Bering Sea Integrated Ecosystem Research Project: Semiannual Progress Report

Project #: B-57

Title: Epibenthos Survey of the Bering Sea

Principal Investigator(s) and Recipient Organization(s):
PI: Jacqueline Grebmeier (jgrebmei@cbl.umces.edu)
Co-PI: Lee W. Cooper (cooper@cbl.umces.edu)
Chesapeake Biological Laboratory
University of Maryland Center for Environmental Science
PO Box 38, 1 Williams St
Solomons, MD 20688

Contract Period and Amount of Funding:
November 1, 2007-October 31, 2009 (currently in no-cost extension period)
Report Period:
September 30, 2008-April 1, 2009
Report Date:
April 20, 2009
Lead Author of Report:
Jacqueline M. Grebmeier

Proposed Timeline and Milestones within Report Period:
Nov. 2007-Feb. 2008: purchase benthic camera system and software; collect retrospective data on past epibenthic collections in the Bering Sea
Mar. 2008: undertake epibenthic survey at process stations during the walrus-prey patch dynamics study in the northern Bering Sea
April-May 2008: undertake epibenthic survey at process stations during the USCGC Healy spring BEST cruise in the Bering Sea; this arrangement will also assist in the collection of infaunal samples in year 1, too, for the core BEST efforts
June 2008-Sept. 2009: process video camera epibenthic data and compare to known collections of epibenthic fauna in the Bering Sea
Oct. 2009: prepare final project report

Project Summary: We have used an experimental benthic camera system to document sea floor epibenthic communities of the Bering Sea. By means of occupying stations over north-south gradients, these studies contribute to testing of BSIERP hypothesis1.a: "Earlier sea ice retreat expected as a result of warming will result in a later (May-June), warm-water spring phytoplankton bloom, increased coupling with zooplankton and greater pelagic secondary productivity. Benthic secondary productivity will decrease."

Progress Summary: Digital video footage (mini-DV format) from a total of 43 shallow water stations (<150 m depth) on Healy cruises 08-01 and 08-02 was successfully obtained in March-May 2008. Typical sea floor footage obtained was about 10 minutes per station. These tapes have been transferred to computer hard drives and individually edited to remove extraneous, non-useful footage. In some cases, due to a high speed of ship drift, video-processing transformations such as slowing the number of frames per second has been necessary to improve the quality of the imagery.

The camera was deployed 9 times during HLY0801 cruise, with steadily improving results that produced usable video at 6 stations. Several challenges were overcome during HLY0801, including adjusting the sub-sea camera focus and the capabilities of the lasers to operate at near-freezing temperatures in seawater as well as being subjected to subfreezing temperatures during deployment from the deck. One of the lasers was also found to be faulty and was replaced by the HLY0802 cruise. Several different ways of

deploying the camera were experimented with; an efficient procedure for deployment using the starboard SeaMac winch was eventually resolved. Ship drift at high winds continues to pose some challenges for good video quality. Thus, by the subsequent HLY0802 we were fully operational, which allowed 37 successful camera stations to occur on this cruise.

Analysis of the video clips recorded during the HLY0802 cruise are underway. Qualitative results have been completed and quantitative results are being generated from visible inspection of the entire video clip and from analysis of still images captured from throughout each record. At this date, all videos have been viewed, along-track epifauna counts recorded, and still images captured. We are also preparing quantitative counts of epibenthic faunal abundance per square meter for comparison with trawled samples and the infaunal samples collected during both cruises. We will also use past data sets on length/weight determinations of dominant epibenthic species to convert abundance to biomass values. At some stations, epibenthic abundances appear to be quite low, and in a few cases, heterogeneous, rocky bottom substrates are making epibenthic abundance estimates challenging.

Briefly, all video clips were viewed in their entirety for qualitative recording and analysis of substrate and biological communities. Quantitative data were also recorded during these viewing sessions as along-track counts of epifauna. Dominant epifauna occurring with high frequency are being counted through still frame analysis (~every 20 seconds) and will be used to estimate the abundance of these organisms. For example, this is proving effective in along-track counts of brittle stars at locations where they blanket the sea floor. A summary table of the results from along-track analysis, including a general description of the substrate, functional groups, classes/species that make up those groups, and short descriptions of substrate and dominant fauna, has been prepared and will be submitted to the BSIERP data archive in the near future.

Since most stations were collected successfully on HLY0802 (Figure 1) and form a nearshore/offshore south to north comparison, we will focus on this cruise to evaluate the analyses and results of our project to date. With the exception of 3 sites, 40 still frames were captured at each station, with time intervals between frames ranging from 11 to 17s. Two stations, NP1 and SL12, had short overall records and were sampled at 10s intervals resulting in 12 and 22 still frames, respectively. No still images were taken from the MN5 video because the left laser did not function well during this deployment, possibly a temperature effect we also observed during HLY0801, precluding quantitative analysis. At this date, image analysis has been completed for a subset of sites using Adobe Photoshop. Measures include: area analyzed; counts, percent cover, and density per m^2 of epifauna by family/species; counts and density of infauna where visible; type of dominant and secondary substrate, percent cover of each substrate type; determination of whether benthic topography is physical or biological in origin; and measures of benthic topography including counts, distribution, density, min/max size of burrows, pits, mounds, and track lines.

Preliminary results presented here are based on along-track counts and habitat descriptions only. Full comparative quantitative analysis of along-track epifauna counts will need to consider the total sampled area for each station. This value is affected by camera height, ship drift speed, and total recording time. Data validation between ship instrument deployment records, shipboard data logs, and camera recorded files needs to be completed to compile the data required to make such computations. We will use continuously collected GPS locations of the ship as necessary to complete records of total area sampled for each station.

However, it is clear from the preliminary analyses that habitat groups can be distinguished using underwater video data. The most clearly distinguished habitat is one characterized by bioturbated silt, abundant brittle stars, and various presence of other mobile and sessile epifauna. The tight clustering of these sites in the multidimensional scaling plot (Figure 2) shows that the epifaunal community

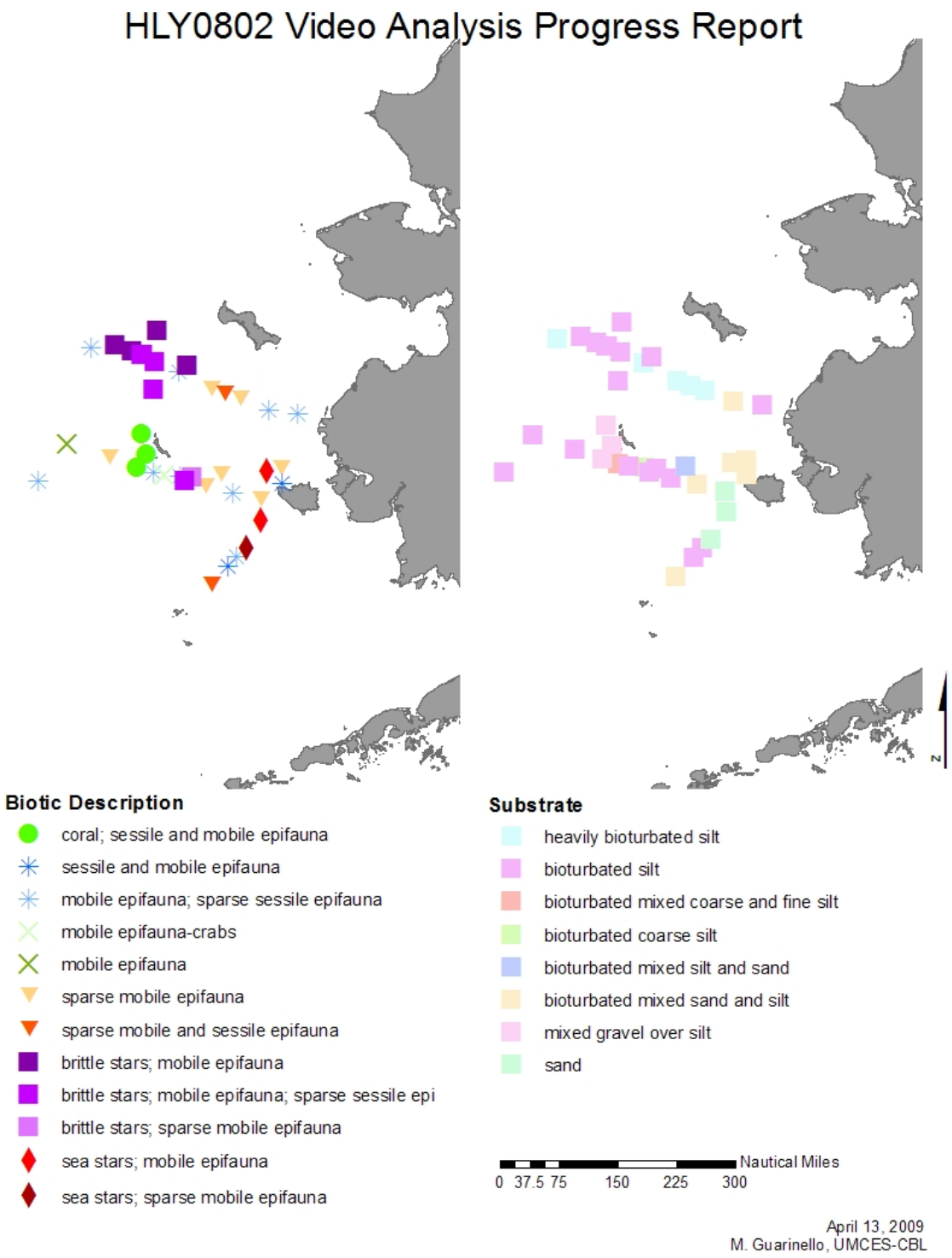

Figure 1. Preliminary map of general habitat descriptions for HLY0802 stations sampled with underwater video.

composition estimated from along-track counts for these sites is very similar. Some relationship between substrate and biota is also most clearly seen at these brittle star sites. Relationships between substrate and fauna are also evident in that the biotic group “coral, sessile and mobile epfauna” only occurs at the

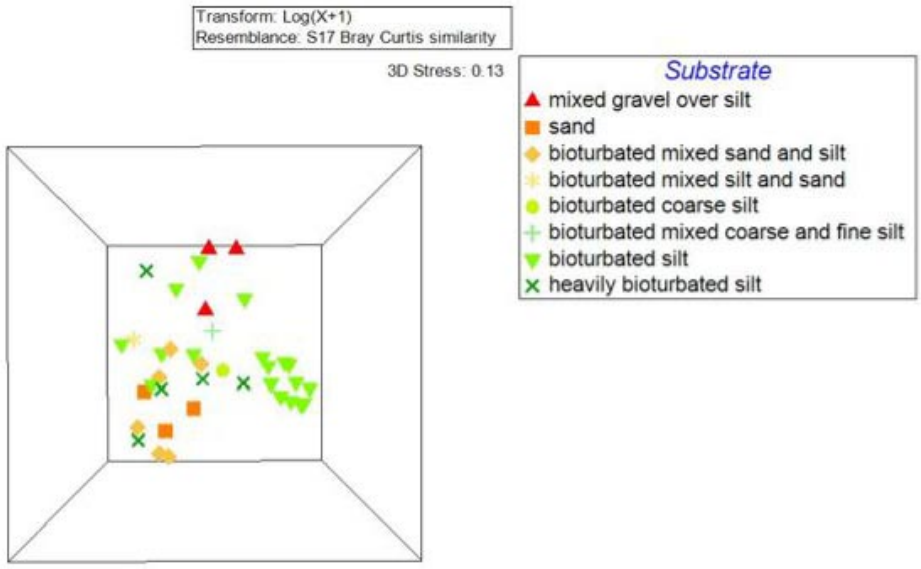

Figure 2. This ordination plot shows the similarity between epifaunal community composition at each site. The symbols show the general biological habitat description currently given to each site.

"mixed gravel over silt" substrate stations. However, the biological similarity between these sites does not produce tight clusters indicating that there may be more heterogeneity in these habitats than in those dominated by silt and brittle stars.

In addition to the epibenthic survey in 2008, 21 infaunal stations were occupied during HLY0802 and sorting is underway. Sediment grain size and chlorophyll determinations have been completed on all these stations; total organic carbon content analyses are in progress.

We consider all milestones to have been completed or on target for completion within the requested no-cost extension period. We will provide the epibenthic video summary data in excel and word format to the BSIERP data archive by October 2009, along with the sediment parameters and benthic infaunal abundance and biomass data. The final report for this project will also be submitted in October 2009.

Lessons learned and project adjustments: The camera system is experimental and not a production system. It was also delivered less than 24 hours before the Healy departed Seattle for the Healy 08-01 cruise as a result of a short time frame between the time funding was approved and transferred to the State University System of Maryland and when the camera system could be built. As a result, we did not have the opportunity to test it prior to use in the field and several efforts had to be made in the field to improve its operation (e.g. focus adjustment, replacement of one spacing laser that did not operate well at cold temperatures). Several iterations had to be undertaken too before an efficient deployment procedure was settled on. In addition, on Healy cruise 08-02, we have identified several discrepancies in the event log that recorded when the camera was placed in the water for GPS coordinate determinations. We have corrected these discrepancies with BEST data management personnel at the University Corporation for Atmospheric Research. The lessons learned from all of these challenges include the need for adequate time and personnel to deploy new sampling systems and sufficient interactions with shipboard data management systems.

Processing of the data sets is not straightforward and requires individual observations of many images to develop a quantitative count of epibenthic diversity and abundance. We are developing a methodology for a streamlined data extraction technique and future camera deployments and analyses should be more time-efficient. Before a software imaging system can be functional we need to evaluate the system with a "human" eye and then "train" the software to make counts for quantitative determinations.

Integration activity: We will transfer the current qualitative data description to Ken Coyle of the BSIERP data management system in preparation for full data transfer in word and excel formats. PIs Grebmeier and Cooper have participated in BSIERP patch dynamics meetings and conference calls. We also plan to transfer select clips of the video footage itself in the form of Quicktime video to the BSIERP data repository for public and scientific use.

Education and Outreach: Co-PI Lee Cooper gave an invited public presentation in Dutch Harbor, Alaska on March 12, 2008 to the general public on the overall objectives of the Healy 08-01 cruise. Some of the video footage collected on Healy 08-01 was also shown in a follow-up presentation after the cruise was over at the Museum of the Aleutians in Dutch Harbor. We hosted onboard Healy during Healy 08-01 a British Broadcasting Corporation Natural History Unit film team that obtained footage for use in BBC Frozen Planet natural history series (see http://en.wikipedia.org/wiki/The_Frozen_Planet) and an independent film team producing a documentary on climate change in the Bering Sea (http://www.florentinefilms.org/inproduction/THIN_ICE.htm). A professional photographer, Mr. Christian Morel from France, also documented the scientific research activities as part of an International Polar Year project during the cruise that will freely make available high-definition images to increase public understanding of polar research issues (http://www.ourpolarheritage.com/en/accueil.php). A middle school science teacher from Anchorage, Mr. Craig Kasemodel, participated in the scientific work and communicated results back to his classes through the PolarTREC (www.polartrec.com) program with both NSF and NPRB support (http://www.polartrec.com/bering-ecosystem-change). Ms. Nora Deans, BEST-BSIERP Outreach Manager participated in the scientific work and maintained a ship log throughout the Healy 08-01 cruise that is posted on the BSIERP web page (www.bsierp.nprb.org). In June 2008: Co-PI Cooper made an invited presentation in Annapolis, MD for the Integration and Application Network of the UM Center for Environmental Science, including a state and federal agency audience. Samples of video clips obtained during this project were used during the talk. The talk is available on-line at http://ian.umces.edu/seminarseries/ Also, in June 2008 PI Grebmeier gave an invited plenary talk at the Ny Alesund Climate Change Symposium before a number of high-level European Union government officials, and some of these video clips were also used.
http://www.kingsbay.no/index.php?option=com_content&view=article&id=245&Itemid=179

Many other forms of outreach activities have occurred in fall 2008 through winter 2009 where the epibenthic videos were shown, including presentations at Yale University, the PICES meeting in Dalian, China, an Aspen Institute sponsored meeting at the Wye River Plantation, the University of Delaware, at Horn Point Laboratory/UMCES, and the Tromsø Arctic Frontiers international meeting, among others.

Next year's Work plan (not part of the 5 page target length): This project is scheduled to be concluded in October 2009. Tasks for the next six months:

1. Resolving discrepancies in the event log
2. Determining the distance traveled by the ship during each camera deployment (if possible from available data)
3. Completing still image analysis
4. Comparing calculated epifauna abundance with trawl data collected in the same relative location via 1) Dr. Jim Lovvorn, University of Wyoming, in 2006 and 2007, and 2) NOAA trawl surveys.
5. Comparing community and habitat analysis with infaunal counts from van Veen samples

Acknowledgments: We thank Ed Davis (University of Tennessee Knoxville) and Dr. Boris Sirenko (Zoological Institute, Russian Academy of Sciences, St. Petersburg) for shipboard assistance in deploying the epibenthic camera system and van Veen for infaunal collections made during both Healy cruises in 2008. In addition, Marisa Guarinello form CBL/UMCES provided technical support for evaluation of the video imaging system and summary text for this progress report.