MARCH 2004 Progress Report to the NOAA Arctic Research Office(ARO)
for
ECOSYSTEM CHANGE IN THE NORTHERN BERING SEA

A. Title of Project: Ecosystem Change in the Northern Bering Sea

B. Principal Investigators: Jackie M. Grebmeier, University of Tennessee Knoxville, Jim Overland, PMEL/NOAA; Terry Whitledge, University of Alaska Fairbanks

D. Brief statement of Purpose or Objective

This project investigates the hypothesis that recent anomalous spring and summer productivity on the Northern Bering Sea shelf relates to decadal-scale atmospheric/sea ice/oceanographic processes, which reflect regime-induced climate changes in the western Arctic. Recent work shows that there are hot spots of biological productivity southwest of Saint Lawrence Island, and that this productivity has been decreasing over the past decade. Reports indicate that the Bering Sea is shifting to an earlier spring transition based on ice melt and changes in atmospheric circulation patterns. Since changes in the North Pacific Oceans show little long-term trend while the trend in Arctic Oscillation appears to be a clearly increasing climate signal, the northern Bering Sea is an important location to monitor ecosystem change. The combination of these studies demonstrate the timeliness for increased focus on the ecosystem of the northern Bering Sea. To establish such a program we have undertaken the following tasks:

1) Establishment of a northwest Bering Sea biophysical oceanographic mooring to document ongoing changes, similar to the successful multiyear FOCI mooring M2 on the southeast Bering Sea shelf.
2) A retrospective analysis of all northern Bering Sea data to put future changes into context and to provide an objective measure for change detection.
3) Process studies of the northern biological hot spots, primarily funded by non-NOAA sources.

E. Accomplishments to Date

Annual hydrographic and benthic sampling at select sites north and south of Bering Strait were completed in 2003 as part of the NOAA Ecosystem Change in the Northern Bering Sea project in collaboration with the National Science Foundation-funded Bering Strait Long-Term Observatory (LTO) project (http://arctic.bio.utk.edu). These studies extended a 19-year time-series of CTD, nutrients, chlorophyll and sediment flux measurements of dissolved oxygen, benthic biomass, and other chemical and biological parameters at productive benthic stations, both north and south of Bering Strait (Fig. 1). This work was in collaboration with Dr. Ed Carmack (Institute of Ocean Sciences, IOS) and the Canadian Coast Guard ship *Sir Wilfrid Laurier* enroute to resupply communities in the Canadian Arctic. A total of 32 stations were completed in the Bering and Chukchi Seas in 2003. The core LTO sites included 16 water column and benthic stations in areas A, B, and D and 5 hydrographic stations in the US-portion of Bering Strait (Area C).

For the first time in 2003 we placed a mooring in the St Lawrence Island Polynya(SLIP) region southwest of St. Lawrence Island. This mooring was emplaced in the A-SLIP region near stations SLIP-1 and SLIP-2 (Fig. 1)

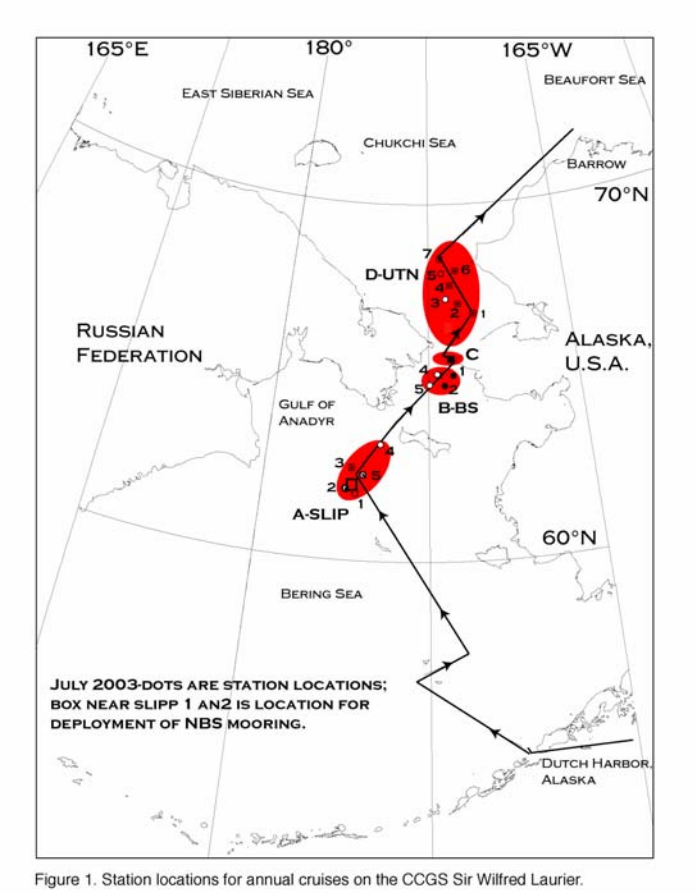

Figure 1. Station locations for annual cruises on the CCGS Sir Wilfred Laurier.

Figure 1. Station cruise track for July 2003 cruise on the CCGS *Sir Wilfrid Laurier.*

The following plan outlines the field work completed in 2003 (see Fig. 1).

1. six CTD-only water column stations in transit to area A (BS1-BS6)
2. five long-term sites south of St. Lawrence in a "hot spot" region (A) where we have been observing bivalve and upper trophic level declines over the past decade
3. deployment of NBS mooring near stations SLIP1 and SLIP 2; plus CTD
4. four stations in the NE Bering Sea (B)
5. five station CTD transect across Bering Strait (C) (U.S. waters only), followed by an 8 consecutive hour water survey at Little Diomede Island in Bering
6. seven stations in the SE Chukchi Sea (D) as completed previously during 1998-2003 and
7. four CTD- only water column stations in transit to Barrow (BD-6, CKS-1, BD-7, BD-8).

Water column CTD with rosette deployment for S/T/D and water column collections at 5 m depth intervals to bottom of deployment (one deployment). Once returned to the deck, seawater was collected from each rosette bottle on the CTD for the following measurements:

a. nutrients-subsamples collected in acid-washed plastic vials and frozen shipboard

b. chlorophyll-subsamples collected and processed shipboard on a Turner fluorometer
c. oxygen-18-subsample collected in glass vials and sealed for land-based analyses.

Table 1. Listing of long-term stations south of St. Lawrence Island where the NOAA mooring has been deployed.

Station (2003)	Historical Station	Date	Latitude (°N)	Longitude (°W)	Depth (m)	Sampling
SLIP1	VNG1	7/14/2003	62.013	-175.056	80	water, sediment
SLIP2	NWC5	" "	62.051	-175.207	82	water, sediment
NBS	no	" "	62.080	-174.993	82	mooring, water
SLIP3	NWC4	" "	62.394	-174.570	73	water, sediment
SLIP5	VNG3.5	" "	62.563	-173.556	65	water, sediment
SLIP4	NWC2.5	" "	63.029	-173.457	72	water, sediment

In summer 2003, we deployed a subsurface mooring in 80 m of water near SLIP-1 and SLIP-2 in the northern Bering biological hot spot (Region A) through funding by the NOAA Arctic Research Office. This mooring consists of two seacats and ten microcats to measure profiles of temperature and salinity, one fluorometer (2 instruments were planned to be deployed, but one was not functional at sea) to assess chlorophyll (phytoplankton biomass), two current meters and an ISUS nitrate meter (see next figure). In the second year, we will recover the first-year mooring and procure and deploy a second system to provide a multi-year continuous capability. Table 2 below provides the mooring deployment array.

03STL-1A, July-03	
Project: St. Lawrence Is.	
Location: Bering Sea	
Latitude:	
Longitude:	
Seafloor: 75 meters	
Currents: 70 cm/s	
Instruments:	
Seacat	2
Micro cat	2
Nitrate Meter	1
RCM-9	2
SBE-39	8
release	1
Mooring:	+5m (7/03 modification)
Instrument	**Depth**
Seacat (FL/P)	11m
RCM-9-C	14m
SBE-39	17m
Nitrate Meter	18m
SBE-39	20m
SBE-39	23m
Seacat (No FL)	27m
SBE-39	30m
SBE-39	35m
SBE-39	40m
Micro Cat	45m
SBE-39	50m
RCM-9-C	55m
Micro Cat	60m
SBE-39	65m
Release	
seafloor	75m
Previous Deployments: None	
Mooring Design Change: N/A	

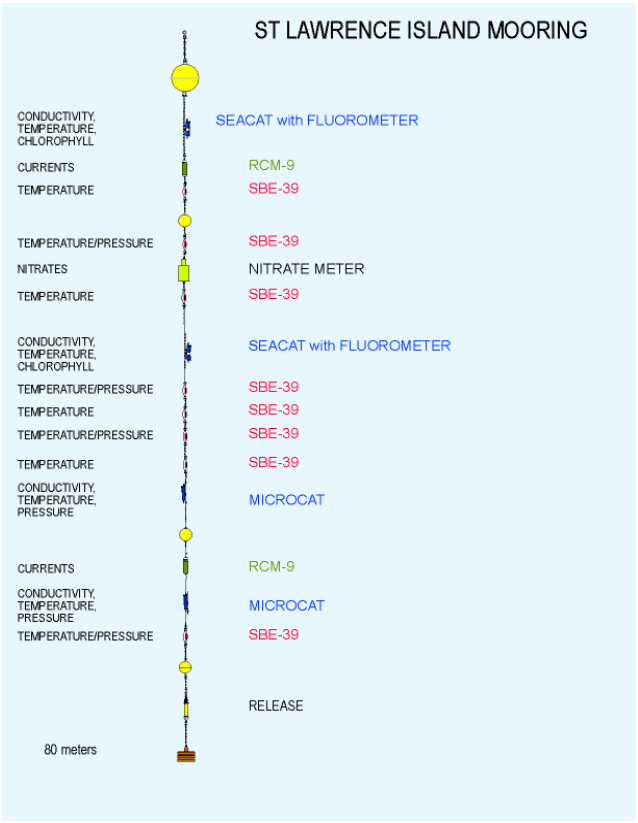

Figure 2. NBS mooring deployment array sensor location (left panel) and location on mooring (right panel).

With regard to the retrospective element, sediment and benthic faunal data from the northern Bering Sea from the 1970s through 2003 are being entered into an excel spreadsheet format for inclusion in a long-term data base. Some of the early 1990s data from the region south of St. Lawrence Island is currently available at through the Joint Office of Science Support Shelf-Basin Interactions database. Historical hydrographic and productivity data from 1970-1990s has been found and is being entered into an electronic format database. Three cruises from 1990-1993 in the northern Bering/Chukchi Sea have been entered to date and the effort will continue during the next year with the capture of data from the 1980s. We have established a digital atlas of sea ice melt patterns for the Northern Bering Sea for 1973-2003 from weekly records; there are periods of south/north melt, east/west melt and west/east melt.

F. Plans for the Coming Year

1. We will reoccupy the long-term site south of St. Lawrence Island in 2004 as completed in 2003. We will retrieve the PMEL mooring array, download the data, then redeploy at the same site for data collection from July 2004 to July 2005. A new ISUS instrument will be deployed to provide a quick turnaround and deployment of a fully calibrated instrument. CTD, chlorophyll and nutrient collections will be made at the mooring site for calibration of the appropriate sensors.

2. The Sir Wilfrid Laurier cruise is scheduled for July 2004 and we will reoccupy the long-term sampling sites in the northern Bering Sea for hydrographic and benthic measurements.

3. Contemporary and retrospective hydrographic, sediment and benthic faunal data will continue to be entered into an excel spreadsheet format for inclusion in a long-term data base. This database will be linked at the NOAA Arctic website with those data archived through the NSF-supported Joint Office of Science Support (JOSS) in Boulder, Colorado. A retrospective will be completed on Nome weather data (starting in 1913) in comparison to St Paul data(starting in 1917). All retrospective data will be assembled by the end of the year for comparative analysis.

G1. Grebmeier: Summary of Financial Expenditures to Date

Salary and Benefits	$41,882
Equipment	$0
Expendables	$1,666
Travel	$1,000
Other (ship support)	$10,000
Overhead	$10,342

G2. Whitledge: Summary of Financial Expenditures to Date (as of 2 March 2004)

Salary and Benefits	$27,256
Equipment	$27,543
Expendables	$ 3,388

Travel	$ 3,506
Other (shop services, shipping, maintenance)	$ 4,135
Overhead	$19,257

G3. Overland: Summary of Financial Expenditures for FY 2003

S. Salo (Salary, Benefits, OH)	$35300
M. Wang (" ")	6041
Other objects(ADP,Travel,Office Exp)	10700
Mooring	$81794
Equipment(per diagram)	$75977
Floats/hardware/Machineshop	$5077
Engineering costs	$740

H1. Grebmeier: Budget for Coming Year

Salary and Benefits	$52,576
Equipment	$0
Expendables	$3,681
Travel	$1,500
Other (ship support)	$10,000
Overhead	$14,266
Total	$82,023

H2. Whitledge: Budget for Coming Year

Salary and Benefits	$36,013
Equipment	$28,000
Expendables	$ 4,500
Travel	$ 4,500
Other (maintenance, shipping, shop services	$ 4,756
Overhead	$25,084
Total	$103,853

H3. Overland: Budget for FY 2004

Overland 3 months	NC
Rodionov (climate)	45072
Kachel(data process)	6486
Benefits and Overhead	42046
Mooring costs	27949
ADP	3000
Publications	2000

Travel	
Deployments	2500
Meeting	1500
Total	$130553