.627	172deg13.226	12pm	49
3/20/10	BHS3	62deg12.99	171deg 1.812	2pm	41
3/21/10	BHS4	62deg19.473	170deg12.457	3pm	31
3/22/10	BHS5	62deg57.214	169deg45.092	10am	113
3/23/10	BHS6	62deg36.246	171deg24.239	2pm	25
3/24/10		62deg12.892	173deg47.992	2.30pm	58
3/25/10		62deg45.203	173deg51.136	2.30pm	56
3/26/10		63deg15.893	173deg43.912	2pm	56
3/28/10		63deg05.440	173deg06.271	3.30pm	41.5
3/30/10	BHS7	63deg05.439	173deg06.276	2pm	53
3/31/10	BHS8	62deg06.375	174deg43.826	2pm	19
4/1/10a	BHS9	60deg19.905	172deg28.270	10am	27
4/1/10b	BHS10	59deg48.842	172deg15.101	2pm	58
4/2/10	BHS11	59deg10.09	170deg38.875	10am	55

Plankton and Benthos sampling

Water samples were collected from the CTD Rosette to achieve water column POM, Chl a, and FAME (fatty acid methyl ester) chemistry for each sampling station. Samples were filtered onto GF/F and GF/C filters and stored frozen. Plankton samples were collected in cooperation with Ted Durbin and Maria Casas, University of Rhode Island, using a 150um vertical ring net at 12 stations in total. Live plankton from the nets was sorted by size and species and frozen in eppi-vials for later isotopic analysis at UAF.

Benthos samples were collected at 13 stations in cooperation with Lee Cooper and Jackie Grebmeier. Two van Veen grabs were retrieved at each station and surface sediment samples were taken for POM, Chl a, and FAME chemical analyses. The remaining grab sediments were sieved through 1mm sieves at all stations to collect benthic organisms. Samples were sorted alive and dominant taxa were segregated, dissected for select tissue, and frozen in eppi-vials for later stable isotope analysis at UAF. In total, over 1,000 filter, sediment, and tissue samples were taken from the pelagic and benthic realms during the PSEA10-01 cruise.

Sediment Core Experimental Incubations

Jared Weems, M.Sc. graduate student at UAF, conducted sediment core incubations to determine benthic bivalve isotopic assimilation in their fatty acids while feeding upon isotopically enriched ice-algal food as part of his thesis project. For these experiments, twenty-three sediment cores were collected using the multi-HAPS corer at station VNG-3.5 (62deg34.640N, 173deg37.485W). In conjunction, the two bivalve species *Nuculana radiata* and *Macoma tellinidae* were collected using a rock dredge and multiple van Veen grabs at stations VNG-3.5, CD-1 (62deg40.611N, 173deg22.093W), and VNG-4 (62deg45.705N, 173deg26.100W). Core incubations and the addition of a single clam of each aforementioned species to each experimental core commenced on March 17th; while under a constant 3degC experimental temperature (Fig. 2). Three treatments were distinguished in the experiment by the single pulse addition of pre-cultured ^{13}C and ^{15}N enriched ice-algae (9 cores), pre-cultured non-enriched ice-algae (8 cores), and a non-fed control group (3 cores). Three initial, or natural, cores were also taken before the experiment to establish the natural background and variability.

Incubations continued through the entirety of the cruise, with set core removal and sectioning days after the experiment began (Days 5, 10, and 18). The variability in core incubation time was set to determine the uptake and assimilation the ice-algal isotopic signature by the fatty acids in each bivalve species. Bubble aeration of each core was maintained for at least 5 hours per day for each experimental core, while oxygen concentrations were monitored. Upon removal of a core from the experiment, the overlaying water was pipetted off, filtered and stored in chloroform for later fatty acid methyl ester (FAME) conversion and compound specific isotope ratio mass spectrometer (CS-IRMS) measurements. The remaining core sediments were sectioned in 1cm inter-

vals and stored frozen. The experimental bivalves added to each core, and any others inhabiting the core, were noted for sediment depth, rinsed, and stored frozen for later FAME conversion and CS-IRMS analysis. This thesis experiment is specifically looking at the assimilation and change in concentration and isotopic value of the individual fatty acids in the bivalve specimens added to the cores.

Subsequent FAME and CS-IRMS measurements with the water filters, core sections, and other organisms inhabiting the cores will not be included as part of this thesis project, but are planned for future publication with team members. All FAME conversions of organic fats will be done back at the home lab in Fairbanks, and the compound specific isotope analyses will be done at the Alaska Stable Isotope Facility, also located on the UAF campus.

Ship based ice observations

A total of 144 ice observations were made between March 10 and April 4, 2010 during daylight hours including location, time, environmental parameters and ice conditions as well as representative images of ice conditions for each location. Average ice coverage was 98% in the study area, dominated by new ice (including pancake ice, nilas) in the polynya regions and first year ice at most locations. Average ice thickness was 49cm with 4cm of snow depth. Less than 0.1% of the ice contained visible amounts of sediment, while 62% exhibited substantial accumulations of sea ice algae in the bottom layers.

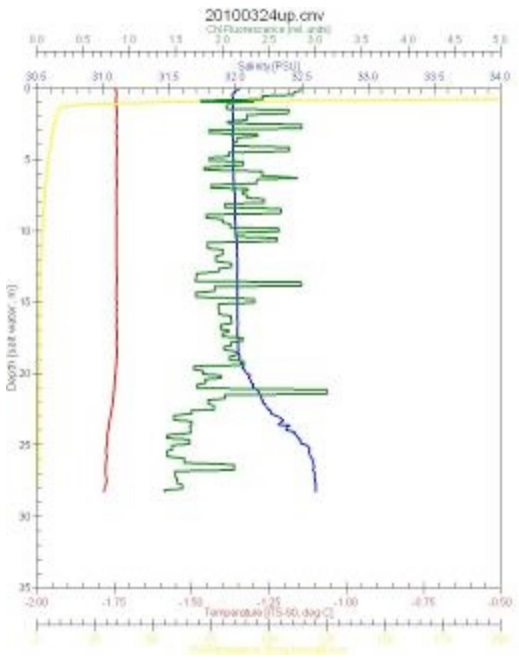


Fig 1:Example for under-ice CTD taken on March 24, 2010.measurements.

Fig. 2) Sediment core incubation experiment conducted during PSEA10-01. Clam species are buried in the sediments and aeration was provided to each core daily.

Cruise report Polar Sea 10-01 - Nitrogen Supply for new production and its relation to climatic conditions on the eastern Bering Sea Shelf.

Didier Burdloff and Ray Sambrotto, Lamont Doherty Earth Observatory, Columbia University

The core sampling at each station included water sampling from the CTD deployment for natural abundance $^{15}N/^{14}N$ and $^{13}C/^{12}C$ in suspended particles, dissolved organic nitrogen (DON) and phosphate (DOP), urea as well as preserved samples taken for phytoplankton identification. Typically, suspended particles, DON and urea were collected at three depths (near surface, mid-depth, and bottom water) based upon observations that the under-ice "winter" water Column was well mixed. At stations with 2 or 3 layers present, typically at winter ice floe edges, 4 or 5 depths were sampled. Sea water for DON and urea was filtered on the ship through 0,2 micron syringe filters then frozen at -80°C for subsequent analysis. About 4 liters of sea water collected from selected depth for isotopic natural abundance of particulate Carbon and Nitrogen were filtered through combusted Whatman GF/F filters then dried for 24 hours in a oven.

Another component of our sampling involved experiments for the determination of nitrogen and carbon uptake during long ice station sampling. *In-situ* incubations were performed at various depths, depending on the CTD PAR light sensor readings. From those specific depths, sea water and ^{13}C bicarbonate and ^{15}N labeled nutrients were introduced in incubation bottles and deployed under ice for 4-6 hours at similar depths. Then the bottles were filtered through Whatman GF/F which will undergo isotopic analysis upon return to Lamont. We successfully completed *in-situ* incubations at 5 designated productivity process stations. The conditions on the ice made it possible also to take 5 ice cores. Each ones have been cut in 2 or 3 items then melted and filtered for natural abundance $^{15}N/^{14}N$ and $^{13}C/^{12}C$.

A final component of our sampling involved benthic sediments. Benthic sediments collection was done through deployment of multiple van Veen grabs. An initial van Veen grab was deployed to allow for the collection of surface sediments from the screened top of the van Veen grab before it was opened. These sediments were collected for organic carbon and nitrogen isotopic natural abundance.

At selected stations, a HAPS corer was used to obtain undisturbed cores from the sea floor for determination of particulate and dissolved organic matter in successive layers of the sediment core as well as in the overlying sea water. Each sediment core has been cut in 1-2 cm layers then frozen at -80°C for subsequent natural abundance $^{15}N/^{14}N$ and $^{13}C/^{12}C$ as well as DON and Urea analysis, respectively in sediment and pore water.

Summary of collections by stations and cast are documented in the following table.

Table 1 : Samples collected during Polar Sea 10-01 to support water column collection and benthic studies

Cast	15N03 & 13CO3 Uptake in situ	15NH4 Uptake in situ	Natural Abundance 15N and 13C in POM	DON/P in water	Urea Conc. In water	Natural Abundance 15N and 13C in Ice core	Top core water (HAPS core)	Sediment Core (HAPS core)	Surface Sediment (Van Veen Grab)
1			4	4	4				
2	6					1			
4			4	4	4		1	1	
6			4	4	4				
7			3	3	3				1
10	6		4	4	4				1
12			4	4	4				
13			3	3	3		1	1	
18	7		4	4	4	1			
22			4	4	4		1	1	
26			4	4	4				
27			4	4	4		1	1	
29			4	4	4				1
33			3	3	3				1
40			4	4	4	1			1
42	3	3	4	4	4	3	1	1	
45			4	4	4				1
47			4	4	4		1	1	
48			3	3	3				1
51	3	2	4	4	4	2			1
52	3 T0	3 T0							
53			4	4	4				
58			4	4	4				
60			3	3	3				
64			3	3	3				
67			3	3	3				
73			4	4	4				

PSEA-01 Cruise Report Report. BEST: A novel molecular approach to measuring In situ feeding rates of copepods in the South Eastern Bering Sea.
E. Durbin & M. Casas,
URI, Graduate School of Oceanography, Kingston, RI.

General

Mesozooplankton play a critical role in determining carbon flow from primary producers to higher trophic levels. In the SE Bering Sea interannual changes in the timing and extent of both sea ice cover and summer stratification will affect their role in determining the path of carbon flow, whether through the pelagic ecosystem or to the benthos. Knowledge of the actual in situ mesozooplankton diet composition and ingestion rates is essential to understanding the flow of carbon in this system. Information about these rates using traditional bottle incubation techniques when sea ice cover is present will be compromised because of the strong vertical gradients in the mesozooplankton prey environment making sampling the appropriate prey field difficult.

The PIs are carrying out a field investigation of in situ feeding rates by dominant copepods on the Bering shelf during spring when sea ice is present. For this they are using a novel molecular technique they have developed to quantitatively measure ingestion rates on different prey species from zooplankton stomach content analysis. The 18S ribosomal RNA gene is being used as a marker to identify different prey species present in the guts of copepods and quantitative real-time polymerase chain reaction (q-PCR) to measure copy number of this gene for each prey species. Ingestion rates will be calculated from this gut content information, 18S copy number/organism, and DNA digestion rates.

Ingestion of the dominant copepods, *Calanus glacialis* and Pseudocalanus spp, are also being determined using the gut pigment method to complement the DNA method.
In addition, quantitative samples were collected to determine zooplankton abundance and developmental stages of the dominant copepods during the early spring period.
By combining the in situ ingestion rate measurements with zooplankton abundance measurements and the prey field composition, we will be able to determine the fate of phytoplankton production under the varying environmental conditions.

Sampling Methods

Samples were collected for these measurements at selected stations shown in Table 1
Quantitative zooplankton samples were collected at each station with a vertical haul from several meters above the bottom to the surface with a 0.5 m diam, 64 μm ring net. A 10 lb weight was attached to the cod end of the net so that it only sampled during retrieval. These samples were preserved in 5% formalin for later enumeration.
Samples for gut DNA and pigment analysis were collected with a vertical haul of a 1 m diam. 150 μm mesh net. This net also had a weight attached to the cod end so that it only sampled during retrieval. This net was typically towed from 30 m to the surface. A subsample from this net was immediately fixed in 95% ethanol for later DNA analysis. The remainder of the sample was anesthetized with MS222 and kept cold on ice while groups of adult female *Calanus glacialis* (3 groups of 10) and *Pseudocalanus* spp. (3

groups of 15) were sorted onto filters for gut pigment analysis. Initially these were processed immediately but a malfunction of our fluorometer occurred during the cruise and filters were subsequently frozen at -80°C for later analysis.

At each station sampled above 4 l of water was collected from Niskin bottles from either 15 or 10 m. Two liters were concentrated with a 10 μm sieve and preserved in acid Lugol's for later enumeration of larger phytoplankton. Between 300 and 600 ml was filtered through a 5 μm polycarbonate membrane filter and frozen at -80°C for later DNA analysis to characterize species present by molecular techniques.

At a number of stations *Calanus glacialis* adult females were kept on ice in sterile filtered seawater for 1.5 hr while they released fecal pellets. These fecal pellets were collected, rinsed in sterile FSW and placed on a 5 μm membrane filter. These were placed in a sterile microcentrifuge tube and frozen at -80°C for later DNA analysis.

When ice core samples were available with ice algae we filtered them onto 5 μm filters for later DNA analysis of species composition. Subsamples were also preserved in Lugol's for microscopic examination. At selected stations we isolated individual phytoplankton cells into sterile seawater culture media to establish cultures of species of interest.

Preliminary observations

The cruise took place during March and the region of the Bering Sea sampled during the cruise was covered with ice with occasional leads. Preliminary observations indicated that the phytoplankton was very low in abundance and dominated by the centric diatom *Thalassiosira* spp with lower abundances of pennate diatoms, presumably from ice algae.

The zooplankton community was very similar in the region south of St Lawrence Island and at most stations along the 70 m transect. The dominant copepod taxa were *Calanus glacialis* and two, possibly three, species of *Pseudocalanus*. Individuals of these different *Pseudocalanus* were sorted live and preserved for later genetic analysis. From St PSEA1001-068 to the last station we sampled (PSEA1001-074) along the 70 m transect a more coastal population was present dominated by small copepods of the genera *Pseudocalanus* and *Acartia* and with relatively few *C. glacialis* present.
Adult females dominated the population of *Calanus glacialis* with a few males and very few younger stages present. Most adult females were full of partially developed eggs. At one station a number (38) were kept for 24 hr in filtered seawater in the refrigerator and a few eggs (15) were observed the following day, indicating that one or two were releasing eggs. We also observed a very few *Calanus* (as well as *Pseudocalanus*) eggs in samples while sorting. The quantitative samples collected with the 64 μm mesh nets should provide information on actual abundances of these eggs.

At the first station sampled (PSEA1001-002) almost no phytoplankton was observed in the guts of *C. glacialis* using the gut pigment method (<1 ng chl equiv cop^{-1}). At several stations following this values were slightly higher (1-4 ng chl equiv cop^{-1}) but still much

less than might be expected for a full copepod (>30 ng chl equiv cop^{-1}). The fluorometer then stopped working at this point and subsequent samples were frozen at -80°C. However, visual observations during the remainder of the cruise indicated that most *C. glacialis* had small amounts of food in their guts. The population appeared to be in a state of readiness waiting for the spring bloom.

Pseudocalanus spp. were very abundant at all stations. All stages, including nauplii, appeared to be present. At all stations a few adult females were observed to be carrying egg sacs containing 2-3 eggs. However, visual and gut pigment observations indicated that all the adult females had negligible food in their guts.

Expected Products:

1. A description of the zooplankton community composition and the age structure of the dominant copepods during early spring in the northern Bering Sea. This will be the first such study using a fine-meshed net where all developmental stages are collected. This will include a description of the reproductive stage of *Calanus glacialis* and water column egg abundance of both taxa.
2. A description of estimated feeding rates of *Calanus glacialis* adult females and *Pseudocalanus* spp. adult females from gut pigment content analysis.
3. A genetic analysis of the different *Pseudocalanus* species present and a morphological description of each species.
4. A molecular analysis of the prey composition of adult female *Calanus glacialis* and *Pseudocalanus* spp. based on DNA analysis of gut contents. These results will be compared with a molecular analysis of the planktonic prey composition and the relative importance of planktonic vs ice algae in the diet evaluated.

5. Table 1: Stations occupied and samples collected during PSEA-1001

Date	Sta ID	0.5 m net	1 m net	PP sample	Fecal pellets	
3/13/10	2, NWC5	x	x	x		
3/14/10	3, NWC4	x	x	x		
3/15/10	5, VNG3	x	x	x		
3/16/10	8, VNG4	x	x	x		
3/16/10	9, NWC2.5	x	x	x		
3/18/10	15, CD2	x	x	x		
3/18/10	16, CD08	x	x	x		
3/20/10	24, NEC3	x	x	x		
3/21/10	26, NEC2	x	x	x		
3/23/10	37, CD10D	x	x	x		
3/24/10	39, SWC4	x	x			
3/25/10	41, NWC3	x	x	x		
3/26/10	43, DLN2	x	x	x		x
3/29/10	48, CDF	x	x	x		x
3/30/10	49,	x	x	x		
3/31/10	54,	x	x	x		x
4/01/10	60,	x	x	x		
4/01/10	64,	x	x	x		
4/02/10	68,	x	x	x		
4/02/10	71,	x	x	x		
4/03/10	74,	x	x	x		

Seabird and Marine Mammal Observations on the Polar Sea BEST-early spring cruise

Kathy Kuletz (Kathy_Kuletz@fws.gov) and Aaron Lang
Maps by Elizabeth Labunski
Migratory Bird Management, U.S. Fish and Wildlife Service, Anchorage, AK

Background

We surveyed marine birds and mammals onboard the *USCGC Polar Sea* as part of the 'Seabird Broad-scale Distribution' component of the Bering Sea Integrated Ecosystem Research Program (BSIERP), funded by the North Pacific Research Board. This project will examine seabird and marine mammal distribution relative to oceanographic and biological features of the Bering Sea. Survey data will be submitted to the BSIERP database and will be archived in the North Pacific Pelagic Seabird Database (USFWS and USGS, Alaska). For the PSEA1001 cruise, we began our surveys on 7 March, after leaving Kodiak. We conducted surveys during daylight hours while the vessel was in transit. This report summarizes our results from 7 March – 2 April, but we continued surveys until our arrival in Kodiak on April 7.

Methods

We surveyed marine birds and mammals from the port side of the bridge using standard USFWS survey protocol during daylight hours while the vessel was underway. One primary observer scanned the water ahead of the ship, using hand-held 10x binoculars for identification, and recorded all birds and mammals within a 300-m arc, extending 90^0 from the bow to the beam. On occasion more than one observer assisted in observations, to increase observations of off-transect birds and mammals of interest. We used strip transect methodology with three distance bins extending from the vessel: 0-100 m, 101- 200 m, 201-300 m. Unusual sightings beyond the 300 m transect were also recorded for rare birds, large bird flocks, and mammals. We noted the animal's behavior (flying, on water, on ice). Birds on the water were counted continuously, whereas flying birds were recorded during quick 'Scans' of the transect window at approximately 1-min intervals, depending on the ship's speed. Because of low bird densities while in the ice, we also recorded birds in the air that were not observed during Scans; these were recorded as simply 'Flying' and future density estimates will apply correction factors if these observations are used. For albatrosses and whales, we also recorded actual distances and angle from the center line, to enable more refined density calculations.

We entered observations directly into a laptop computer using the DLOG3 program (Ford Ecological Consultants, Inc.) with a GPS interface from the ship's system. Location data from the GPS were automatically written to the program at 20 second intervals, as well as our entries on weather conditions, Beaufort Sea State, ice type and coverage, and glare conditions. At the beginning of each transect we recorded wind speed and direction, air temperature, and sea surface temperature. Data were exported into an Excel spreadsheet, edited for minor corrections, and summarized.

During this cruise we conducted a pilot survey effort by helicopter, with the goal of improving data on winter distribution and habitat use for Kittlitz's murrelets and black guillemots. Based on ship-based surveys that helped us define potential habitat for these alcids, and MODIS satellite imagery, we conducted helicopter surveys on 28, 29, and 31 March, for a total of 439 km. For these surveys, two observers (one with recording responsibilities) used a laptop computer with Dlog to record all birds and mammals, with 300 m one side of the route considered 'on transect'. The helicopter flew at approximately 300 – 500 ft altitude at a speed of ~ 60 mph.

Results and Discussion

During 7 March – 2 April 2010, we surveyed a total of 1,807 km of transects, with 524 km surveyed before we reached ice, and 1,283 km surveyed while in the ice. On transect, we recorded a total of 30,265 birds belonging to 22 marine species, but 99% of the total count was Spectacled Eider (Table 1). During ice-free days (7 – 9 March), Common Murres and Northern Fulmars were the predominant species. During the days with ice, in addition to large flocks of Spectacled Eiders, the main identified species were Black Guillemots, Crested Auklets, King Eiders, and Kittlitz's Murrelets (Table 1). Marine mammals were found primarily in the areas with ice (Table 2).

The data obtained during this cruise greatly expanded data collected over the last three springs on the winter distribution and habitat associations for Black Guillemots and Kittlitz's Murrelets. The murrelets were found throughout the southern polynya of St. Lawrence Island, as well as east of the Pribilof Islands and southeast of St. Matthew Island (Fig. 1). The general habitat consisted of open leads (ranging from 0.2 – 8 km long) with ice of 6/10th to 9/10th coverage. All murrelets were in basic plumage and most were in pairs.

The helicopter surveys proved efficient and worthwhile for recording distribution and habitat data for Kittlitz's Murrelets and Black Guillemots. Observers could easily spot and distinguish the murrelets and guillemots, and the only other bird species were eiders, Long-tailed Ducks, and gulls (Table 3). The encounter rate for Kittlitz's Murrelet was higher during helicopter surveys (0.046 per km) compared to ship-based surveys (0.005 per km), even when we included murrelets that were 'off transect' for the ship-based surveys. On the helicopter surveys, Kittlitz's Murrelets accounted for 37 % of all birds observed on transect, however, these flights were only conducted in what we judged to be potential Kittlitz's habitat, based on our ship-based observations. The helicopter also allowed for good photographic documentation on general habitat and data on distribution patterns of the birds.

We recorded 440 marine mammals of 9 species, of which 97 (mainly Bearded Seals and Pacific Walrus) were on transect (Table 2). Notably, we recorded 36 Bowhead Whales over the course of one morning, while southwest of St. Matthew Island (Fig. 2). In addition we recorded 11 Bowhead Whales during the helicopter survey near St. Lawrence Island (Fig. 2).

Table 1. Bird observations made on 7 March – 2 April 2010, during the PSEA10-01 cruise. Note that the percentage on transect by species does not include Spectacled Eiders.

	Total observed, all bins		Total on Transect	
Species - common name	Days with No Ice	Days with Ice	Count	Percentage without SPEI
Unidentified Loon	1		1	0.07
Red-necked Grebe	1			0.00
Laysan Albatross	7		6	0.40
Northern Fulmar	95	7	98	6.57
Pelagic Cormorant	1		1	0.07
Red-faced Cormorant	1		1	0.07
Unidentified Cormorant	3		2	0.13
Spectacled Eider		91229	28774	
Steller's Eider	1		1	0.07
Common Eider		1	1	0.07
King Eider		69	17	1.14
Unidentified Eider		60		0.00
Black Scoter	5		5	0.34
Long-tailed Duck		4		0.00
Glaucous Gull		13	5	0.34
Glaucous-winged Gull	24	3	25	1.68
Black-legged Kittiwake	13		13	0.87
Unidentified Gull		1		0.00
Common Murre	1197	4	974	65.33
Thick-billed Murre	14	8	22	1.48
Unidentified Murre	124	96	124	8.32
Black Guillemot		98	98	6.57
Unidentified Guillemot		9	4	0.27
Marbled Murrelet	6		6	0.40
Kittlitz's Murrelet		62	10	0.67
Brachyramphus murrelet		8	8	0.54
Crested Auklet	55	15	40	2.68
Parakeet Auklet	25		25	1.68
Least Auklet	4		4	0.27
Unidentified Alcid	1	3	1	0.07
Unidentified bird		1		
Total marine birds	1576	91691	30265	100.0
Non-marine birds				
Gyrfalcon		1	1	
Common Raven		2	0	

Table 2. Marine mammal observations made on 7 March – 2 April, 2010 during the PSEA1001 cruise.

	Total observed, all bins		Total on Transect	
Species	Days with No Ice	Days with Ice	Count	Percentage
Bowhead Whale		36	6	6.2
Humpback Whale	2			0.0
Beluga Whale		7	4	4.1
Unidentified Whale	1			0.0
Harbor Seal	1		1	1.0
Spotted Seal		1	1	1.0
Ringed Seal		7	3	3.1
Ribbon Seal		1		0.0
Bearded Seal		69	30	30.9
Unidentified Seal		60	14	14.4
Pacific Walrus		247	35	36.1
Unidentified Pinniped		8	3	3.1
Total Mammals	4	436	97	100.0

Table 3. Marine bird and mammal observations made on three helicopter surveys, 28-31 March 2010, for a total of 439 km, during the PSEA1001 cruise.

	Counts			
Species - birds	On Transect	Off Transect	Total	Percent of On Transect
Northern Fulmar		1	1	0.00
Spectacled Eider		242	242	0.00
Common Eider	7	11	18	12.96
King Eider	6	10	16	11.11
Unidentified Eider		9	9	0.00
Long-tailed Duck	18	88	106	33.33
Glaucous Gull	2	1	3	3.70
Unidentified Gull		1	1	0.00
Black Guillemot	1	3	4	1.85
Kittlitz's Murrelet	20	4	24	37.04
Unidentified Alcid		1	1	0.00
Total marine birds	54	370	424	100.00
Species - mammals				
Bowhead Whale	10	1	11	90.91
Unidentified Seal		2	2	0.00
Pacific Walrus	1	12	13	9.09
Unidentified Pinniped		1	1	0.00
Total Mammals	11	16	27	100.00

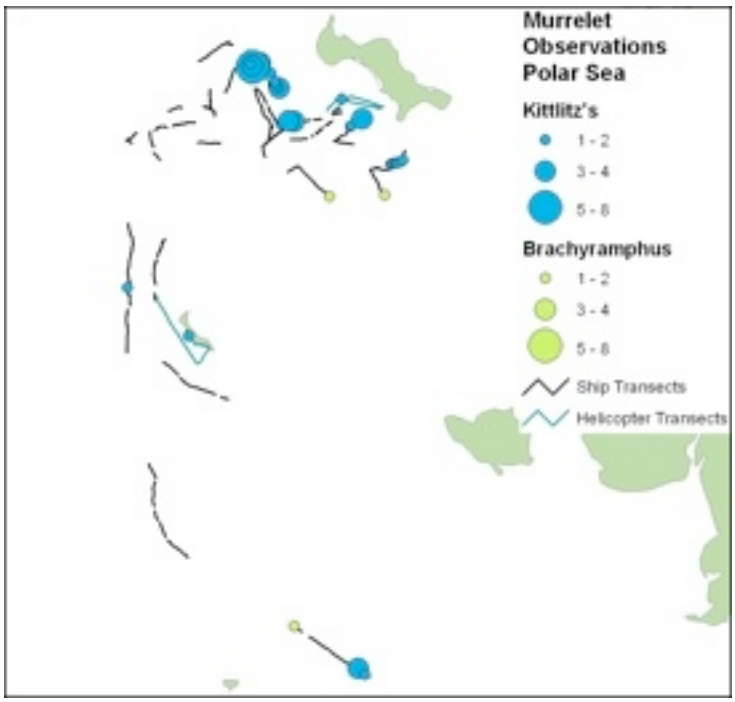


Figure 1. Distribution of Kittlitz's murrelets recorded during ship-based surveys (black lines) and helicopter surveys (blue lines) on the BEST 2010 spring cruise, March 7 – 2 April.

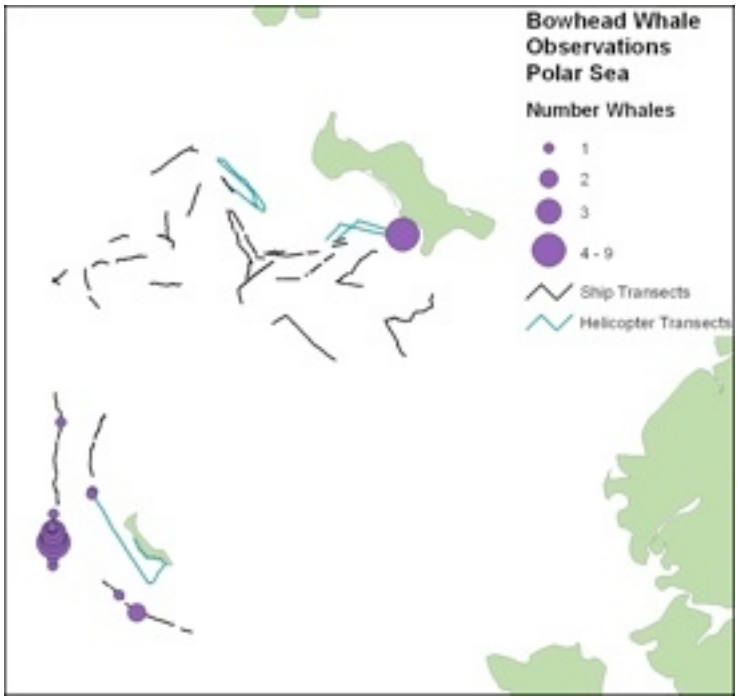


Figure 2. Distribution of Bowhead whales recorded during ship-based surveys (black lines) and helicopter surveys (blue lines) on the BEST 2010 spring cruise, March 7 – 2 April.

Appendix: Selected Outreach Efforts

Cruise co-chief scientist Jackie Grebmeier explains the cruise aims and prior research results at a community meeting in Gambell (Saint Lawrence Island), January 2010.

Polar Sea Cruise March 6 - April 6

Benthic, ice, and associated studies south of St. Lawrence Island

YOUR CORRESPONDENT: Matt Sexson is a **USGS biologist studying spectacled eiders** as part of his PhD work at UAF. In his spare time, he's out on a US Coast Guard icebreaker, assisting BEST-BSIERP investigator Lee Cooper and his team. All photos by Matt Sexson except where noted otherwise.

ON THE AIR: KMXT Public Radio journalist **Diana Gish** toured POLAR SEA when the ship docked in Kodiak before heading north into the Bering Sea. **Listen to the story**

April 5: Sampling the water column

A major component of our science mission on POLAR SEA involves one of the most versatile sampling instruments on board. It's called a CTD, which stands for Conductivity, Temperature, and Depth. It might as well be short for "collects tons o' data," because that's exactly what it does.

A CTD measures multiple characteristics of the water column -- including temperature, conductivity, and light penetration at various depths -- simultaneously. Plus, it can collect water at up to 12 separate depths. This water will be used by scientists who are studying aspects of the Bering Sea such as chlorophyll content, an important source of nutrients in the Arctic.

A multitalented marvel

The CTD **(right)** is outfitted with an array of sensors and lasers, plus 12 bottles arranged in a circle. Each bottle is attached to a trigger, which when pulled seals the bottle.

As soon as we are on station, Coast Guard Marine Science Technicians (MSTs) carefully pull the CTD out of its hangar. They use a winch to carefully lift it off the deck and lower it into the water. The cable connected to the CTD can transmit data to and from a computer on the ship.

An operator monitors the CTD from the ship and directs the winch operator to lower and raise the instrument to various depths. As soon as the CTD is at depth, the operator sends a signal to the instrument to close specific bottles, capturing water from that depth.

Sampling the watery secrets of the Bering Sea

All the while, sensors collect data that would have taken scientists hours to collect, if at all. Starting at the bottom and working its way up, the CTD returns to the ship with several gallons of pure premium Bering Sea salt water and priceless information regarding the chemistry and health of the Bering Sea. **Right: POLAR SEA makes her way through the sea ice, as seen from a US Coast Guard helicopter.**

For more information

JUMP TO RECENT STORIES

- March 30: Sea ice research
- March 25: Eiders!
- March 18: Benthic sampling
- March 14: On station
- March 10: Seabird surveys
- March 7: Underway
- March 5: In Kodiak

AT SEA WITH THE COAST GUARD

Loading ...

Scenes from the spring cruise of the USCG Polar Sea. Photos courtesy of US Coast Guard personnel. Other links:

- *Crew Journal (blog) from the ship, featuring entries that begin "Deck force spent the day breaking ice off the railings and all over the ship ..."*
- *USCG official cruise website with updates, crewmember highlights, and more*

QUOTABLE

The CTD returns to the ship with several gallons of pure premium Bering Sea salt water and priceless information regarding the chemistry and health of the Bering Sea.

Benthic and ice teams began

For more information ...

Want to know more about how a CTD works and what it's teaching us about the ocean? NOAA researcher Peggy Sullivan explains.

March 30: Sea ice research

Few of us can say that we've walked on the Bering Sea. For sea ice biologists on POLAR SEA, it happens weekly as they investigate the ecology of sea ice. Scientists reach the ice by ladder, crane, or helicopter. Towing equipment in sleds, they make their way across ice and snow adjacent to the ship. Coast Guard bear lookouts accompany the science team, just in case. All the while, the team is working in negative temperatures and strong arctic winds.

Studying solid water

On site, scientists drill several holes in the ice using a gas powered auger (left). Various pieces of equipment are then employed to capture silt, sand, and algae that naturally falls off the underside of the ice; or to film animals that might be crawling on the underside. Finally they take water samples and measure water temperature at various depths below the ice.

Earning their samples

Using a drill and long tubular bit, scientists also collect ice cores. The cores are cylinder shaped and about the width of a can of soup, but up to 3 feet long depending on the thickness of the ice. The cores are cut into sections representing different layers of the ice. The sections are returned to POLAR SEA where they are allowed to thaw. Scientists then use microscopes to scan the resulting water for tiny animals that were living within the ice.

Growing up, I would have never thought that many animals could live in the harsh conditions of the northern Bering Sea. Maybe walrus and polar bears, but surely nothing within the ice. However, there are thousands of tiny animals living in and under the sea ice. We are just starting to learn about the importance these organisms and their ice habitat within the arctic food web.

March 25: Eiders!

Imagine being in a helicopter, flying over seamless sheets of ice and snow.

As the endless plain of white begins to lose its novelty, a dark oasis appears on the horizon. It isn't a lead or pool of dark blue water. It is a large mass of nearly 350,000 Spectacled Eiders in a winding lead of open water.

As you fly closer, the mass transforms into individual birds. Closer yet, you're able to discern males (black and white) and females (brown) and you begin to grasp the enormity of the flock.

Yesterday, I am confident that I saw nearly every Spectacled Eider in

sampling at our third station this morning after the Polar Sea fought through think ice overnight.
22 days ago

International Arctic Fisheries Symposium 2009 Proceedings now available at http://www.nprb.org
20 days ago

Thousands of Spectacled Eiders observed off of the Polar Sea. Benthic sampling yields clams

twitter Join the conversation

ABOUT POLAR SEA

Like her

sister ship HEALY, POLAR SEA'S missions include scientific and logistical support for US interests in both polar regions.

Track POLAR SEA through the sea ice of the northern Bering Sea (24-hr delay)

The 75,000 horsepower ship is designed to move through 6 feet of ice at a speed of 3 knots.

Lore feum quisciliqui ting eugait ullandignim zzrit iriustrud doluptat volum il il iustin utet, sum dolore tat volobor autpat alisim quipis nit iure vendrerit eugait ing et ad magnim am.

the world. A once in a lifetime sight! Click for larger image

Sea ice: refuge for a threatened species

From November through March, the world population of threatened Spectacled Eiders overwinters in the northern Bering Sea. Here, they depend on abundant clams and worms to survive the winter. I track their movements throughout the year using satellite transmitters that I attach to individual eiders.

On POLAR SEA, we are using current locations from marked eiders to observe sea ice conditions in areas where eiders occur. The marked birds also guide our benthic sampling, which will help us better understand what eiders prefer to eat. Other biologists on this cruise are observing the sea ice in areas where eiders historically wintered, trying to learn why the population has shifted its winter distribution in the past 20 years.

March 18: Benthic sampling

One of our missions out here is to collect sediment and benthic organisms from the sea floor so we can better understand the ecology of the northern Bering. Predators including eider ducks, walrus, and fish depend on the organisms that live in and on the bottom of the ocean as a primary source of food. Changes in the distribution and abundance of the organisms on the sea floor could trigger change in populations of upper level predators or lower level prey.

Grabbing the bottom

A large clam-shell looking device called a Van Veen grab is lowered to the sea floor by a Coast Guard technician. Right: The grab must be sprayed with hot water as it is lowered to keep it from freezing open before it goes under the sea surface. (Tom Van Pelt)

When the grab reaches the bottom about 60 meters below, it digs into the mud and sand. When the technician retrieves the grab, the two halves close, scooping up about 30 pounds of mud and the organisms within.

Slowly the grab is brought to the surface, opened, and dumped into a large wash tub. Spoonfuls of mud are taken from the grab and later analyzed for nutrient content and sediment grain size.

Treasure

Then biologists carry the tub over to a sieve, where a sea water rinse reveals buried clams, snails, worms, brittle stars, and the occasional fish or crab (right; click for larger image).

Sampling occurs both night and day, in temperatures that are well below freezing. Hoses and nozzles cease to work, equipment and tools freeze in place, and ice coats the gloves, face masks, and protective clothing of those fortunate enough to work on the deck.

Later, the organisms will be identified and counted to estimate their distribution and abundance across the northern Bering Sea. Samples will also be used to evaluate the diet of spectacled eiders, which are thought to depend on specific clam species to survive harsh winter conditions.

March 14: On station

After much anticipation, POLAR SEA arrived at her first sampling station yesterday. The sampling area in the

Dapibus neque lacus vel elit

northern Bering Sea is a little over 9,000 square miles in size. Within this area approximately 30 points, or stations, have been designated as sampling sites. Some of the stations are being sampled in multiple years to look at differences and similarities over time. As soon as the ship is in position, a number of teams are deployed to collect samples, with some work occurring regardless of time of day or temperature.

Sea ice scientists and their equipment leave the ship via helicopter or on a freight platform (right) attached to a crane. Researchers interested in invertebrates, water chemistry, and sediments work off the port side where a Coast Guard winch operator assists in the lowering of various nets, grabs, and instruments.

Spectacled Eider biologists survey surrounding areas for suitable ice habitat and wintering eiders. At the conclusion of each station, scientists return to labs on the ship where samples are processed, analyzed, and/or stored for future research. Then POLAR SEA continues to the next station while scientists and crew process samples, rest, or visit the mess hall.

This morning was my first full shift on the benthic sampling crew, 11:30 PM (13 March) to 11:30 AM. The temperature was -9˚F, with a -23˚F wind chill.

March 10: Seabird surveys

East of the Pribilof Islands, POLAR SEA makes her way north. As the ship drives through sea ice toward the main research area located south of St. Lawrence Island, pieces of ice sometimes 3 feet thick can be heard splitting across the bow and scraping down the port and starboard sides.

All the while, US Fish and Wildlife Service biologists scan for sea birds and marine mammals from the bridge. Over leads and pockets of open water, they spot Common Murres, Black Guillemots, and Kittlitz's Murrelets. Seals often pop up before dipping under water again. The data collected by the Fish and Wildlife Service will contribute to our understanding of the distribution of these species in an ice filled Bering Sea.

Other scientists are busy preparing for sampling in the days to come. Scientists evaluating marine sediments, invertebrates, water, ice, and algae are setting up collection and analysis equipment on deck and in lab spaces, and Spectacled Eider biologists are using real-time satellite telemetry data to prepare for surveys by helicopter.

March 7: Underway

Aboard POLAR SEA, I left Kodiak on a beautiful Sunday morning bound for the northern Bering Sea. There, the scientists and crew of the most powerful icebreaker in the US will survey for sea birds and ducks, collect invertebrate samples from the sea floor, measure aspects of the water column, and collect sea ice and algae samples.

Most of the scientists on board have been on research cruises in the past and many have been to the northern Bering in winter. As for me, this is my first cruise on a live-aboard vessel of any kind; every experience is new, most are exciting, some are gut wrenching. The rhythmic and sometimes violent roll of the ship, the endless labyrinth of passageways and stair towers, the sound of waves crushing against the bow, and the combined scent of axle grease and the mess hall are unique to this floating home away from home.

Over the next month, I'll post log entries that describe my experiences and the science being conducted aboard POLAR SEA.

March 5: In Kodiak

The public was invited to tour the 75,000 horsepower ship when POLAR SEA

docked in Kodiak on 5 March. Right: Dutch Harbor. (Carin Ashjian)

Kodiak Daily Mirror Excerpt from 5 March 2010 edition

The study is conducted in an area where Arctic animals such as walruses, bearded seals and spectacled eiders use sea ice as a platform to take advantage of abundant seafood on the sea floor. Changing ice conditions are likely to influence potential expansion of Bering Sea fisheries farther north as well as shrink Arctic habitat currently available on the shallow continental shelf.

Some data and samples to be collected include seafloor sediments, sea ice, and water samples and plankton. Other research includes studies of the distribution of bird and marine mammals, including the world's population of spectacled eiders.

The BEST-BSIERP Bering Sea Project is a six-year study of the Bering Sea ecosystem,
from the benthos and the atmosphere to human communities, and everything in between.
NORTH PACIFIC RESEARCH BOARD :: NATIONAL SCIENCE FOUNDATION

Contact the BEST-BSIERP Program Manager with project-related questions.
Contact the Visual Information Specialist with website-related questions.

Site Map