Results from BEST, BSIERP, and other IPY-relevant research in the northern Bering Sea

Lee W. Cooper
Jacqueline M. Grebmeier
Chesapeake Biological Laboratory
University of Maryland Center for Environmental Science
Solomons, Maryland 20688
USA

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Dalian P.R. China

Video clip courtesy of BBC Planet Earth team on Healy 04-02

Acknowledgments

M. Janout[1], K. E. Frey[2], R. Pirtle-Levy[3], J.R.Lovvorn[4]
A. Humphrey[5], Chad Jay[6], Xuehua Cui[5]

- [1]University of Alaska Fairbanks
- [2]Clark University, Worcester
- [3]North Carolina State University, Raleigh
- [4]University of Wyoming, Laramie
- [5]University of Tennessee
- [6]Alaska Science Center, U.S. Geological Survey

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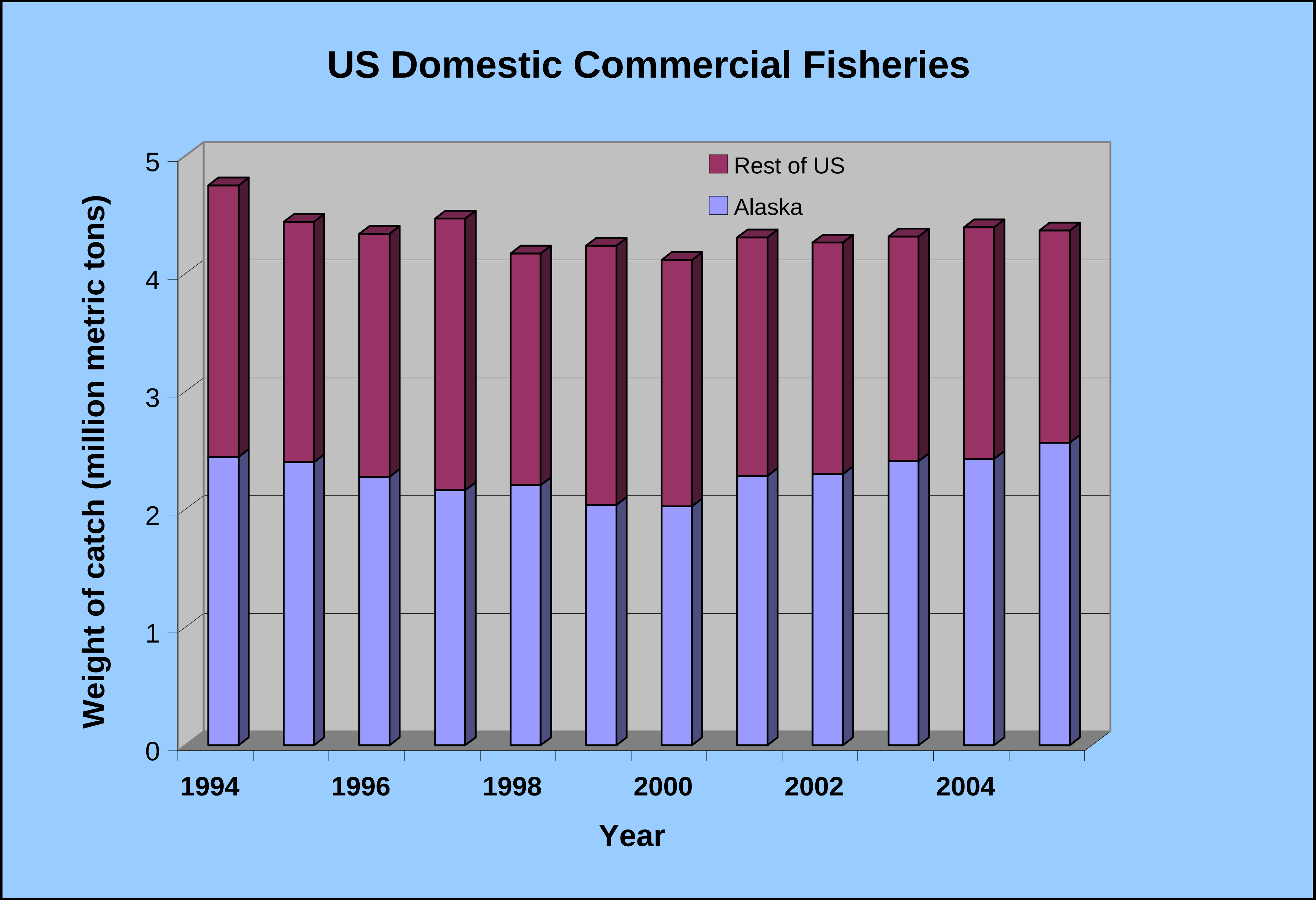
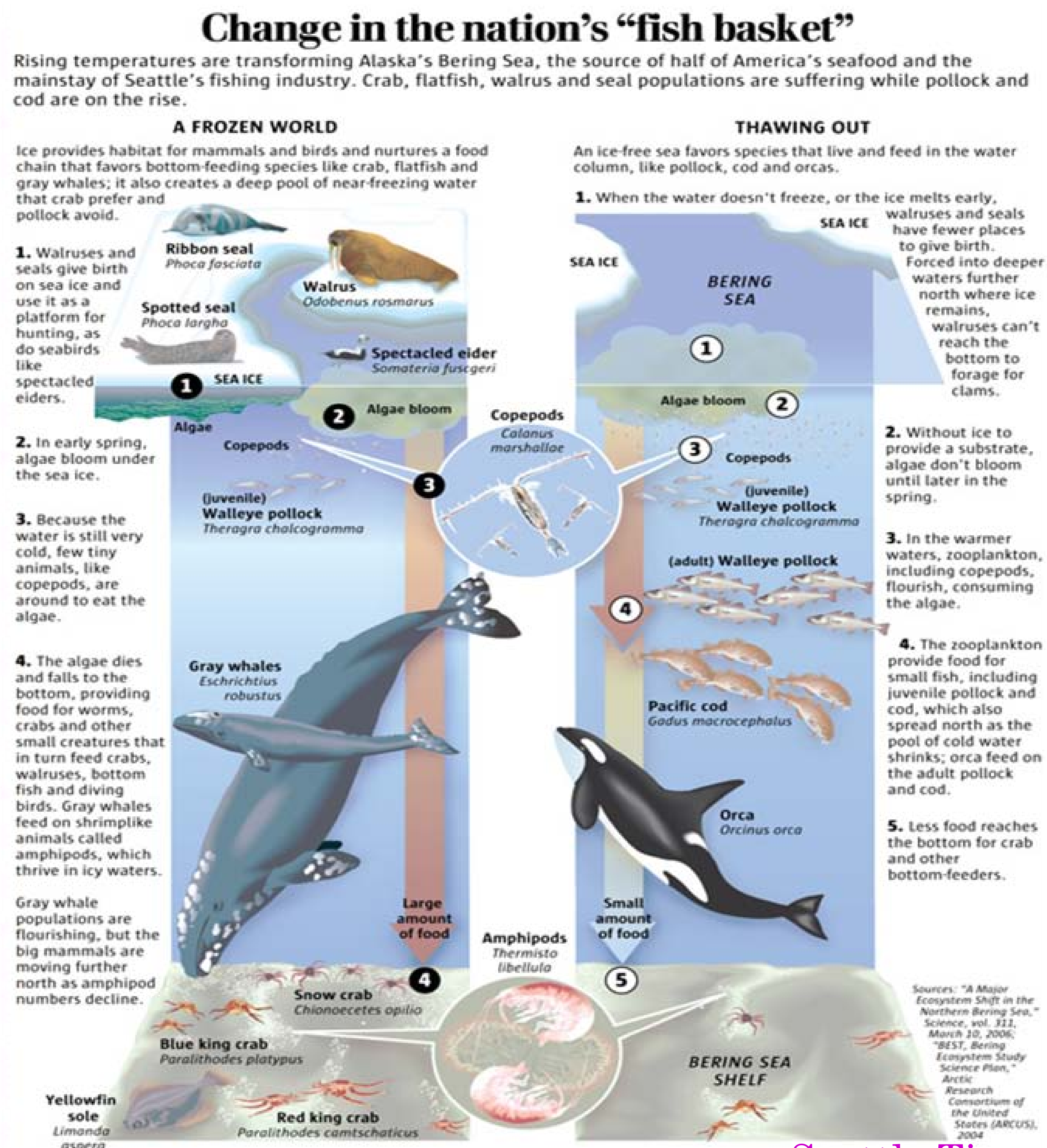
Integrated U.S. Ecosystem Research in the Bering Sea

Bering Ecosystem Study (BEST)
U.S. National Science Foundation
http://www.nsf.gov

Bering Integrated Ecosystem Research Program (BSIERP)
North Pacific Research Board
(government chartered independent research foundation with oversight through U.S. Department of Commerce)
www.nprb.org

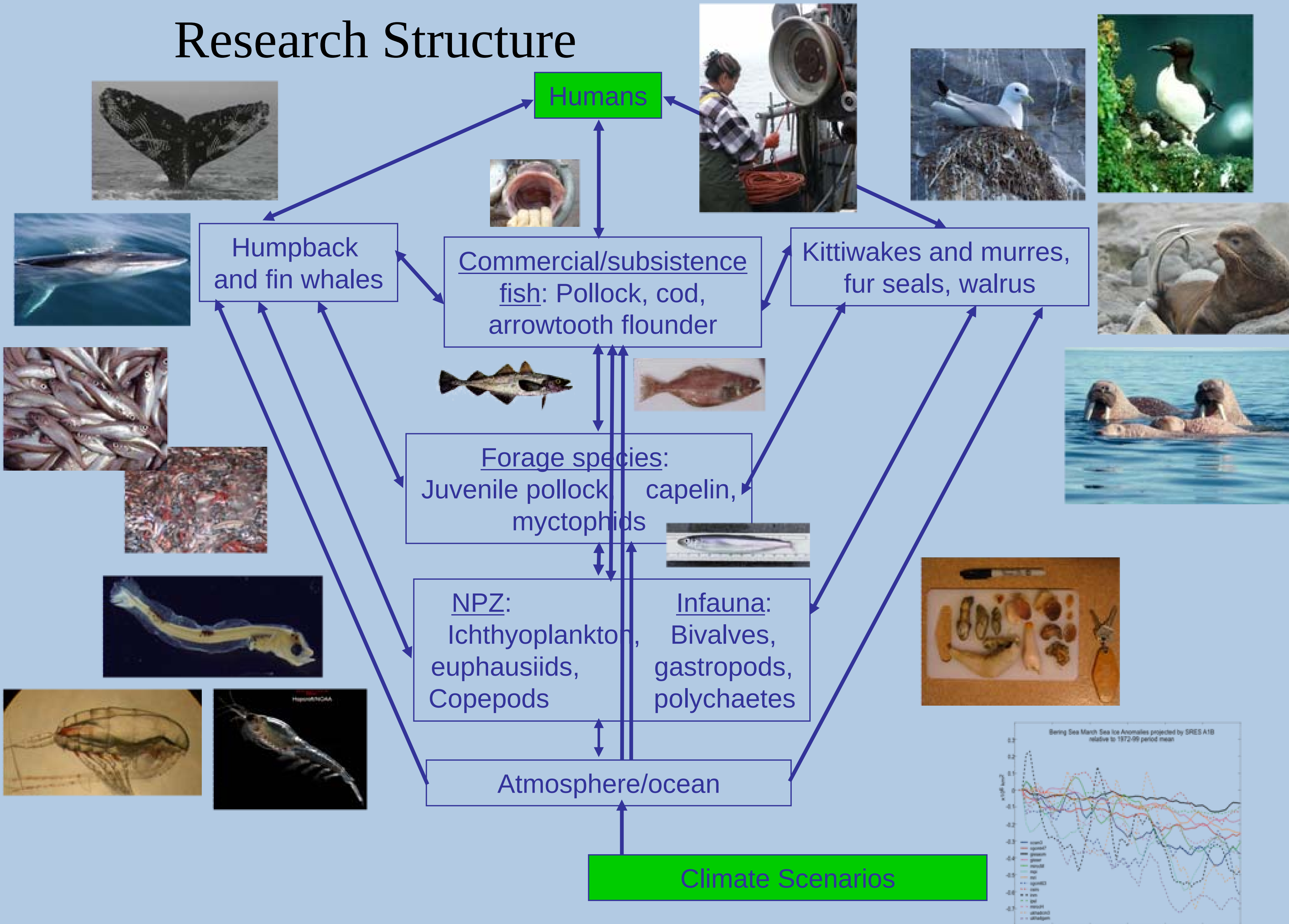

http://bsierp.nprb.org/
Google
Free AOL & Unlimited...
Complete Sun and M...
UNDERSTANDING ECOSYSTEM PROCESSES IN THE
Bering Sea
NSF
AN HISTORIC PARTNERSHIP BETWEEN THE NORTH PACIFIC RESEARCH BOARD AND THE NATIONAL SCIENCE FOUNDATION
AT A GLANCE
General Program Information
Meet the Scientists
Study Region Map
Photo Gallery
NEWS + UPDATES
In the News
Scientific Cruises
Media
Teachers + Students
OUR FOCUS
An Ecosystem Approach
Human Communities
Ecosystem Modeling
Animal Stories
FOUNDATIONS
History
Bering Sea Ecosystem Research: An unprecedented scientific effort between NPRB and NSF
SIX YEARS
93 SCIENTISTS
MILLIONS
OF CREATURES
ONE STORMY SEA
In the News
PROGRAM UPDATES
SAB Election Results
The votes for the Scientific Advisory Board have been tallied. Terms were randomly determined per the Program Management Plan. Congratulations to:
Kerim Aydin, Rolf Gradinger, Phyllis Stabeno (1-year term)
Carin Ashjian, Rodger Harvey, Mike Sigler (2-year term)
JOB OPPORTUNITY
OSU College of Oceanic + Atmospheric Sciences Research Associate (Postdoctoral)
Study the distribution and


US Domestic Commercial Fisheries
Rest of US
Alaska
Weight of catch (million metric tons)
0
1
2
3
4
5
1994
1996
1998
2000
2002
2004
Year

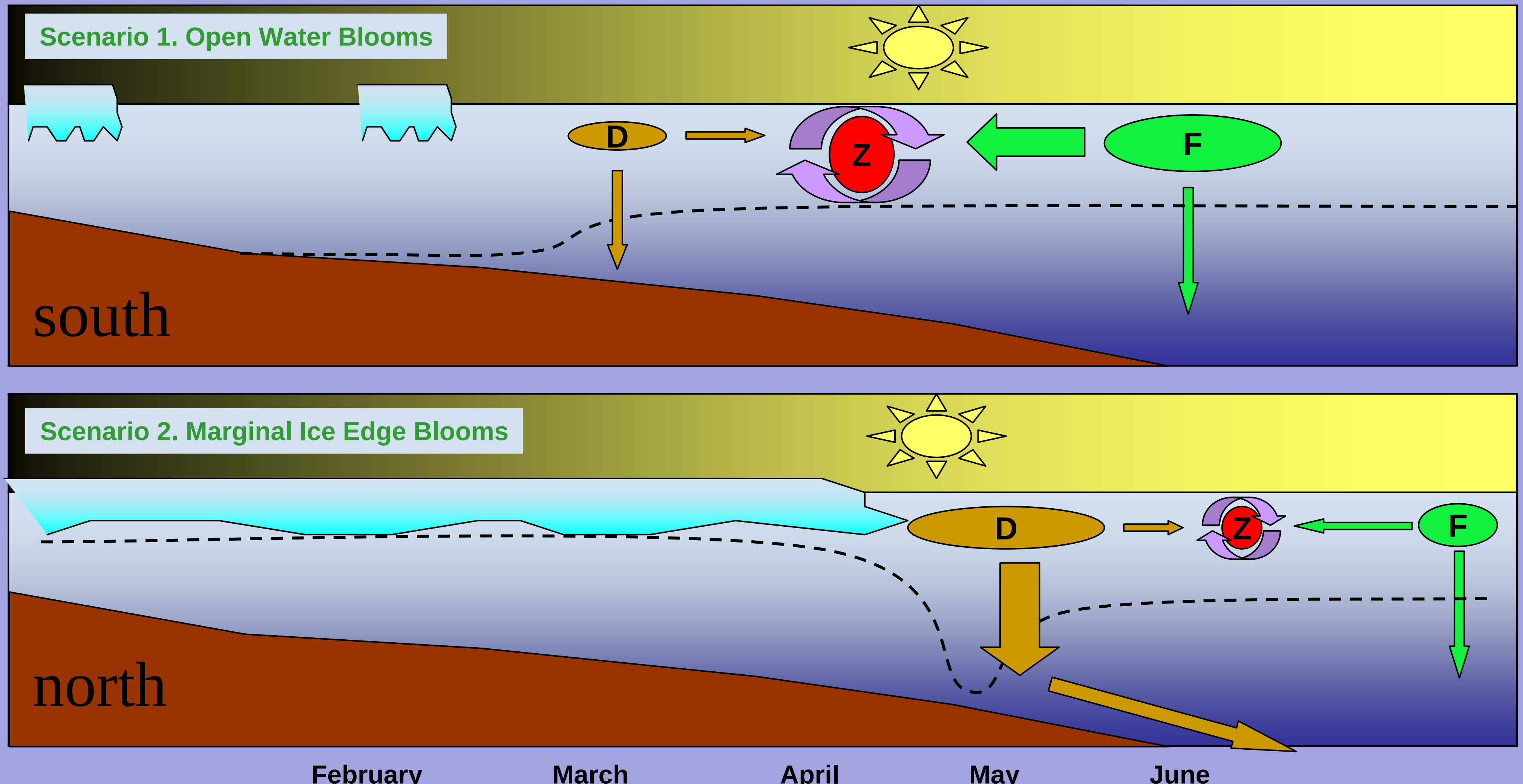


Seattle Times Oct. 1, 2006

BSIERP – BEST Field Research Structure

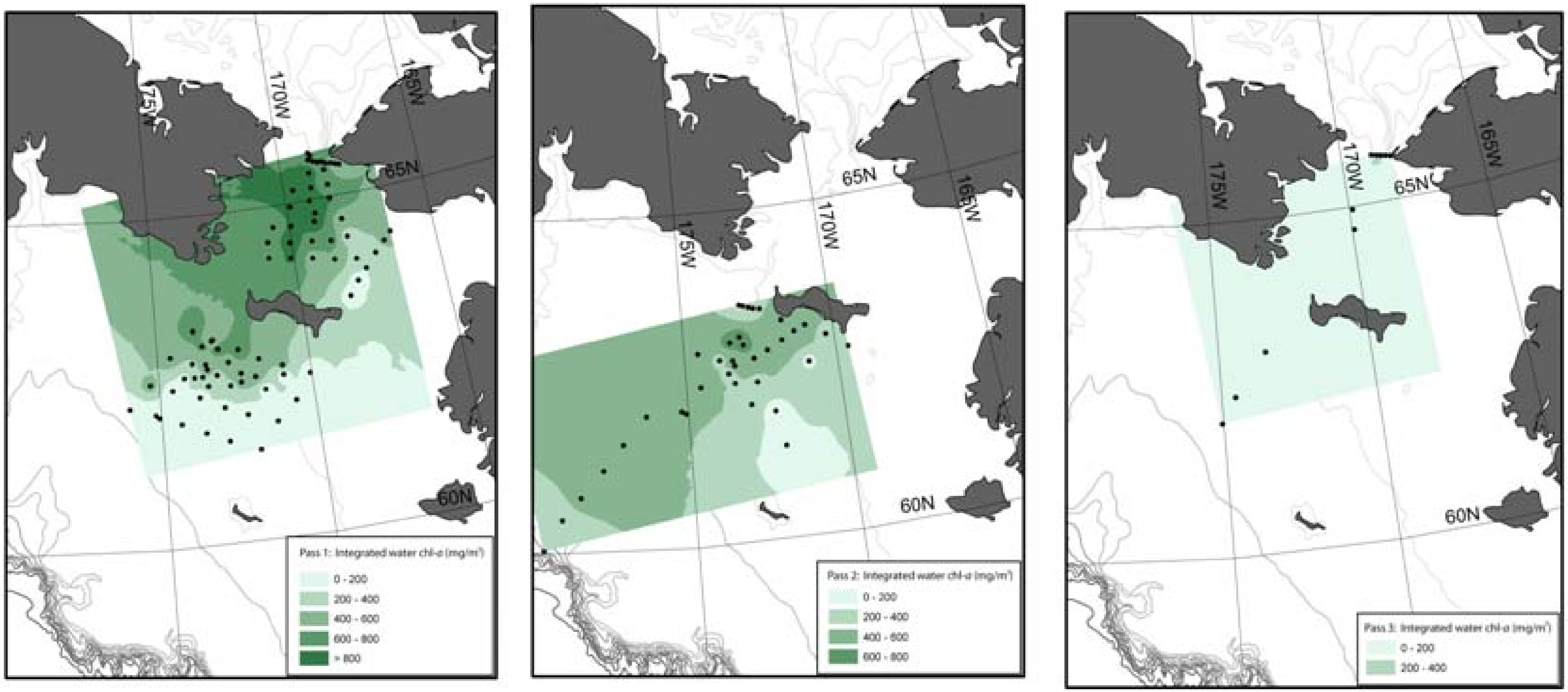


South to north pelagic to benthic ecosystem transition

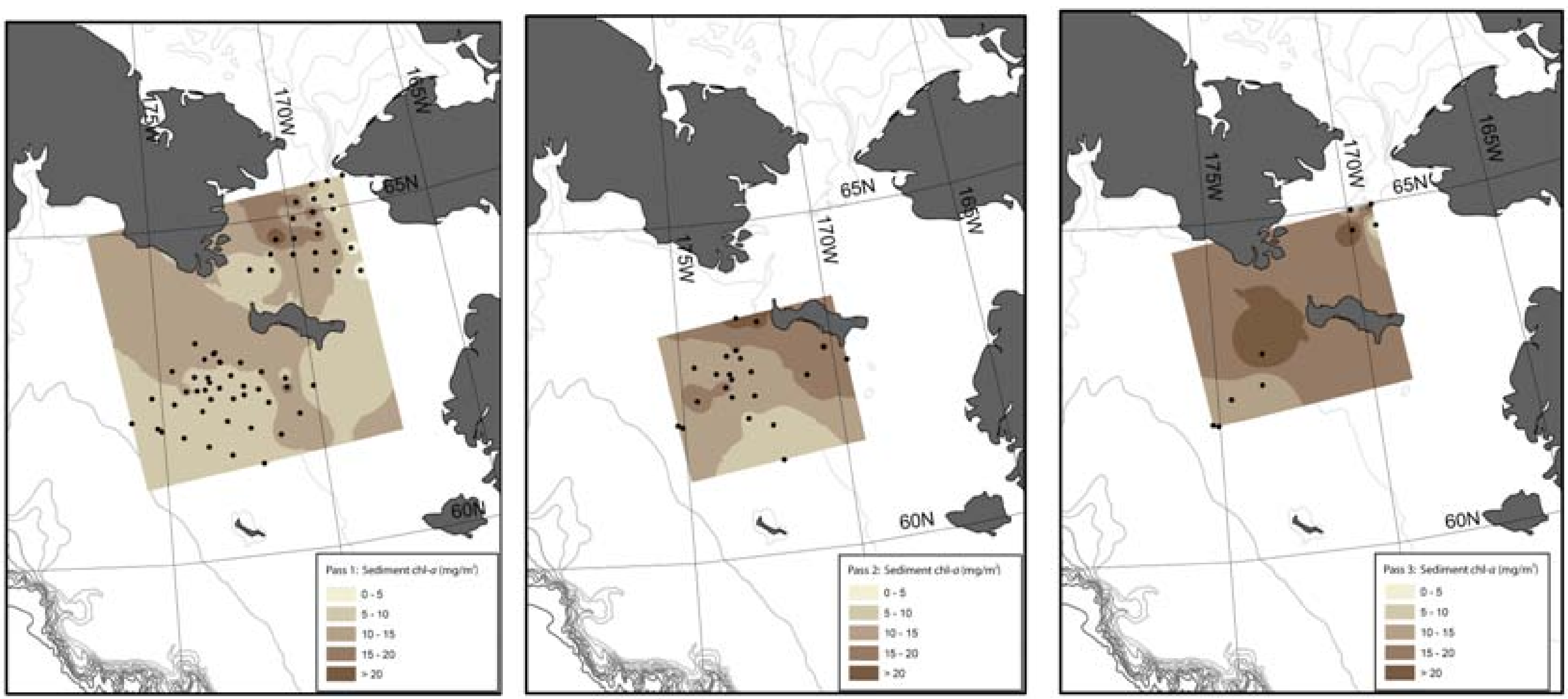


Graphic courtesy of Brad Moran and Mike Lomas

Key - Diatoms, Zooplankton, Flagellates



9-27 May 2006 | 27 May-3 June 2006 | 12-15 July 2006



Integrated water column chlorophyll

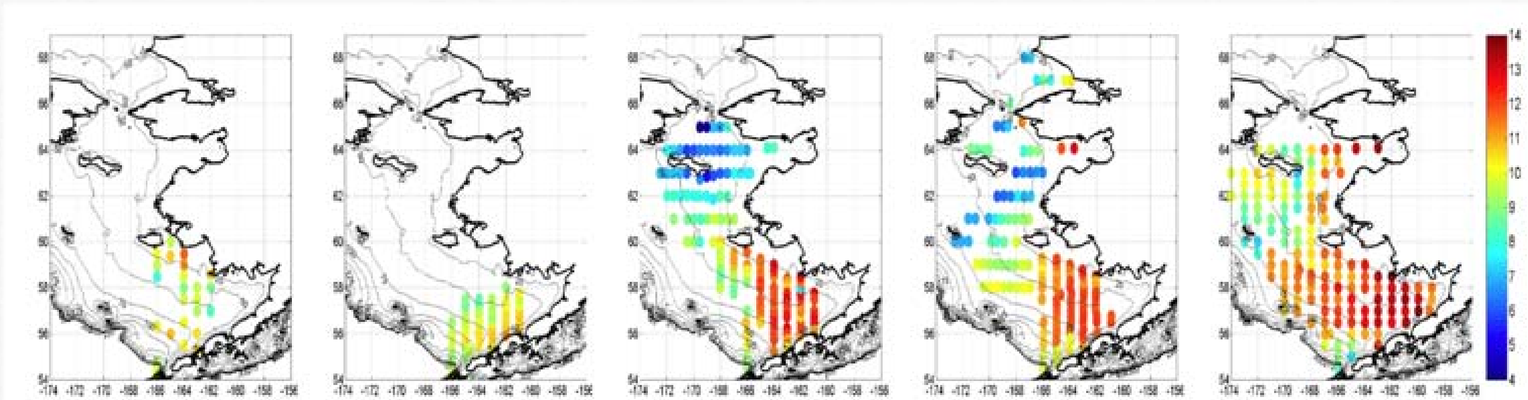
11-1053 mg m^{-2}

Mean chlorophyll in surface sediments

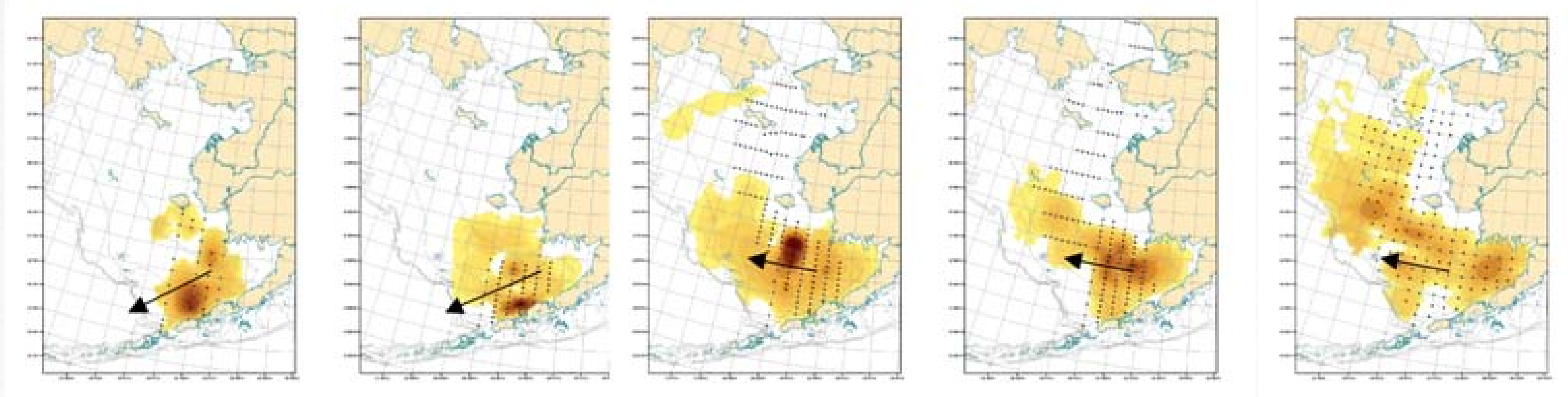
<1 to 40 mg m^{-2}

Surface Seawater Temperature (5 m)

2000 **2001** **2002** **2003** **2004**

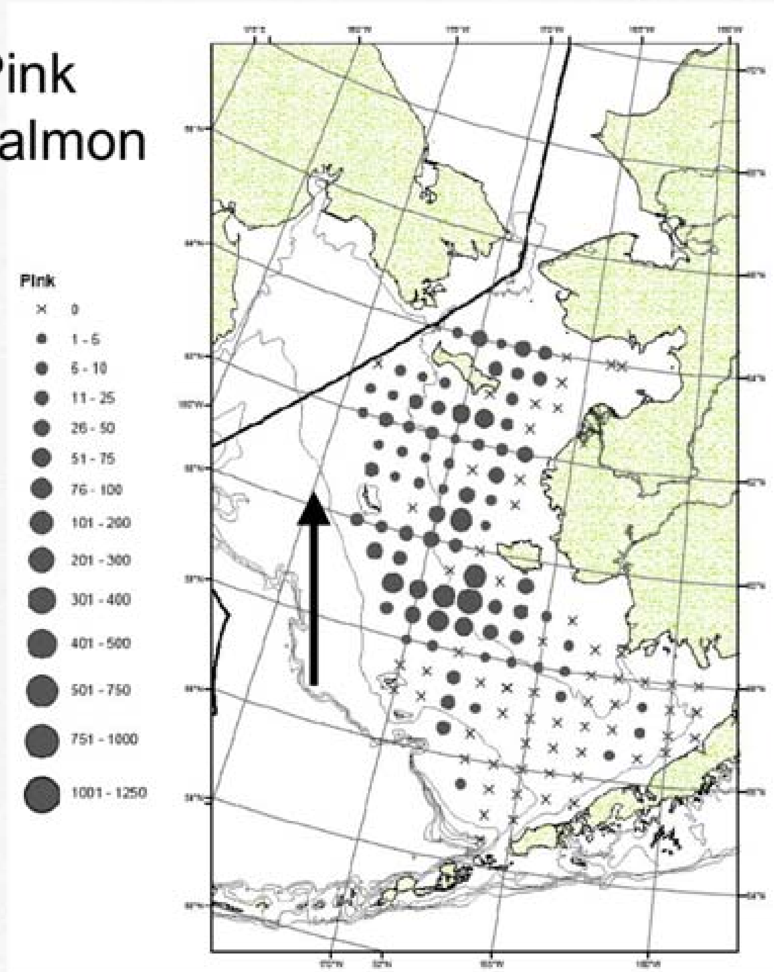


Juvenile Sockeye Salmon Distribution and Seaward Migration Pathway change in Bristol Bay sockeye salmon distribution and seaward migration pathways in relation to warming sea surface temperatures

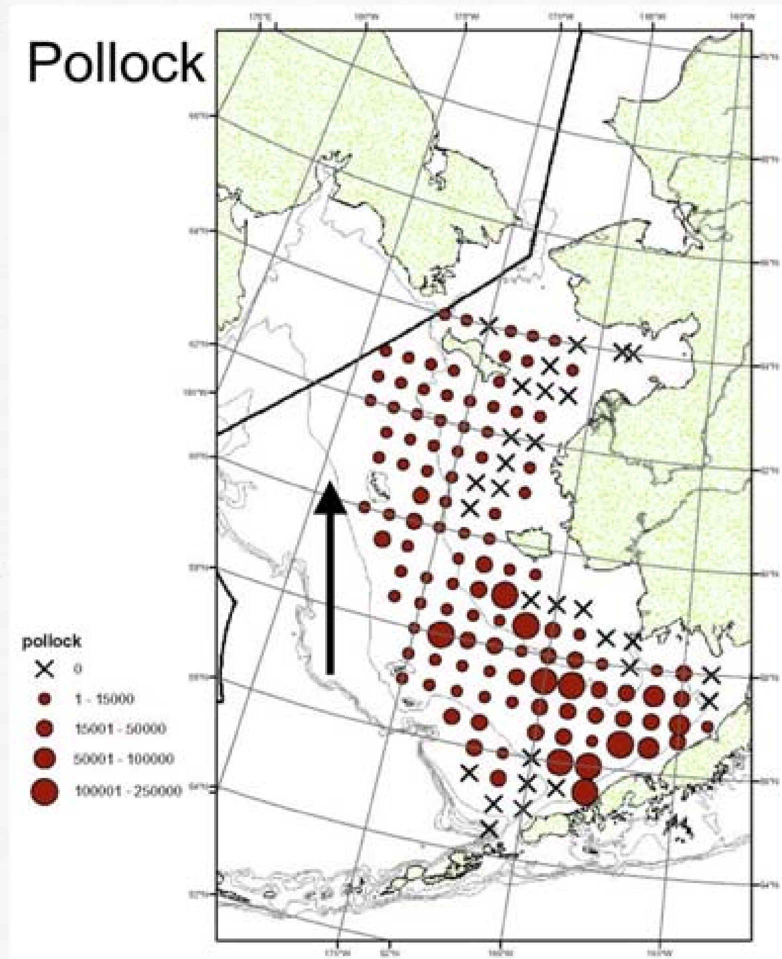


Low Survival High Survival [courtesy Ed Farley/NOAA]

Pink salmon



Pollock



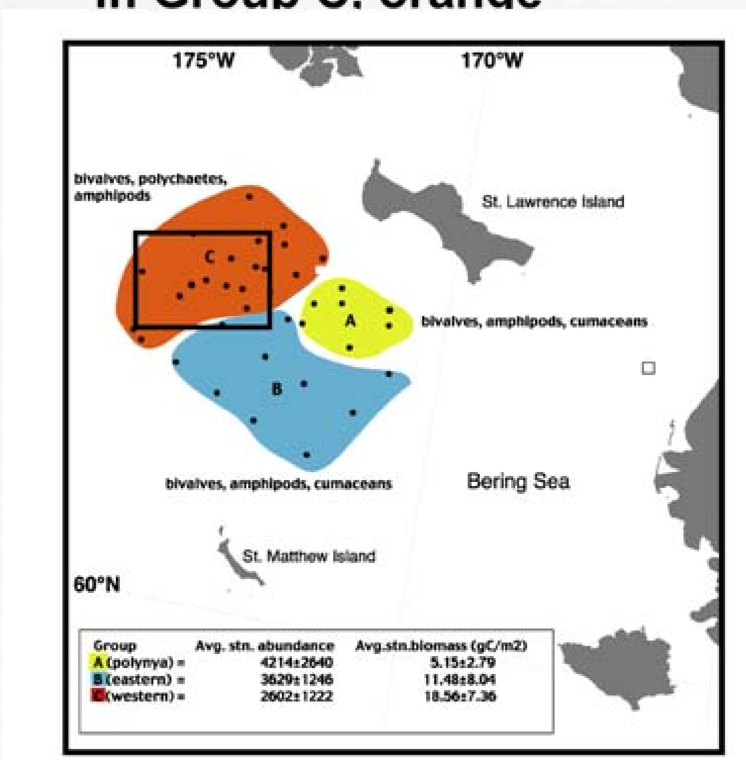
10 Million new Salmon in the N. Bering Sea in 2004; coincident with increased northward movement of pollock

[courtesy Jack Helle/NOAA]

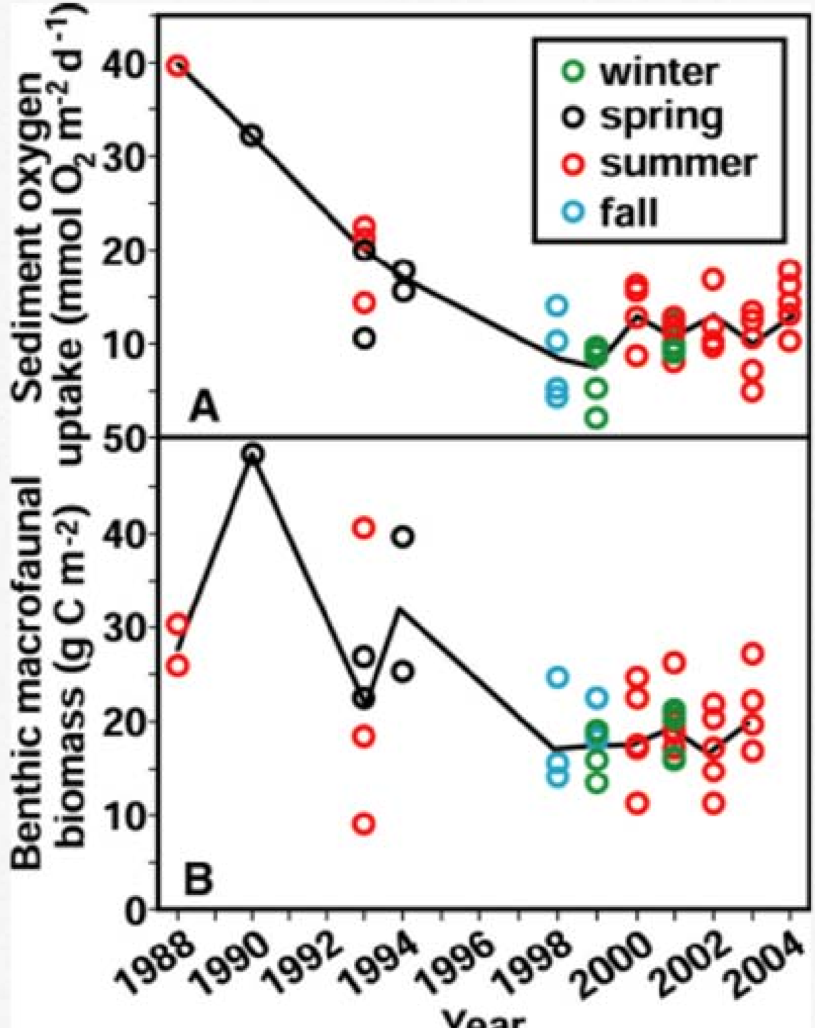
Change in sediment oxygen uptake (indicator of carbon supply to benthos) and benthic macrofaunal biomass SW of St. Lawrence Island

(trend lines through mean)

BSEO-S sites embedded in Group C, orange



[Simpkins et al., 2003, Polar Biology 26]



[Grebmeier et al., 2006, Science 311]

Significantly changing taxa

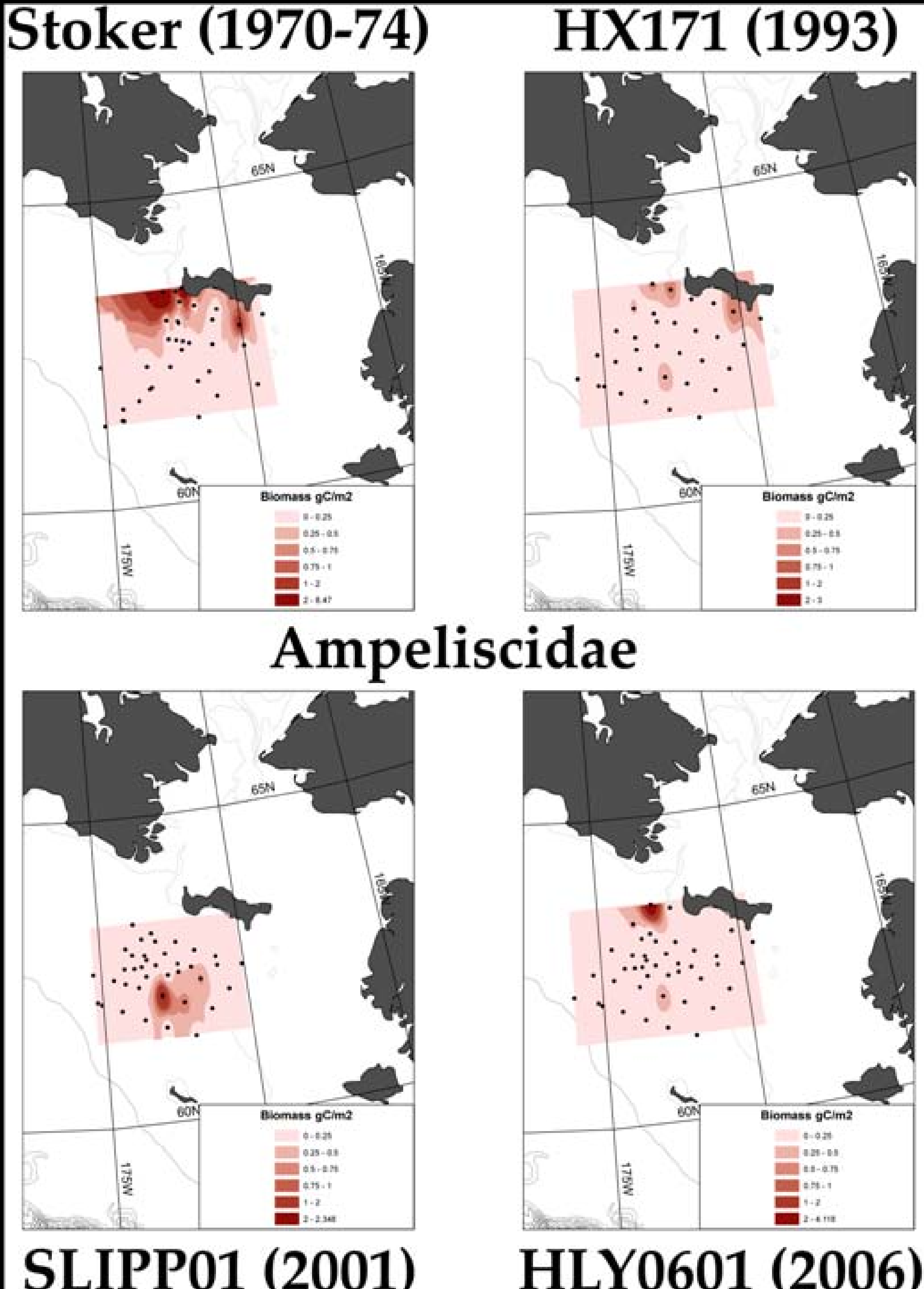
Ampeliscidae

Haustoriidae

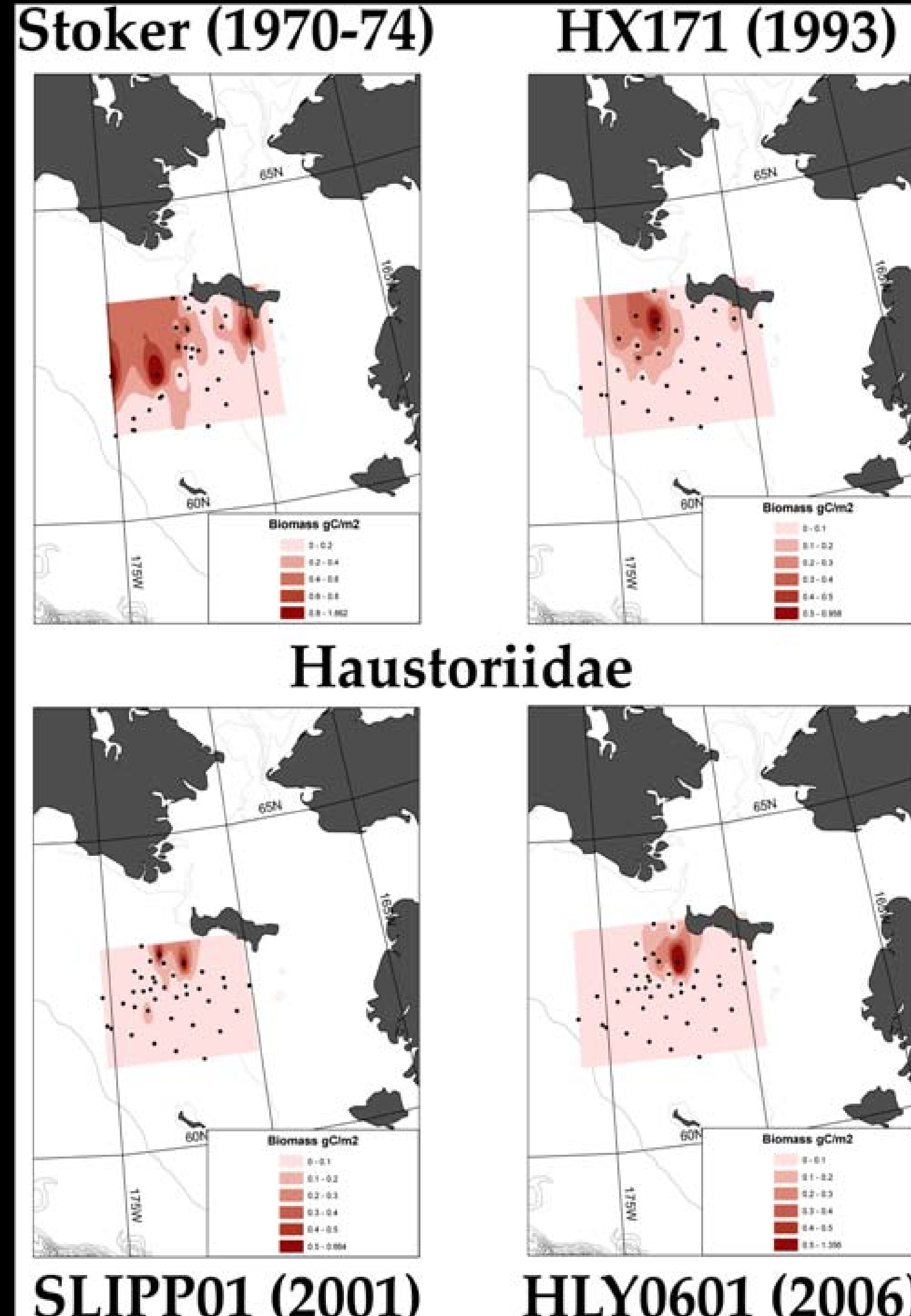
Leuconidae

Orbiniidae

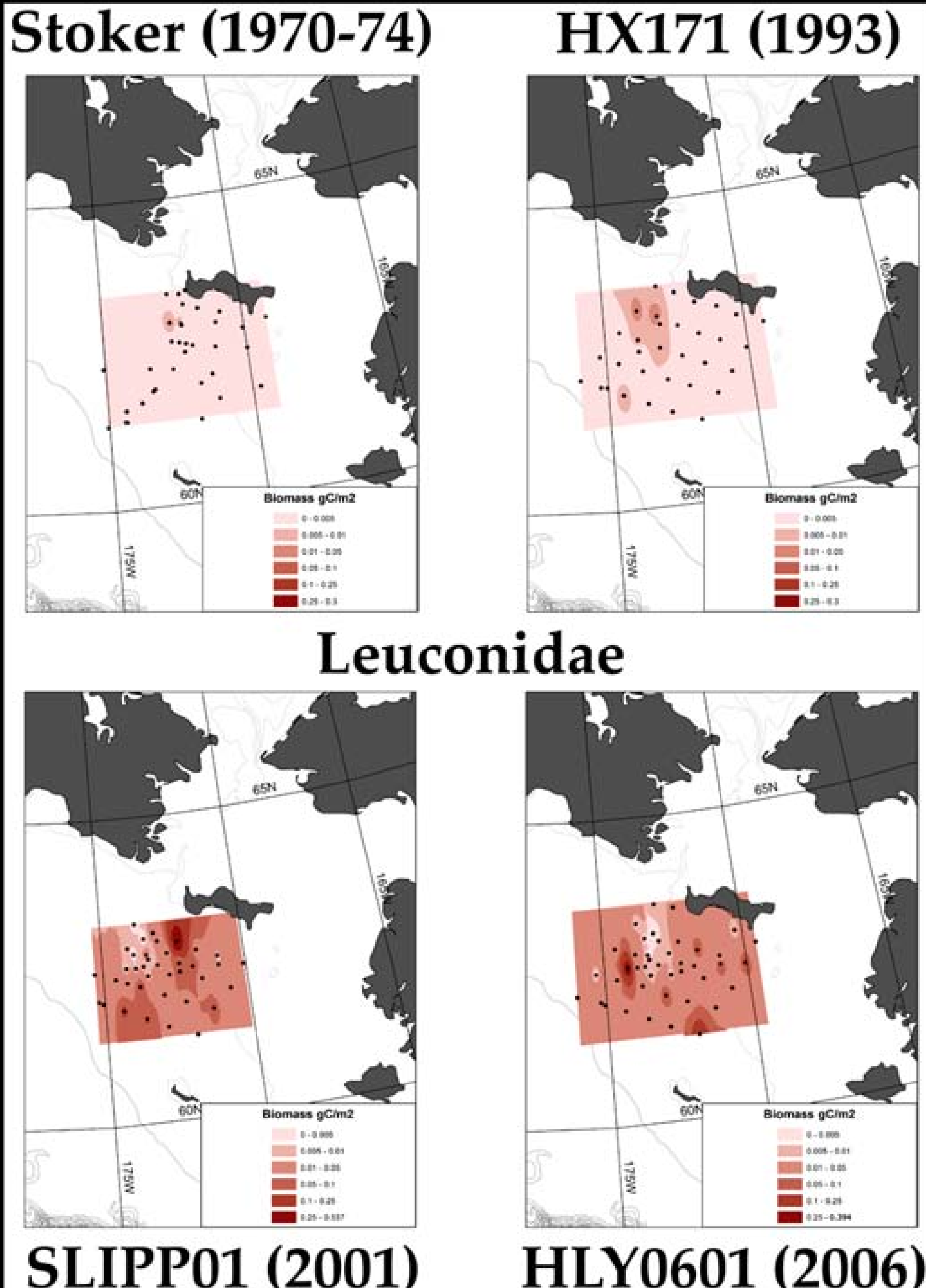
Significantly changing taxa



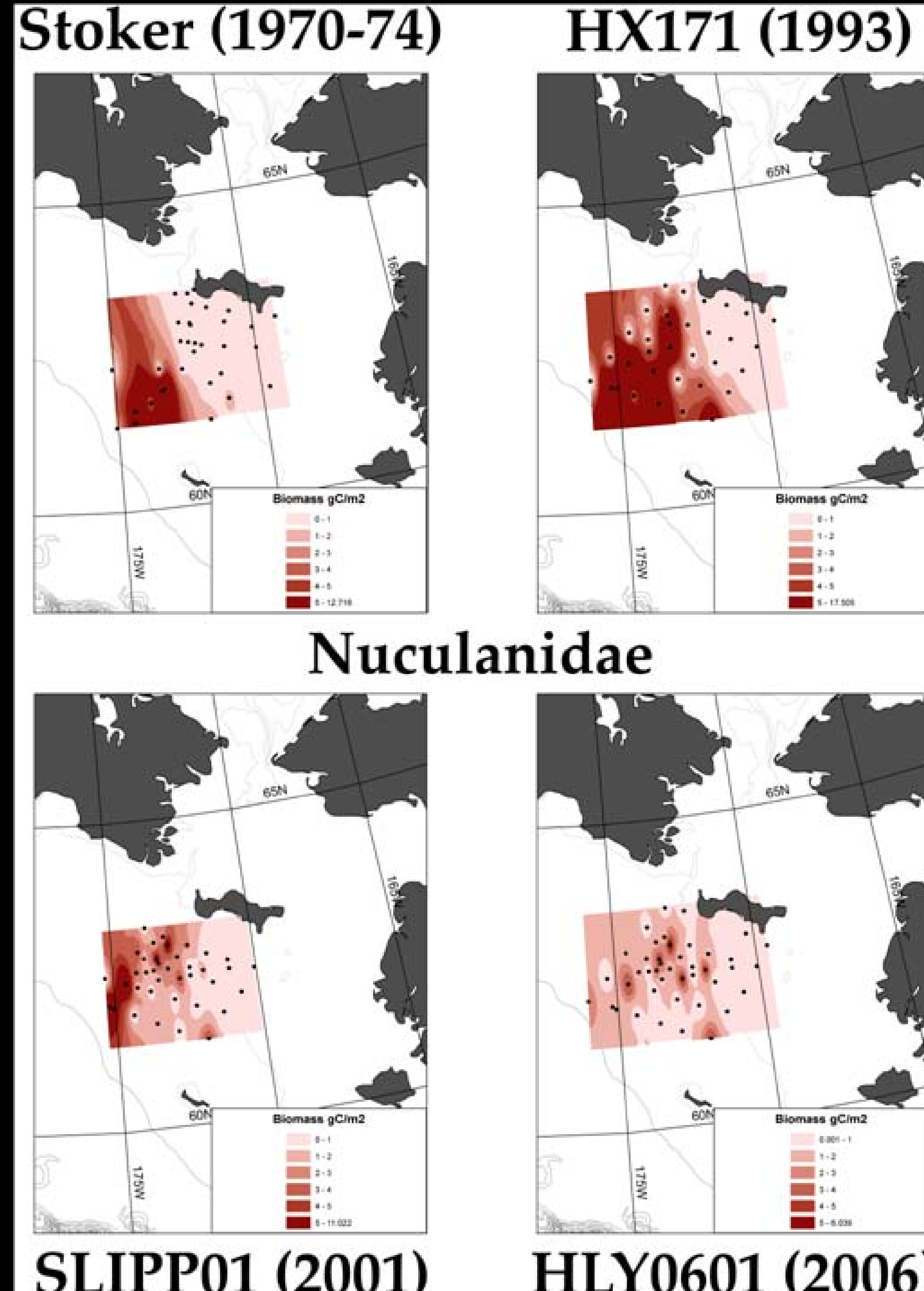
Stoker (1970-74)
HX171 (1993)
Ampeliscidae
SLIPP01 (2001)
HLY0601 (2006)
65N
60N
175W
165W
Biomass gC/m2
0 - 0.25
0.25 - 0.5
0.5 - 0.75
0.75 - 1
1 - 2
2 - 8.47
2 - 3
2 - 2.348
2 - 4.118



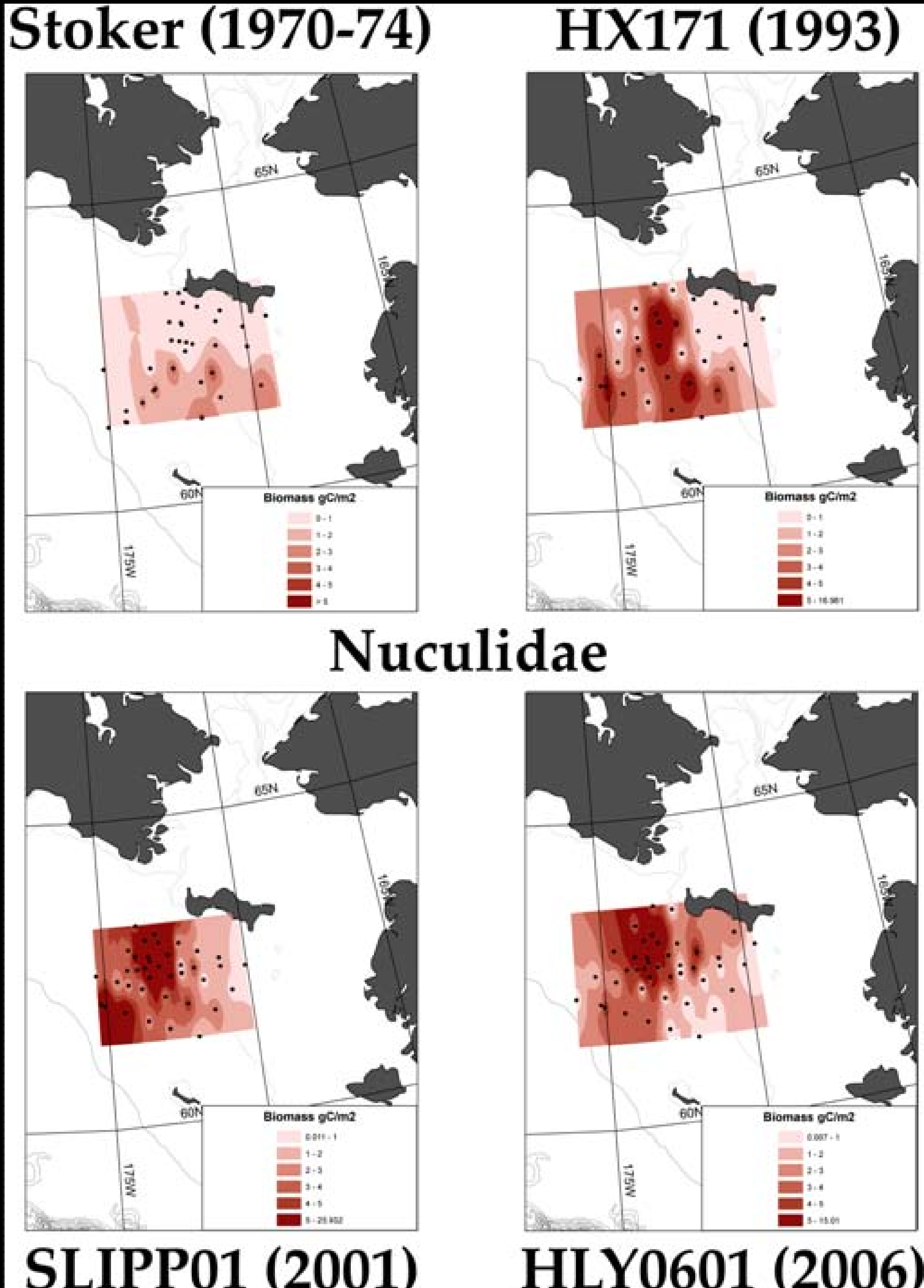
Stoker (1970-74)
HX171 (1993)
Haustoriidae
SLIPP01 (2001)
HLY0601 (2006)
65N
60N
175W
165W
Biomass gC/m2
0 - 0.2
0.2 - 0.4
0.4 - 0.6
0.6 - 0.8
0 - 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.4
0.4 - 0.5

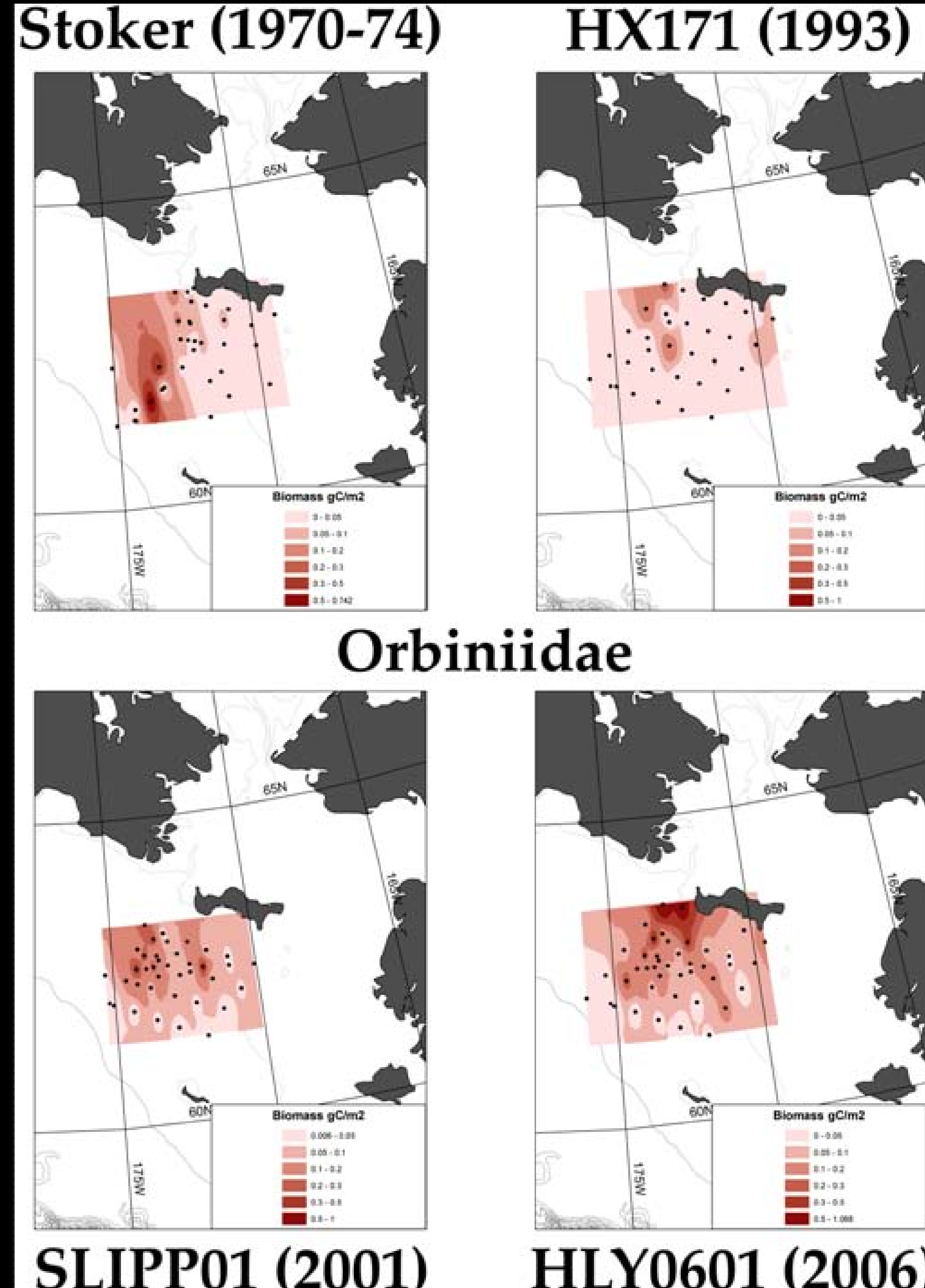


Stoker (1970-74)
HX171 (1993)
Leuconidae
SLIPP01 (2001)
HLY0601 (2006)
65N
60N
165W
175W
Biomass gC/m2
0 - 0.005
0.005 - 0.01
0.01 - 0.05
0.05 - 0.1
0.1 - 0.25
0.25 - 0.3
0.25 - 0.537
0.25 - 0.394



Stoker (1970-74)
HX171 (1993)
Nuculanidae
SLIPP01 (2001)
HLY0601 (2006)
65N
60N
165W
175W
Biomass gC/m2
0 - 1
0.001 - 1
1 - 2
2 - 3
3 - 4
4 - 5
5 - 12.716
5 - 17.505
5 - 11.022
5 - 6.039


Stoker (1970-74)
HX171 (1993)
Nuculidae
SLIPP01 (2001)
HLY0601 (2006)
65N
60N
175W
Biomass gC/m2


Stoker (1970-74)
HX171 (1993)
Orbiniidae
SLIPP01 (2001)
HLY0601 (2006)
65N
60N
175W
Biomass gC/m2

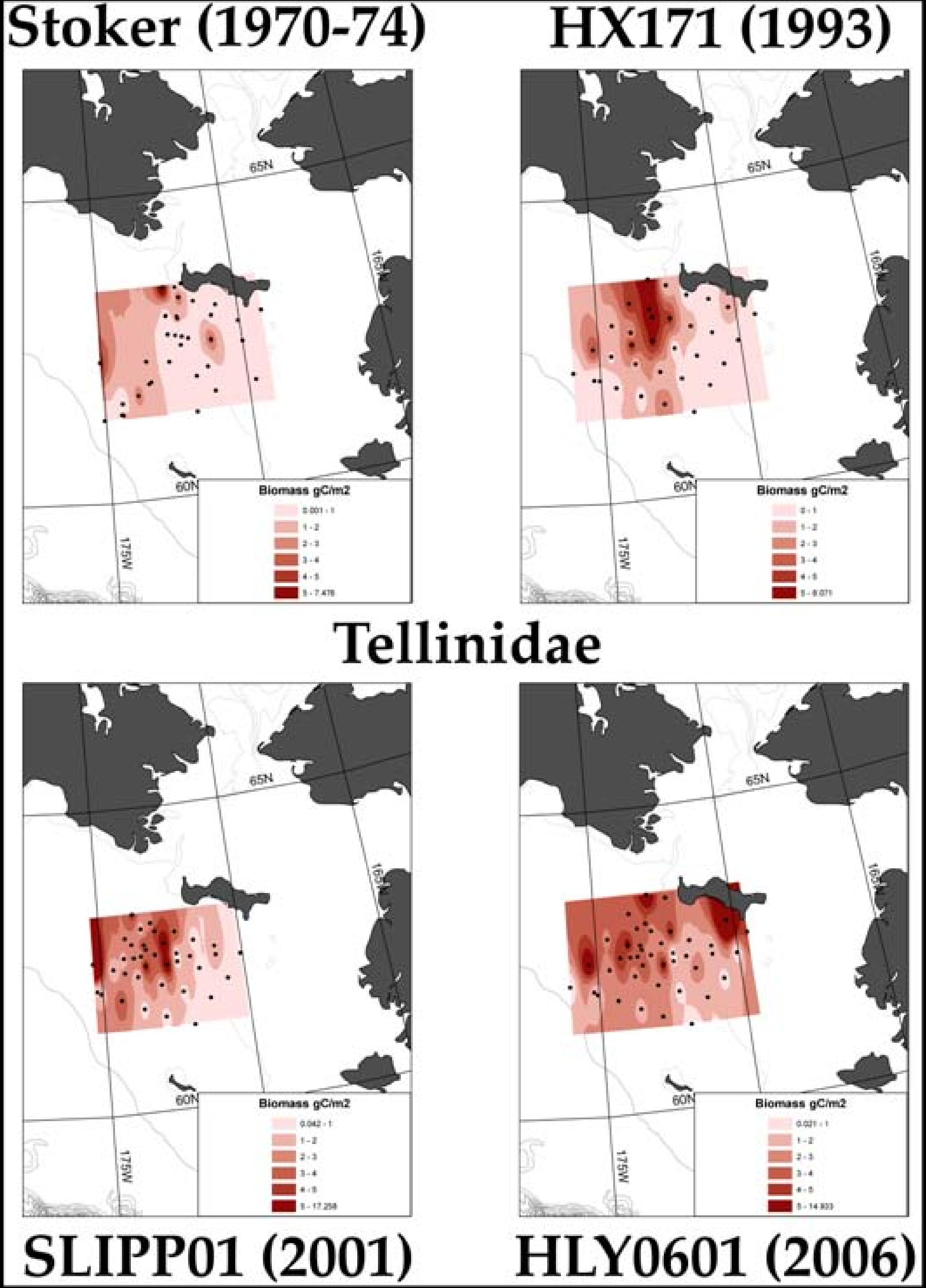
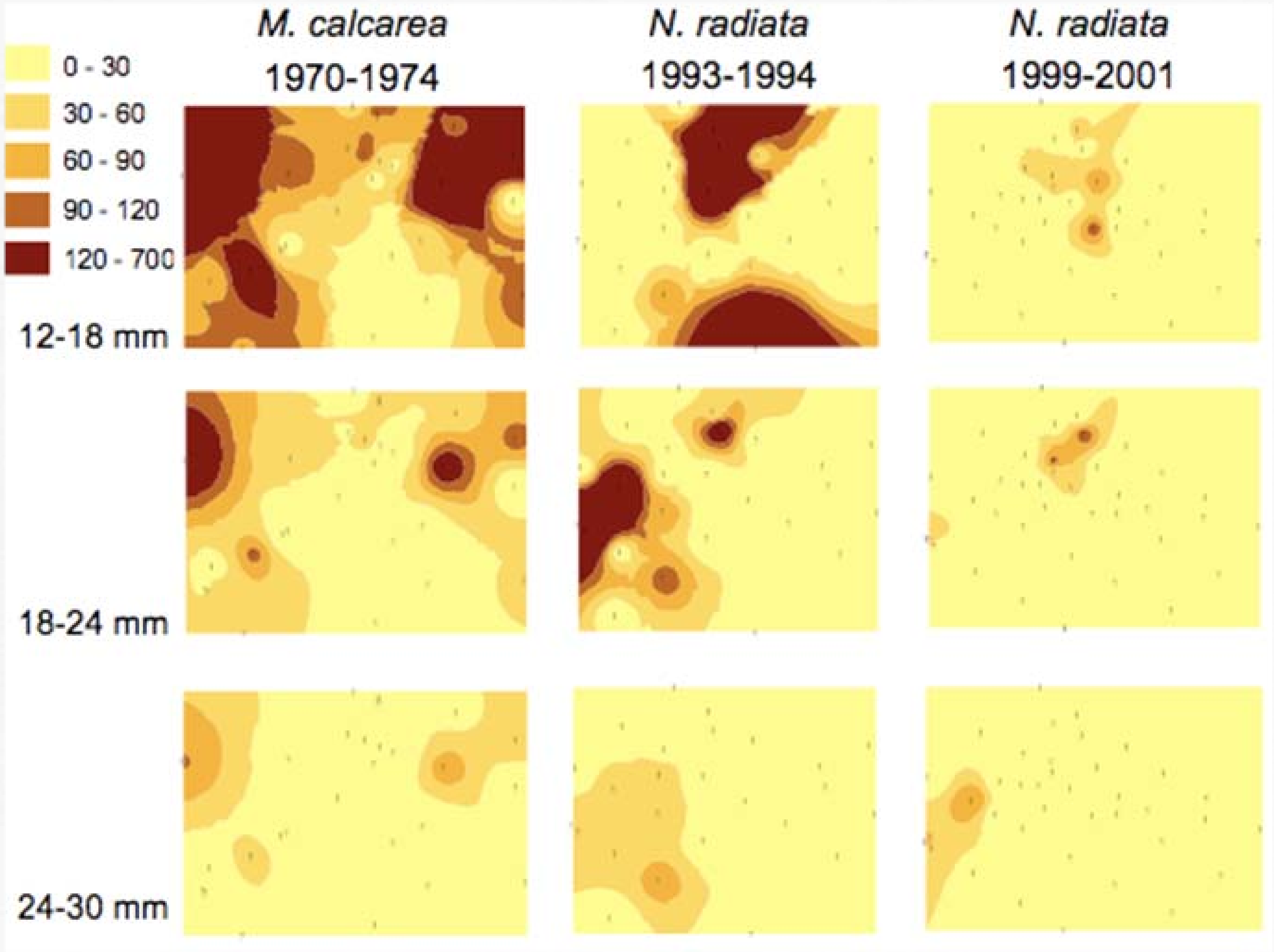

Stoker (1970-74)
HX171 (1993)
Tellinidae
SLIPP01 (2001)
HLY0601 (2006)
65N
60N
175W
Biomass gC/m2

FIG. 5

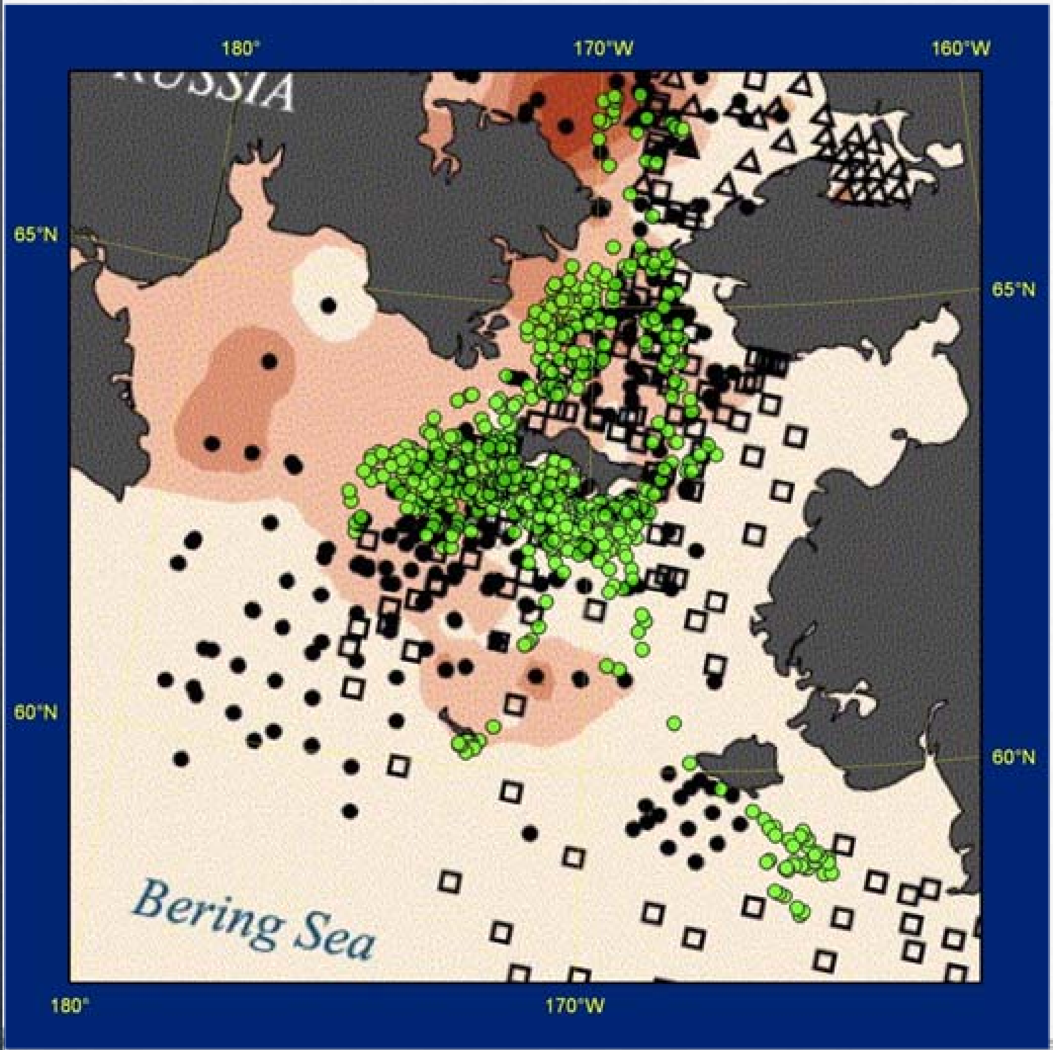


Lovvorn et al. manuscript submitted

Shorthorn sculpin: 352mm, 599g

Live ampharetid worm

Ecological impacts
Most biologically productive sector of the Arctic marine system is the Bering and Chukchi Seas



- bivalve prey for walrus

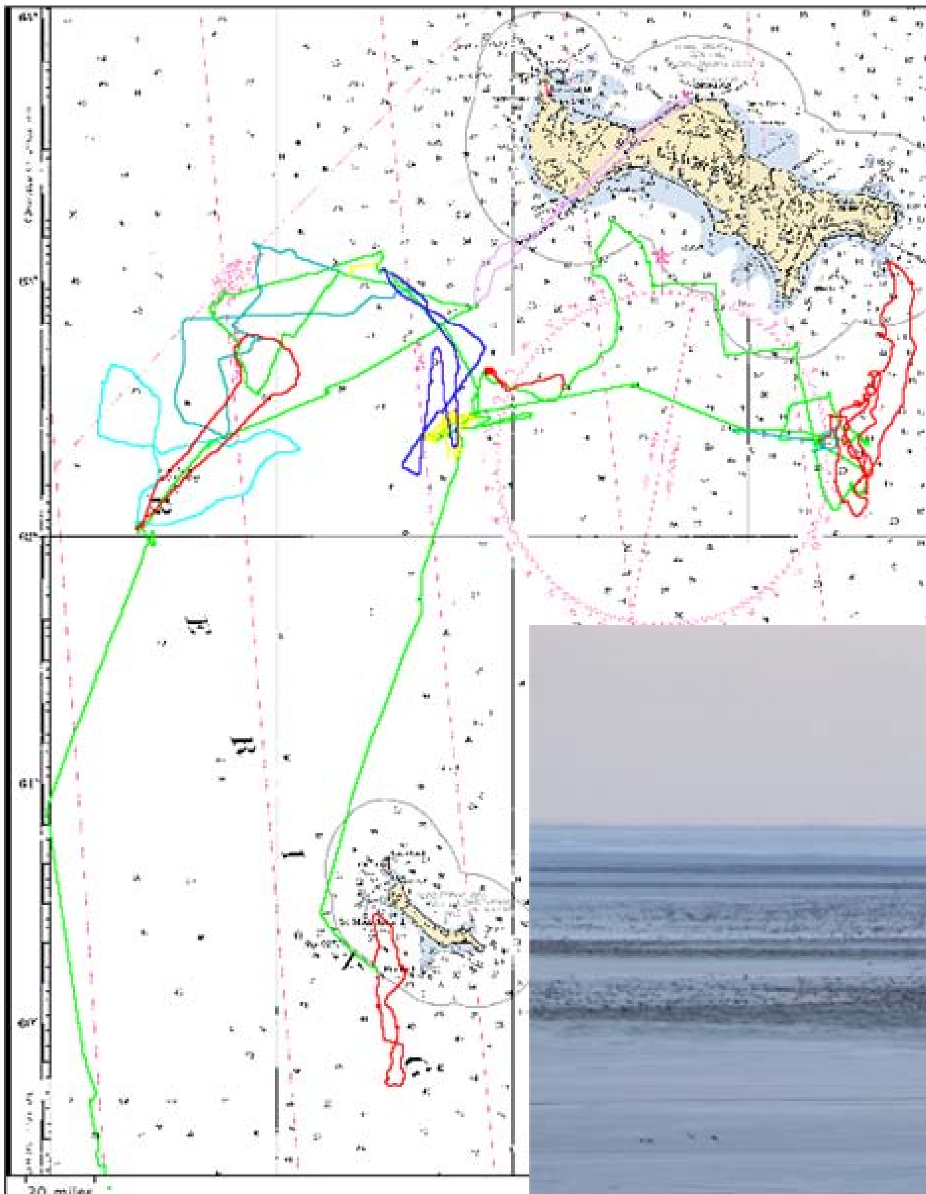
[courtesy Gay Sheffield, ADFG]

- 2006 tagged walrus locations (green dots, courtesy of Chad Jay, USGC) overlain on ~35 year composite of benthic infaunal biomass (Grebmeier et al. 2006)*
- different black symbols differentiate different collectors (Grebmeier et al. 2006)*
- note general location walrus in regions of high benthic prey biomass

*Progress in Oceanography 71: 331-361

Walrus tagging

clip courtesy of Tony Fischbach, Alaska Science Center, USGS



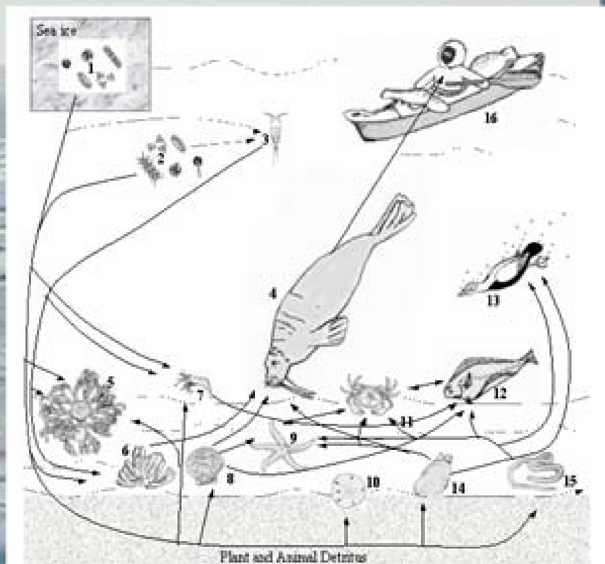
Helicopter tracks flown as part of walrus and spectacled eider surveys

"Walrus-prey" Patch Dynamics Study (BSIERP and BEST)

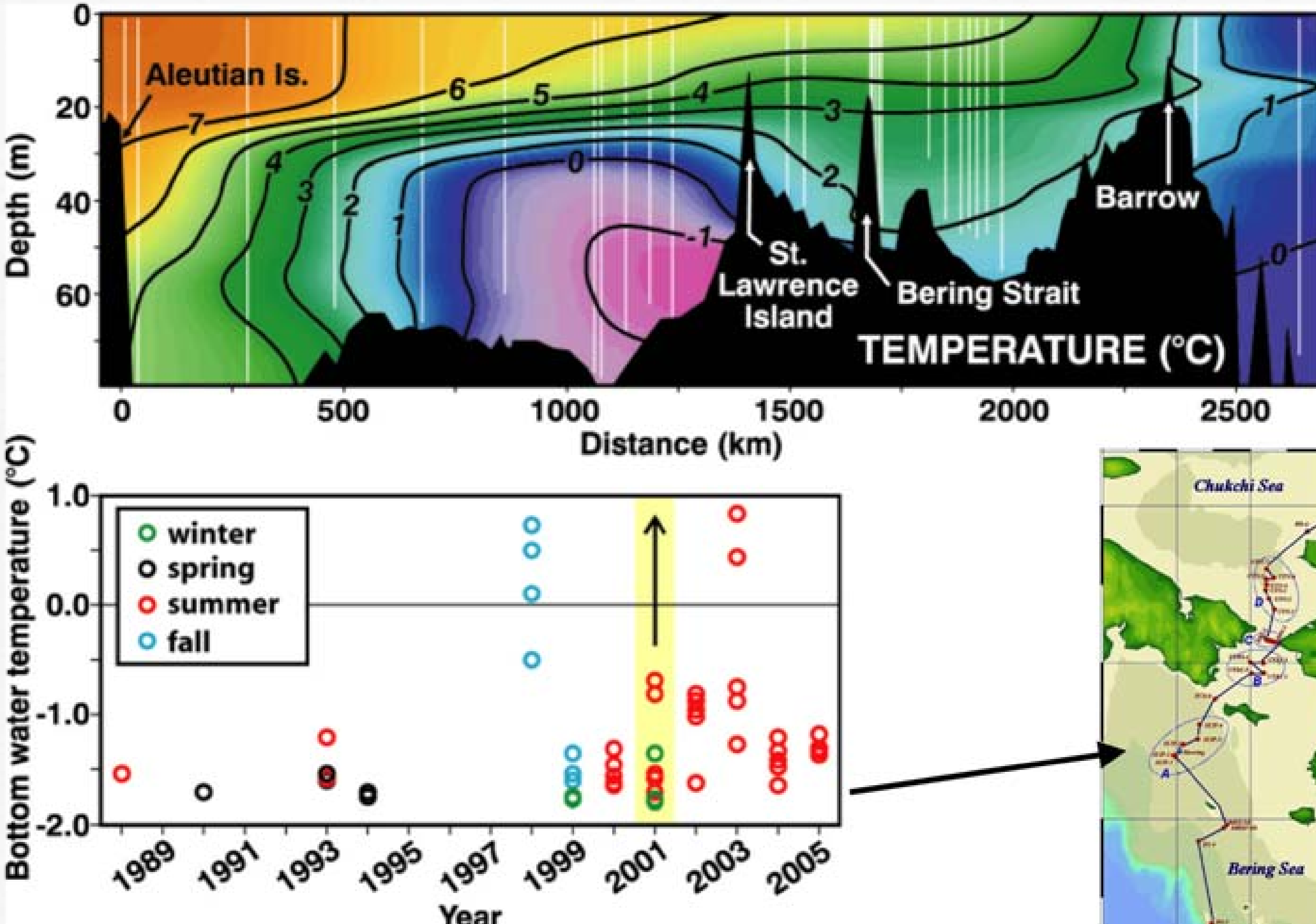
PIs: Chad Jay (Alaska Science Center, USGS, Jackie Grebmeier and Lee Cooper, University of Maryland Center for Environmental Science)

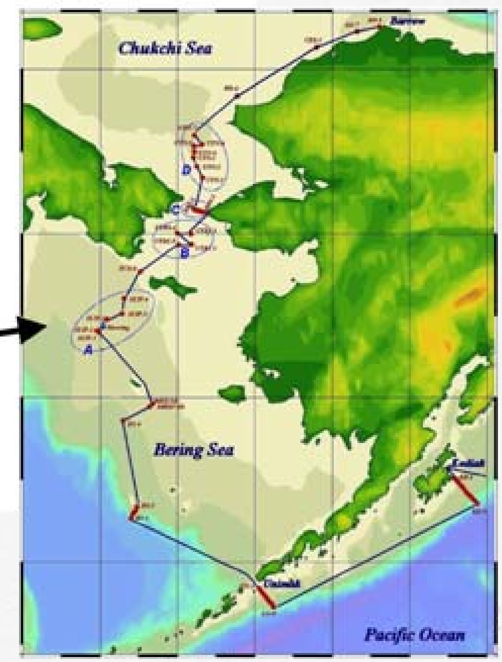
Objectives

- field/retrospective evaluation of benthic infauna, sediments, and oceanographic conditions in context of walrus feeding sites, both historical and tagged
- grid of benthic infauna in walrus feeding area at various spatial scales (<5-20 nautical miles) to evaluate variable prey patches and food quality; videographic evaluation of epifauna
- helo survey and tagging of walruses
- predator/prey caloric content, stable isotopes, and pilot predator/prey DNA studies



[Grebmeier and Dunton 2000]



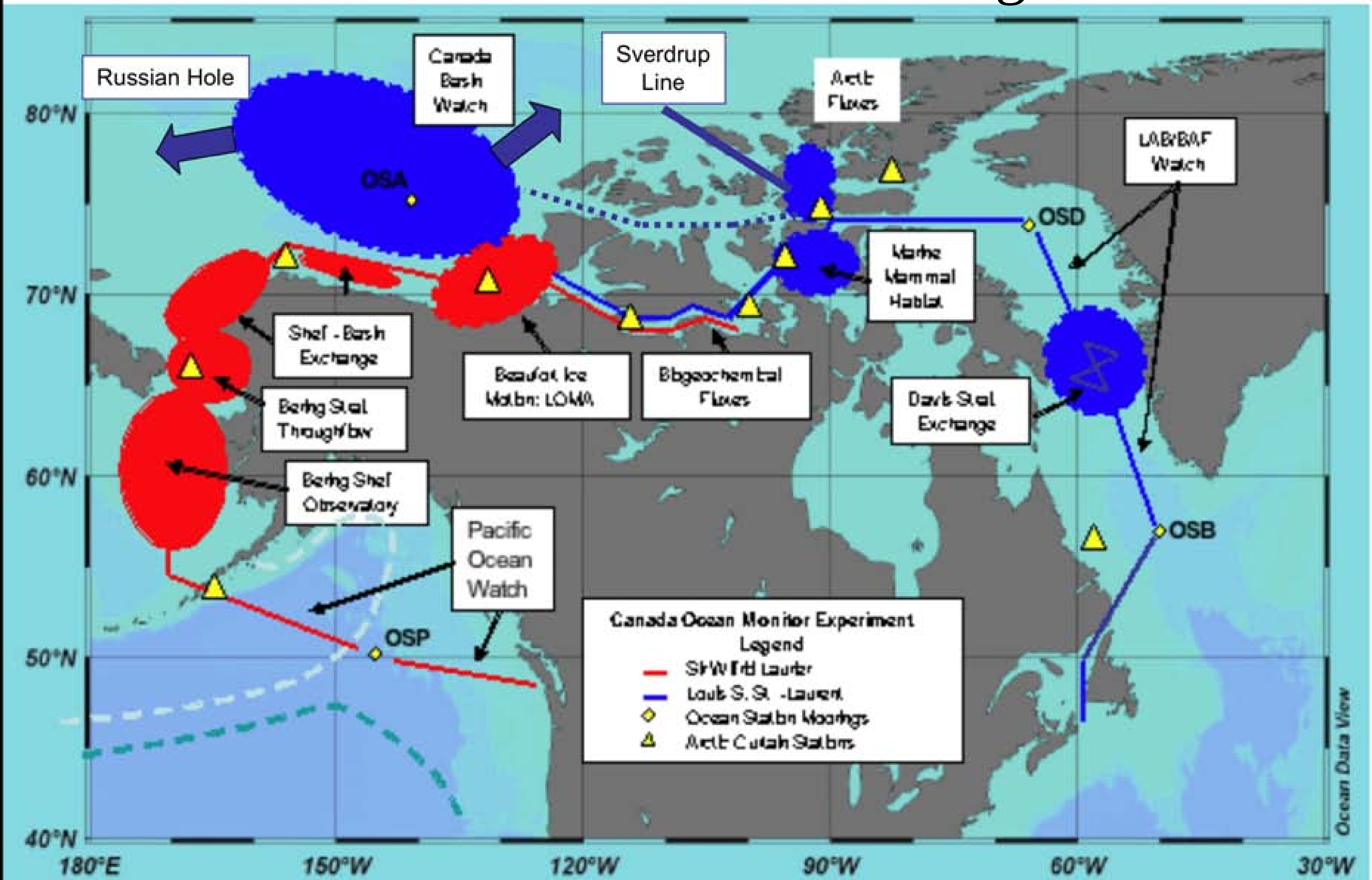


Seawater temperature extending from the Aleutian Islands, Alaska (top left) to Barrow, Alaska (top right) in July 2001 from the CCGS *Sir Wilfrid Laurier*. Bottom panel is time series of bottom water temperatures (<0°C) in cold pool SW of St. Lawrence Island.

Annual July cruises on CCGS *Sir Wilfrid Laurier*

[Grebmeier et al., 2006, Science 311]

Canada's Three Oceans Program



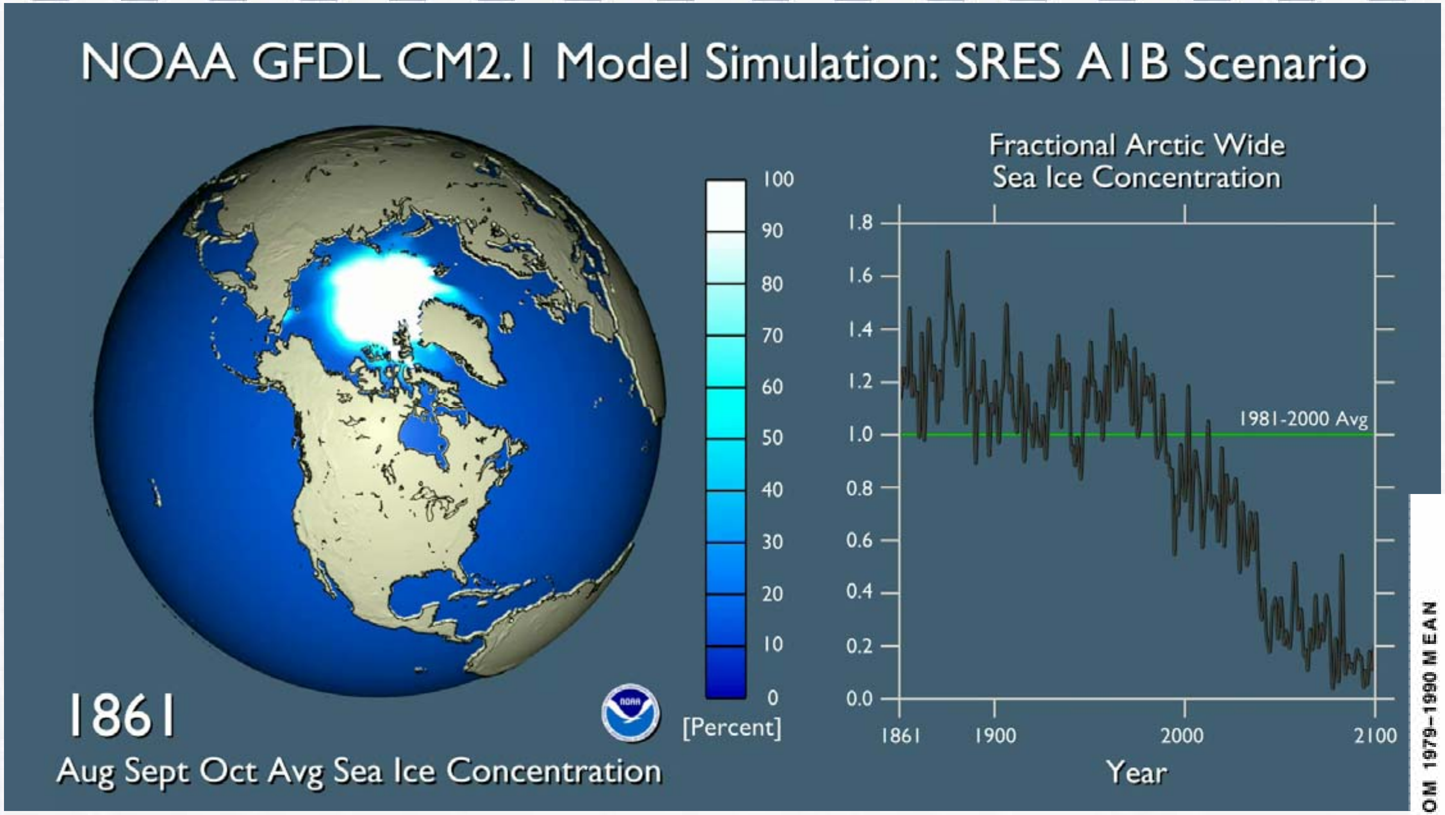
Canadian work planned in Bering Sea through 2050

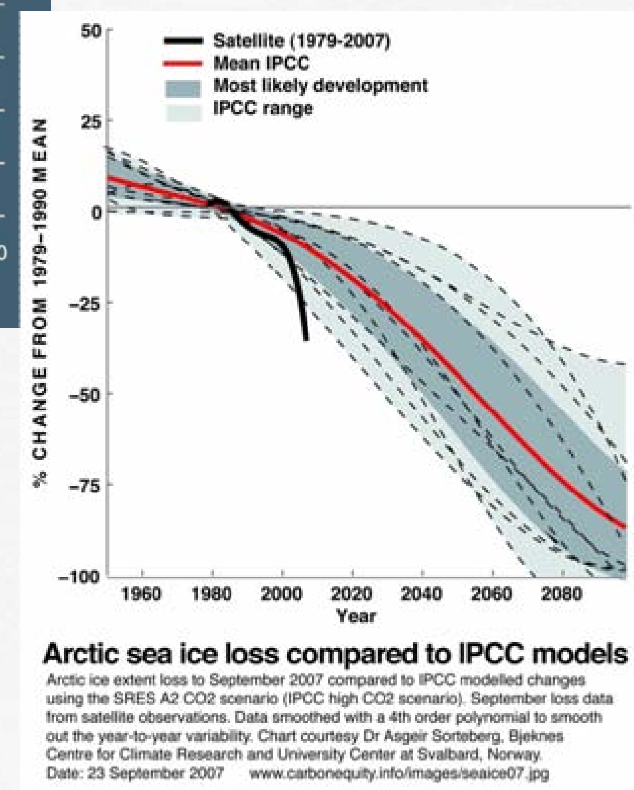
International participation BEST-BSIERP cruise March 2008

Boris Sirenko, Zoological Institute, Saint Petersburg

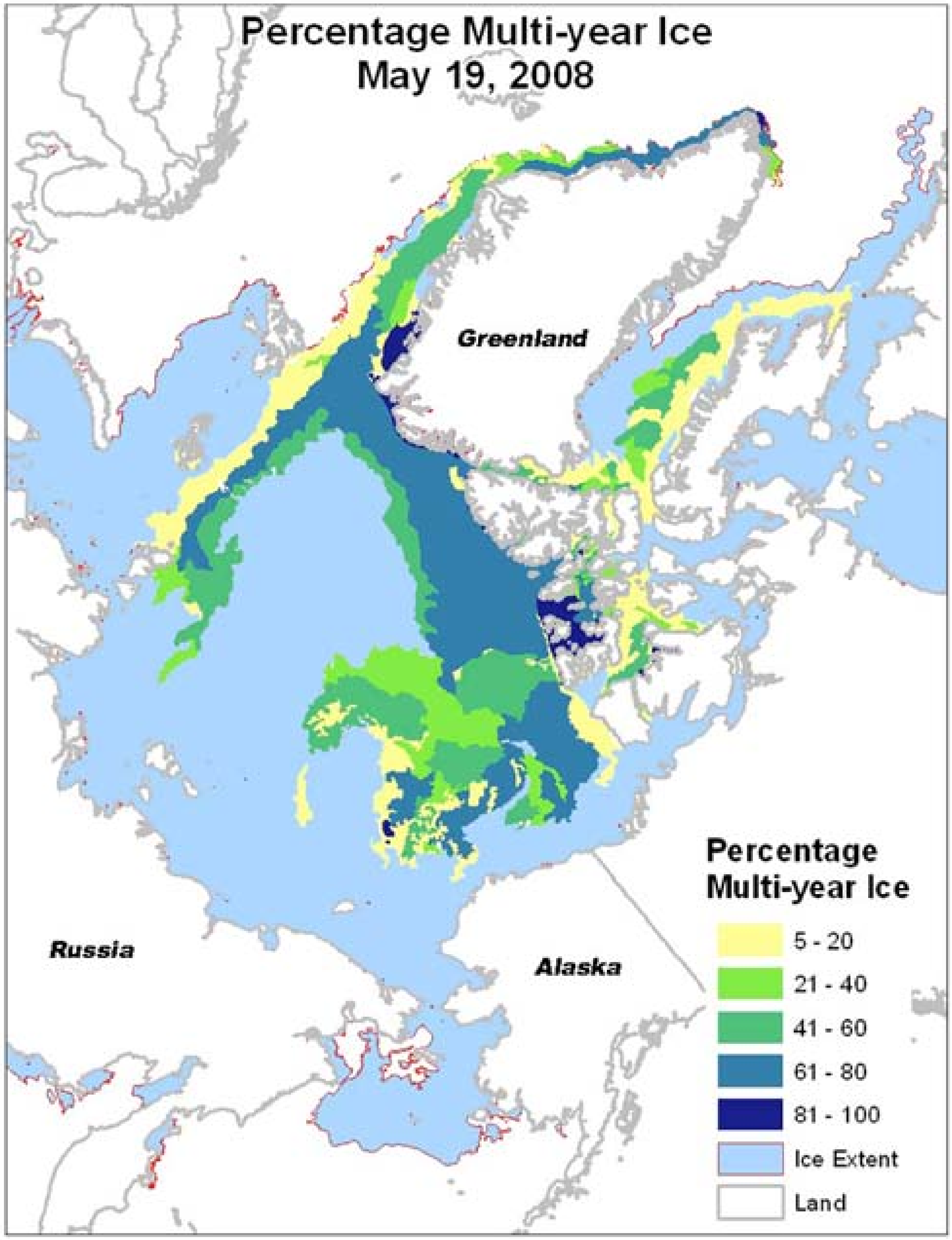
Christian Morel photos

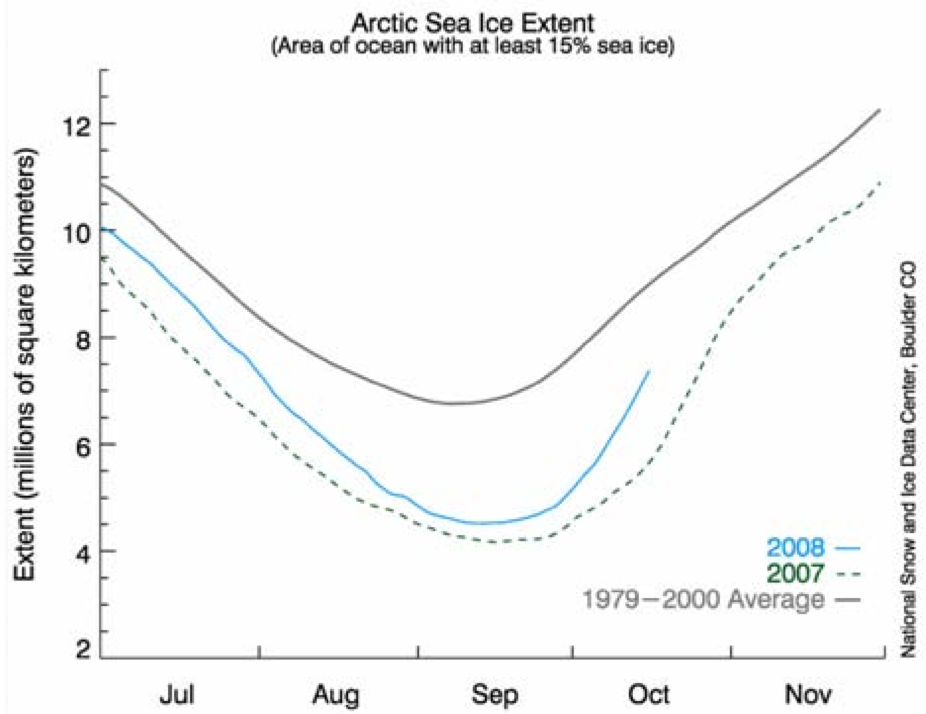
Jinping Zhao and Yutian Jiao, Ocean University of China





Mis-match of models vs. seasonal sea ice retreat 2007-2008





Source: U.S. National Snow and Ice Data Center

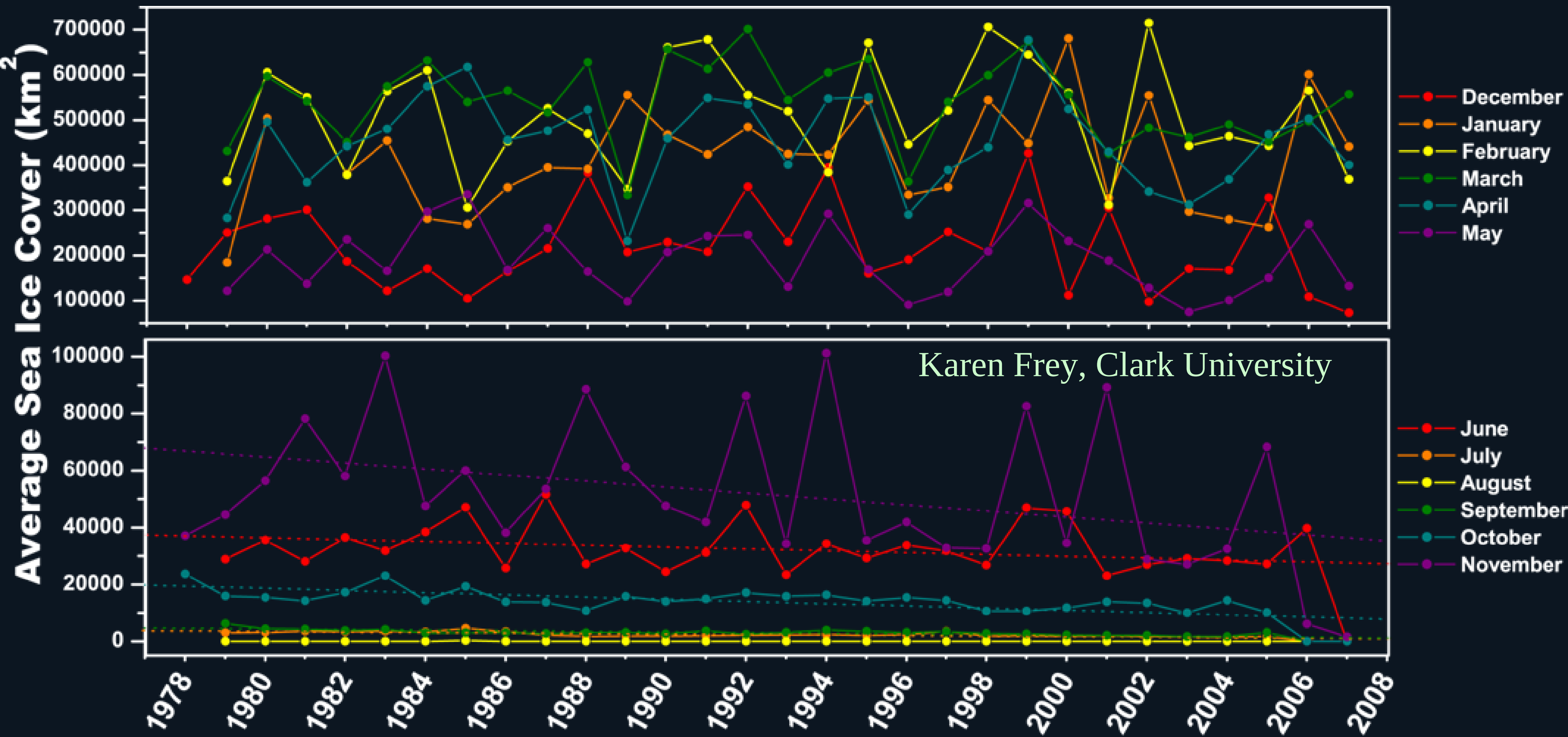
"I think we're going to beat last year's record melt, though I'd love to be wrong."

"If we do, then I don't think 2013 is far off any more. If what we think is going to happen does happen, then it'll be within a decade anyway."

Julienne Stroeve, NSIDC, quoted by BBC, 18 June 2008

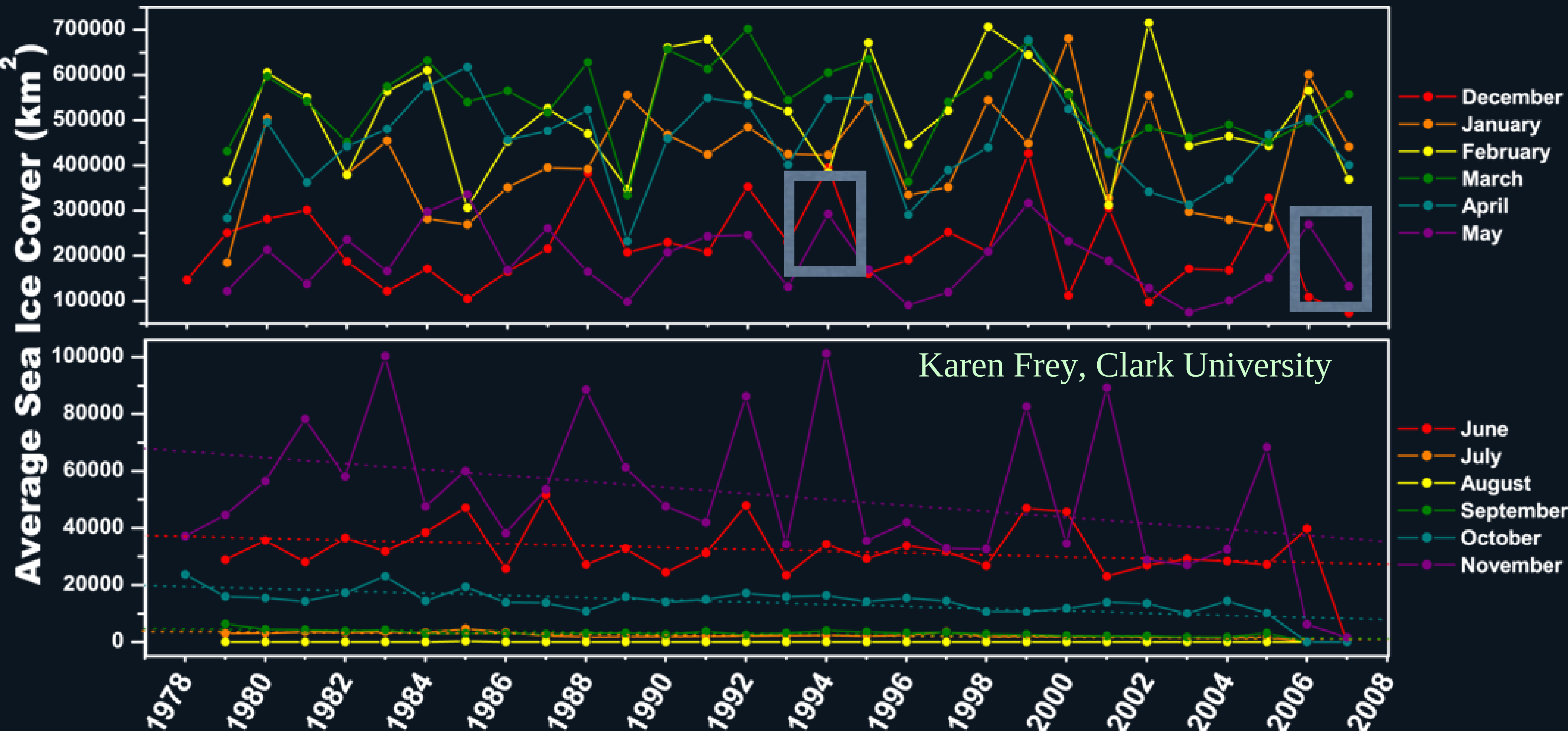
Bering Sea Ice Trends (1978–2007)

SMMR and SSM/I Satellite Passive Microwave Sea Ice Concentrations

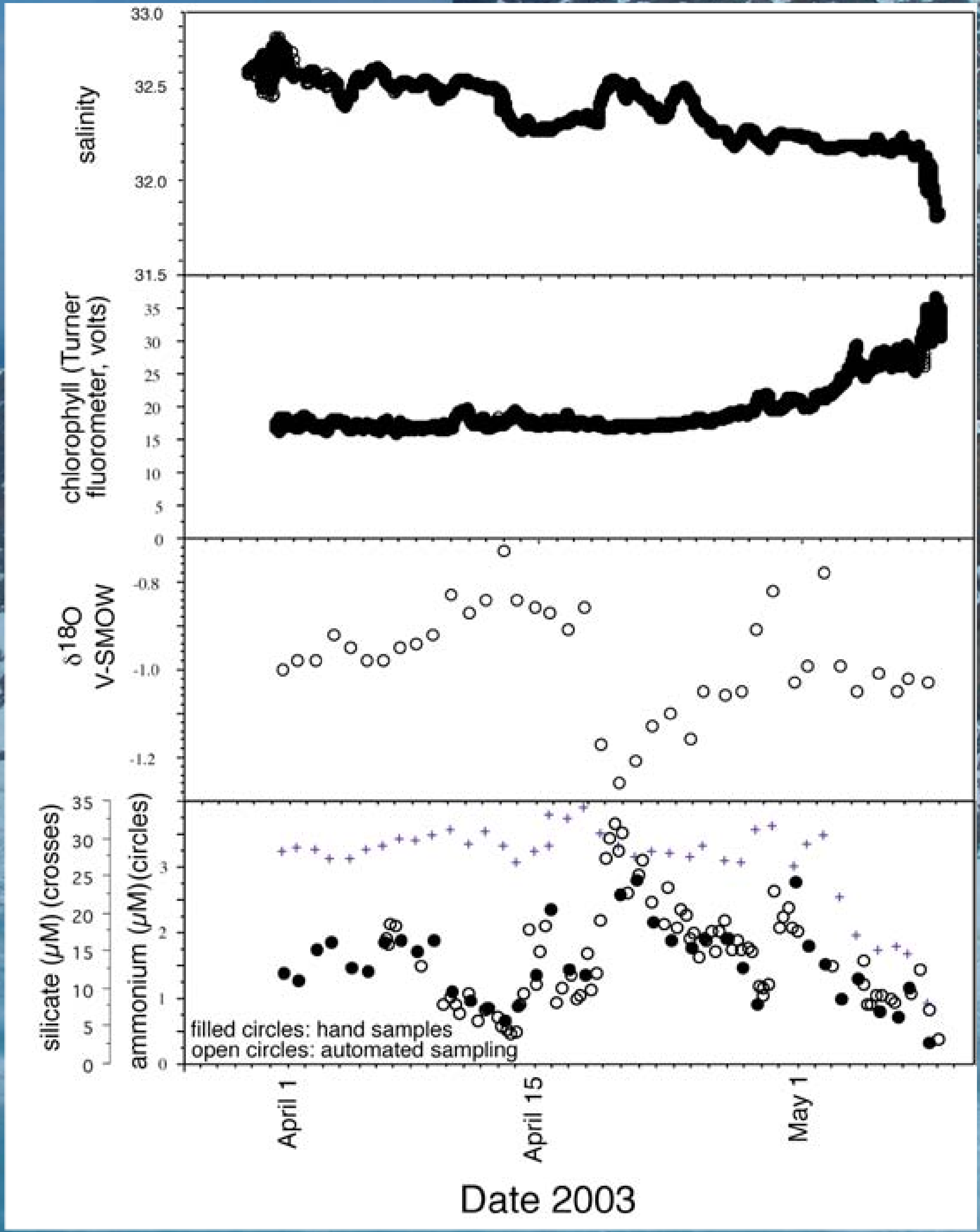


Bering Sea Ice Trends (1978–2007)

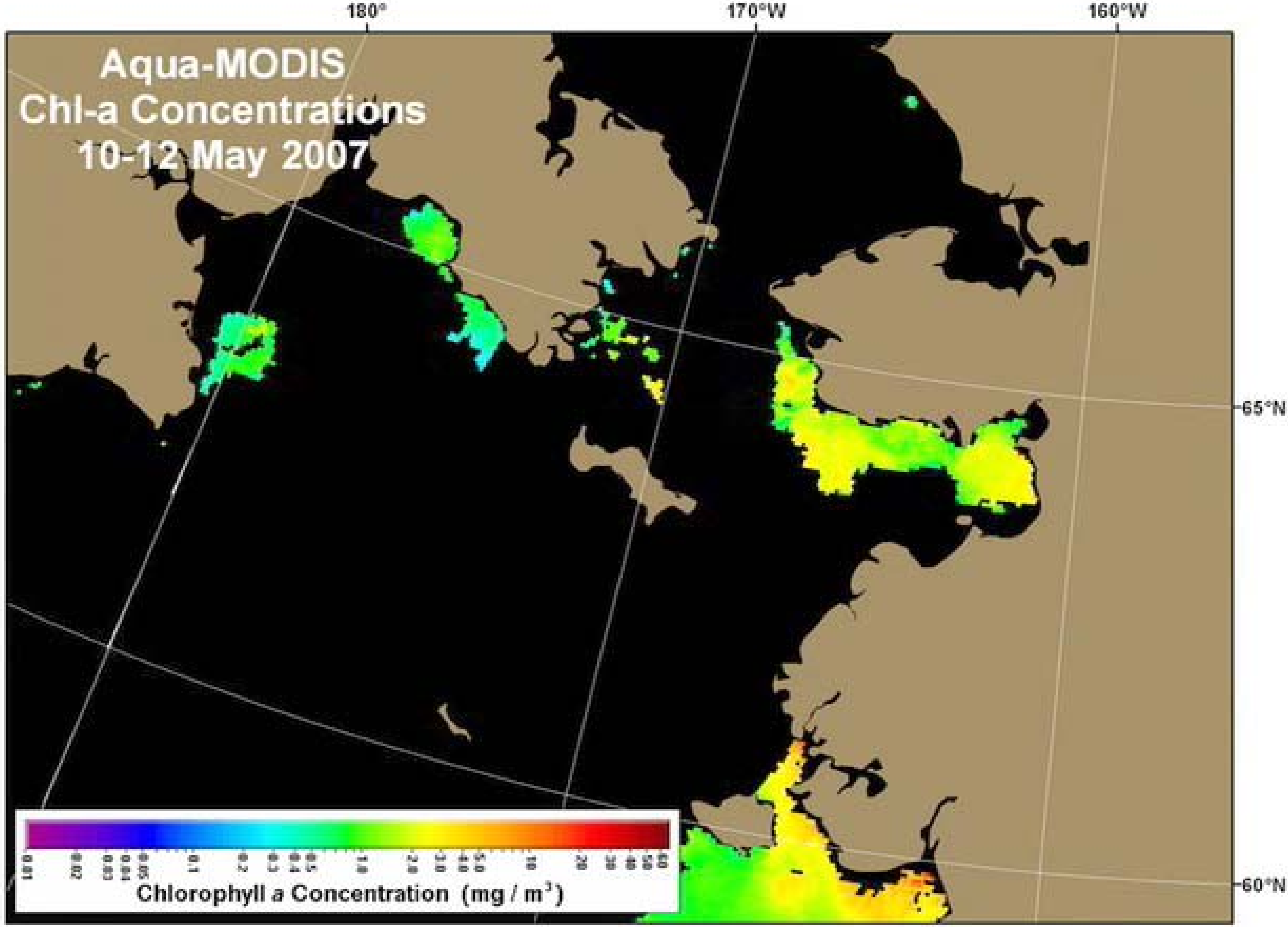
SMMR and SSM/I Satellite Passive Microwave Sea Ice Concentrations



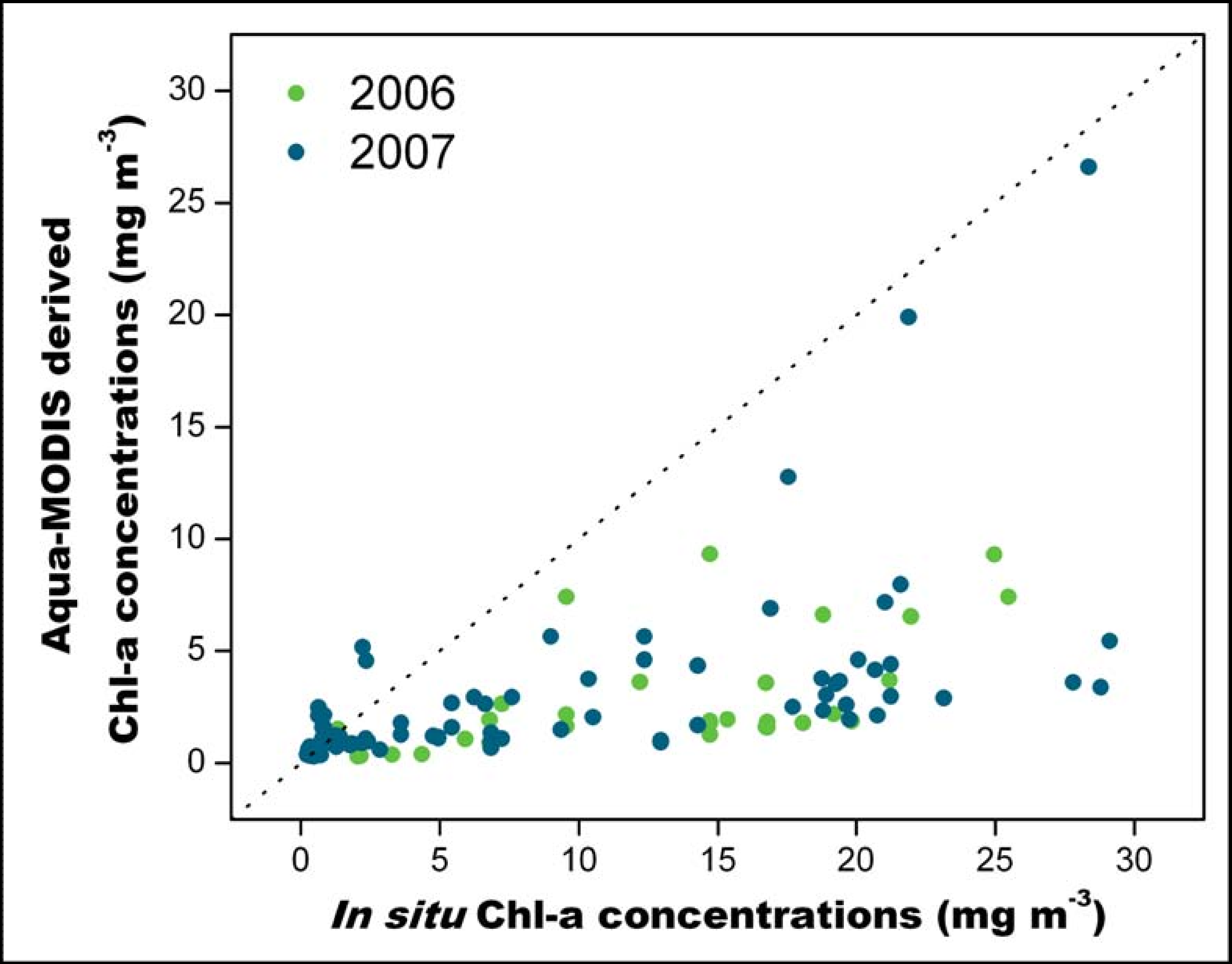
Water pumped ashore over ice for analysis

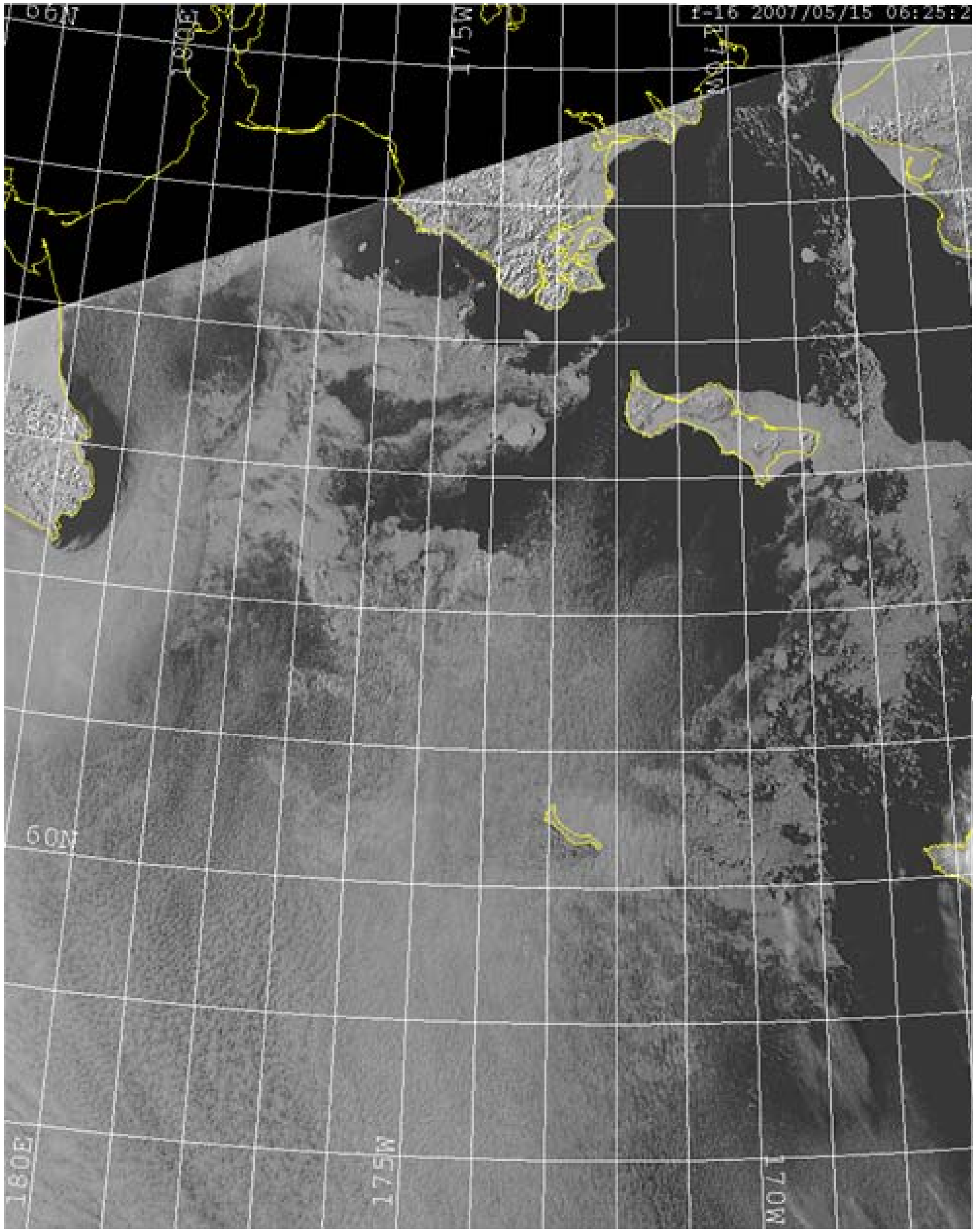


Data from *Arctic* 59: 129-141, 2006

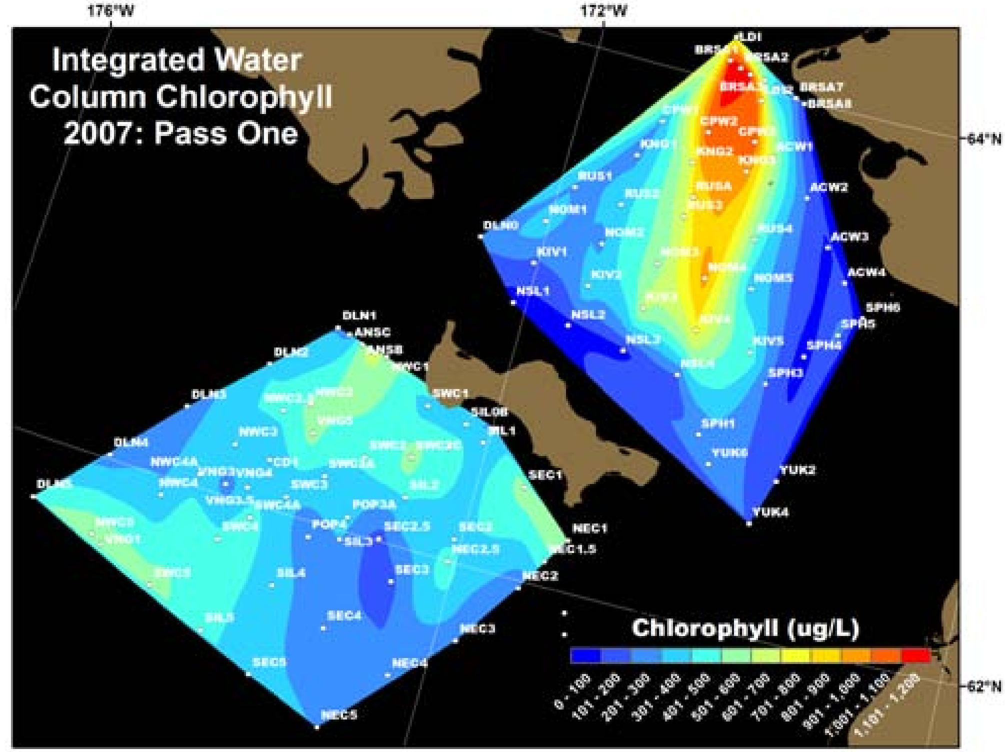

Aqua-MODIS
Chl-a Concentrations
10-12 May 2007
180°
170°W
160°W
65°N
60°N
0.01
0.02
0.03
0.04
0.05
0.1
0.2
0.3
0.4
0.5
1.0
2.0
3.0
4.0
5.0
10
20
30
40
50
60
Chlorophyll a Concentration (mg / m³)

Satellite vs. *In Situ* Chl-*a* Concentrations

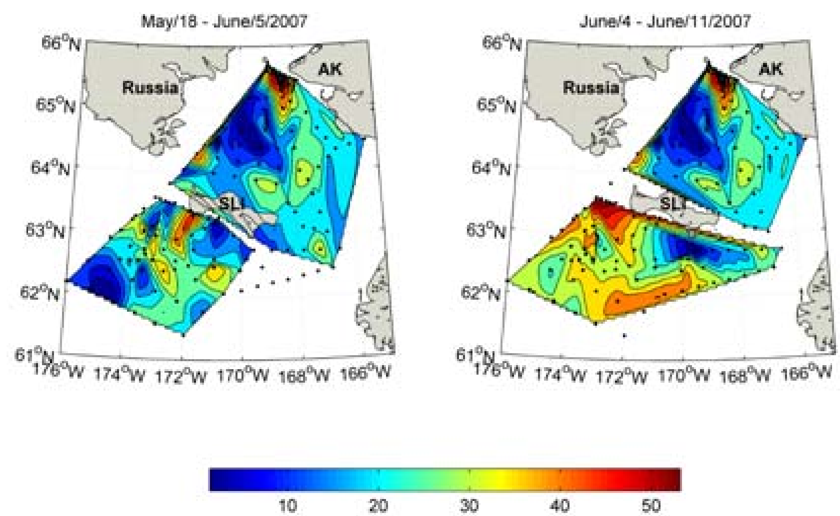




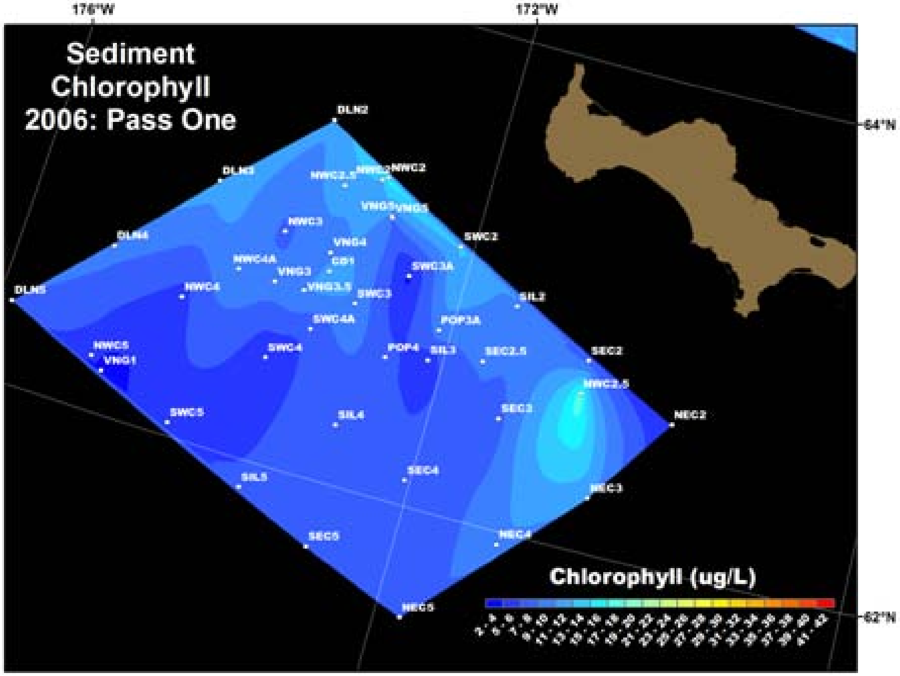
16 May 2007



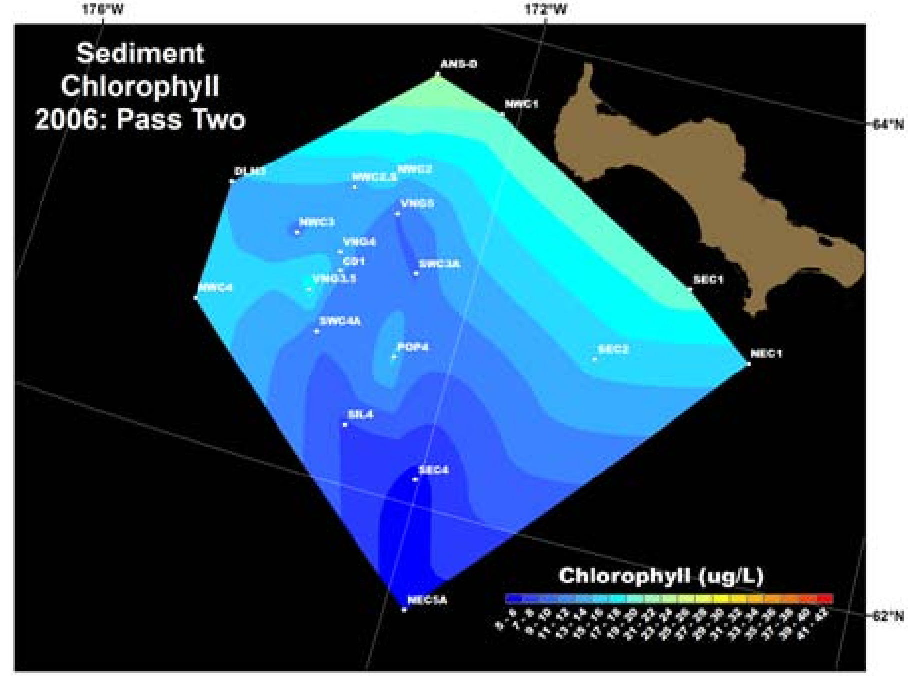
18 May - 4 June 2007



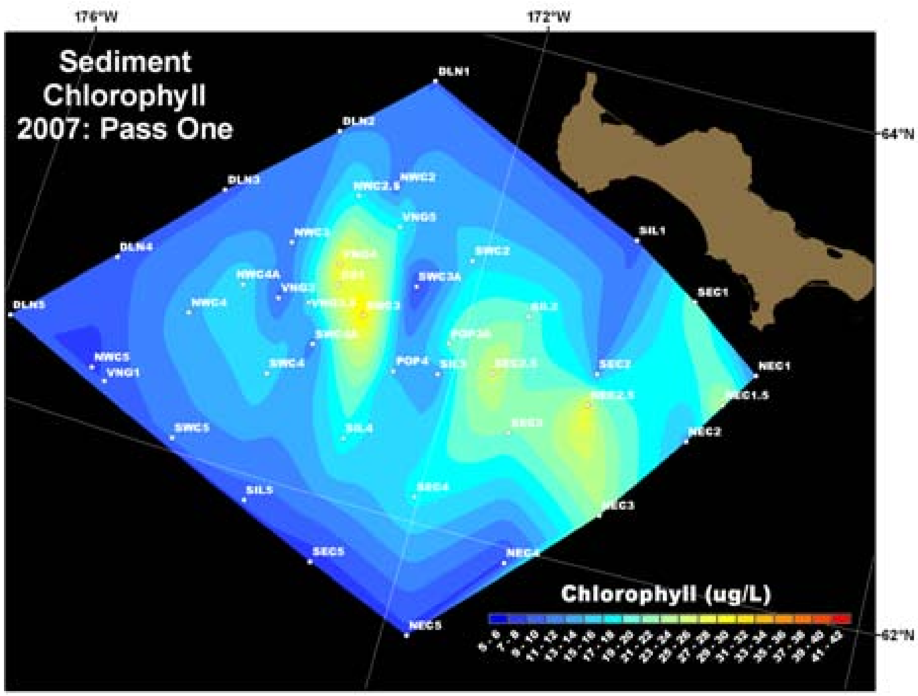
Depth of chlorophyll maximum



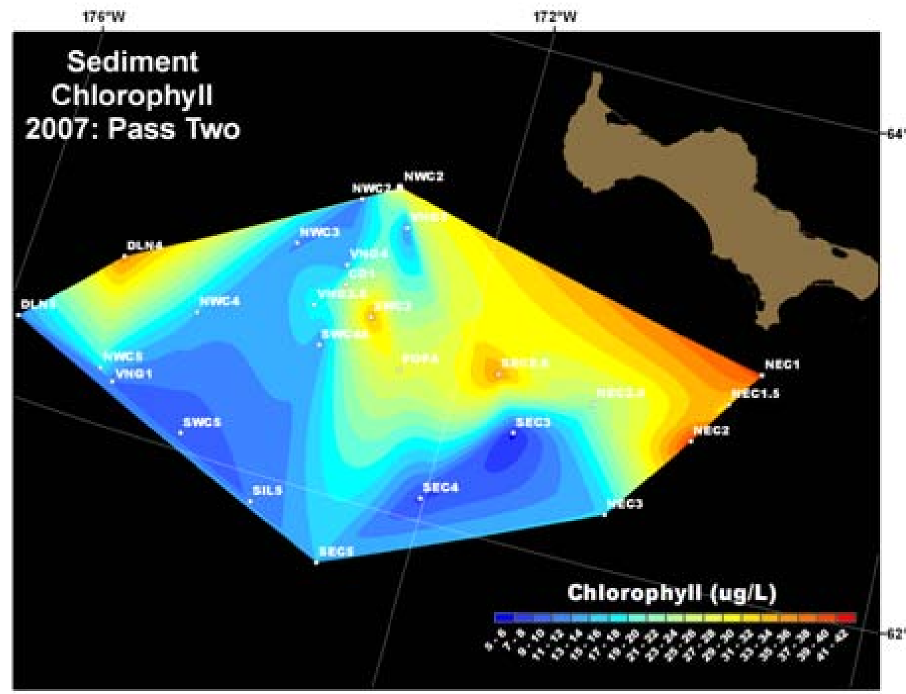
May 9-19, 2006 (Pass One)



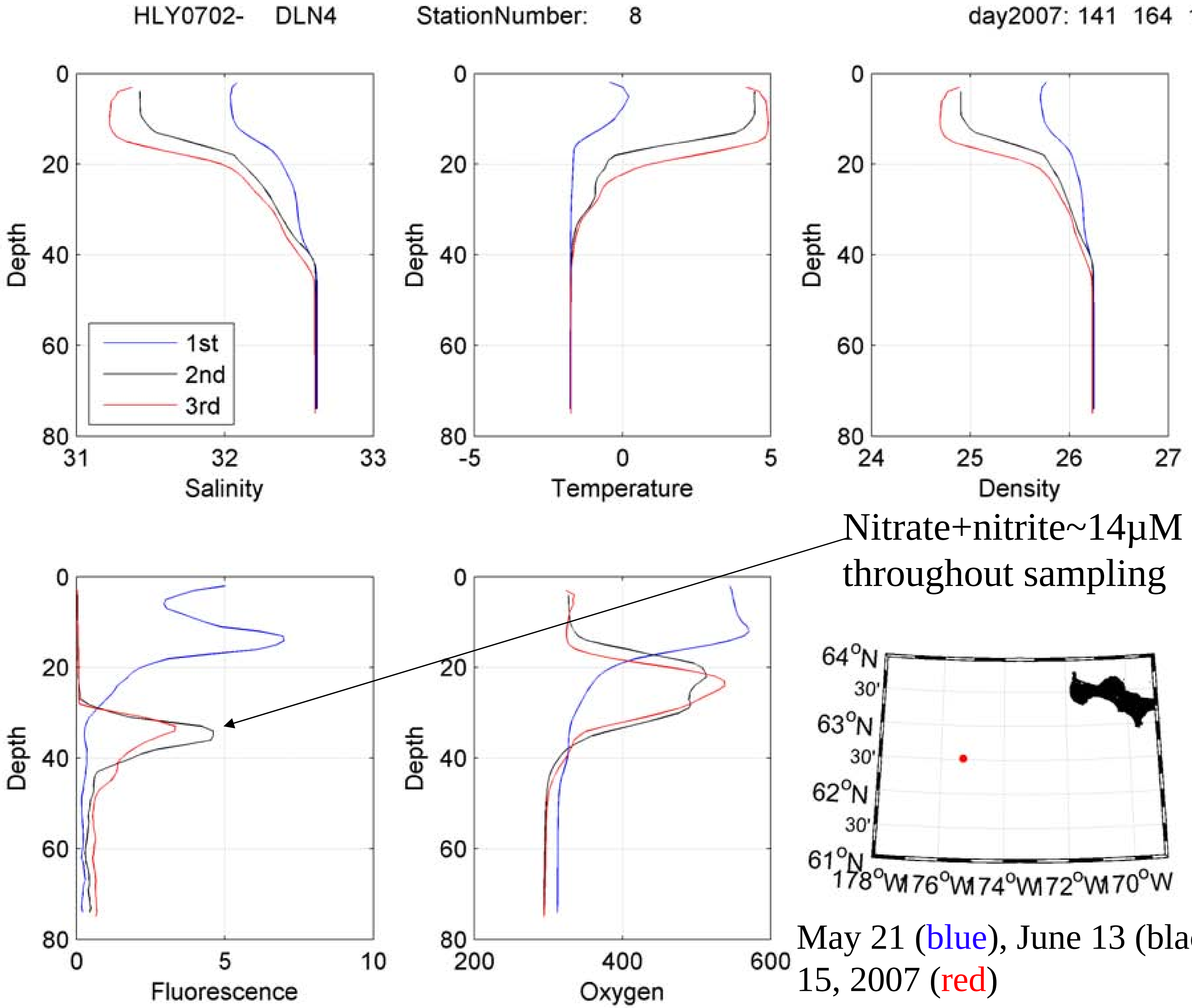
May 27-June 1, 2006 (Pass Two)



May 18-29, 2007 (Pass One)



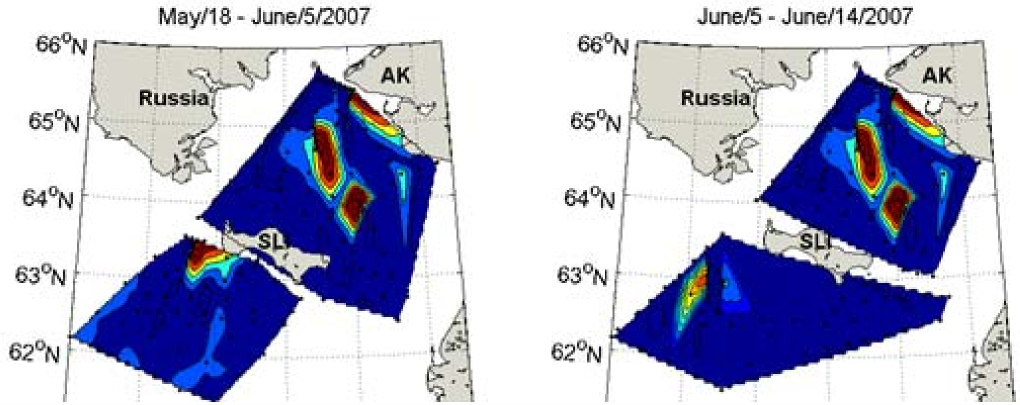
June 5-15, 2007 (Pass One)



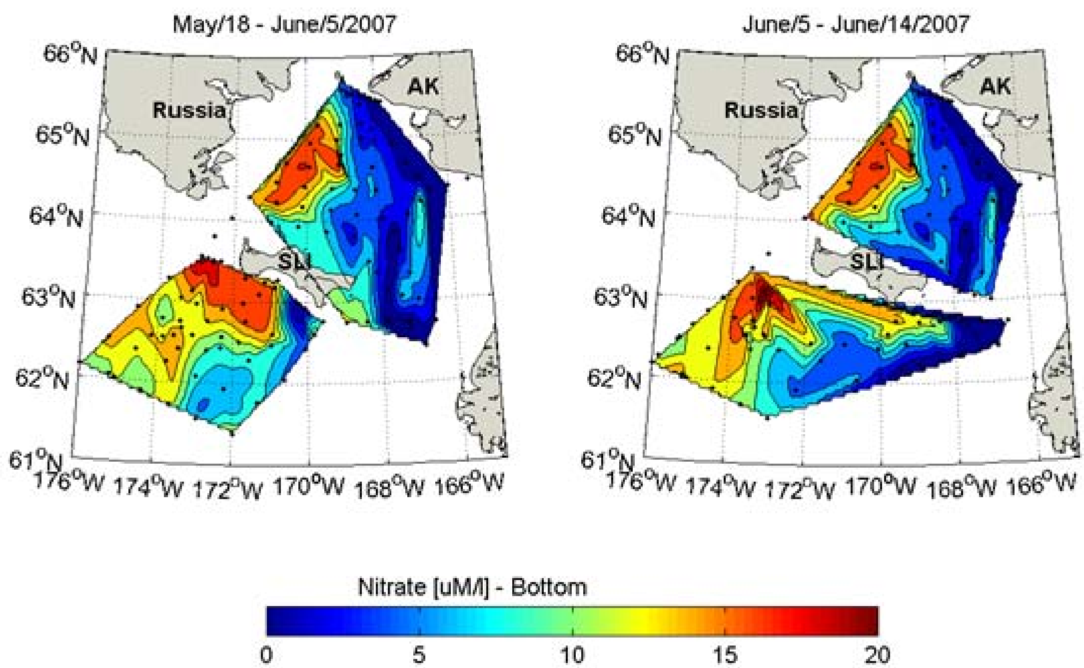
Nitrate+nitrite~14µM at 35m throughout sampling

May 21 (blue), June 13 (black), June 15, 2007 (red)

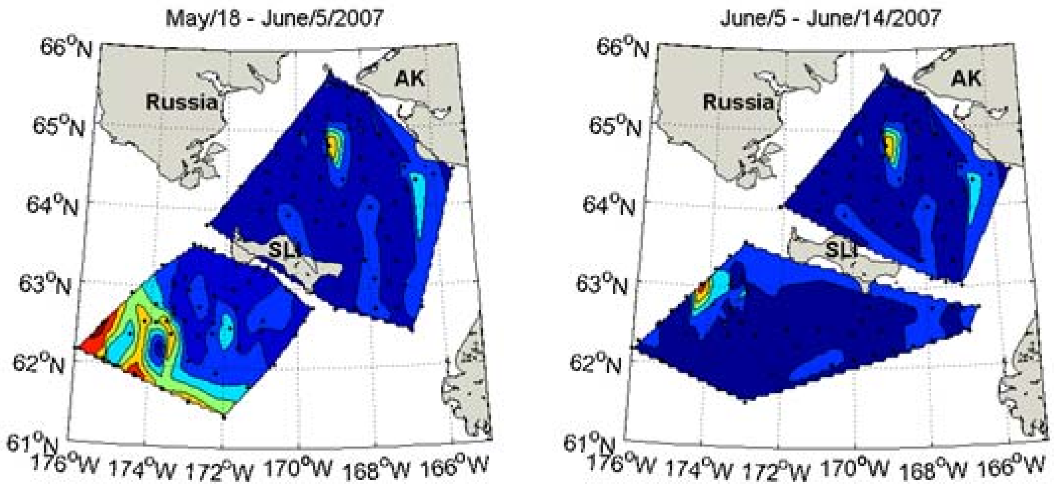
Nitrate (µM) surface (top panel) and bottom water (lower panel)



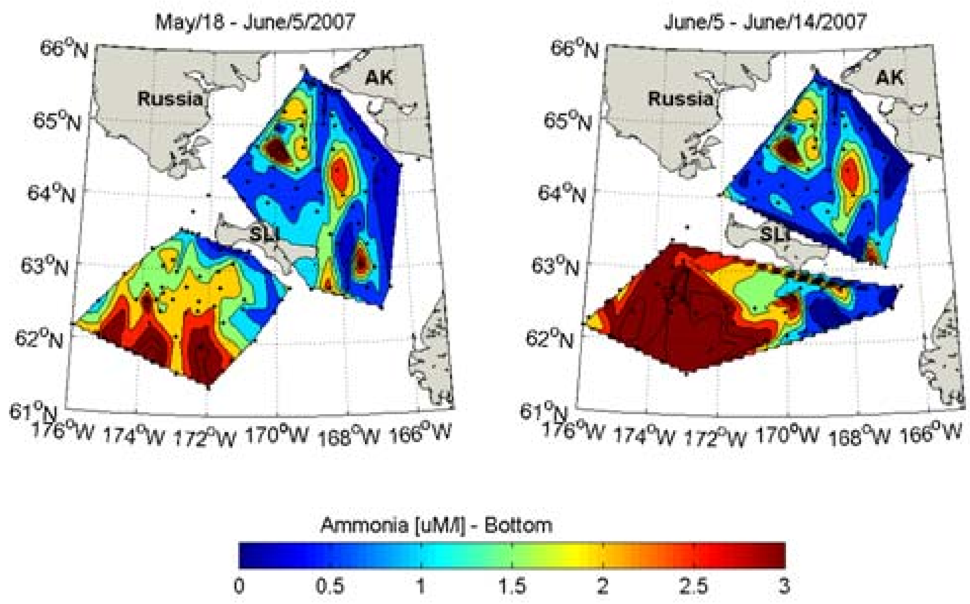
Pass 1 Pass 2



Ammonium (µM) surface (top panel) and bottom water (lower panel)



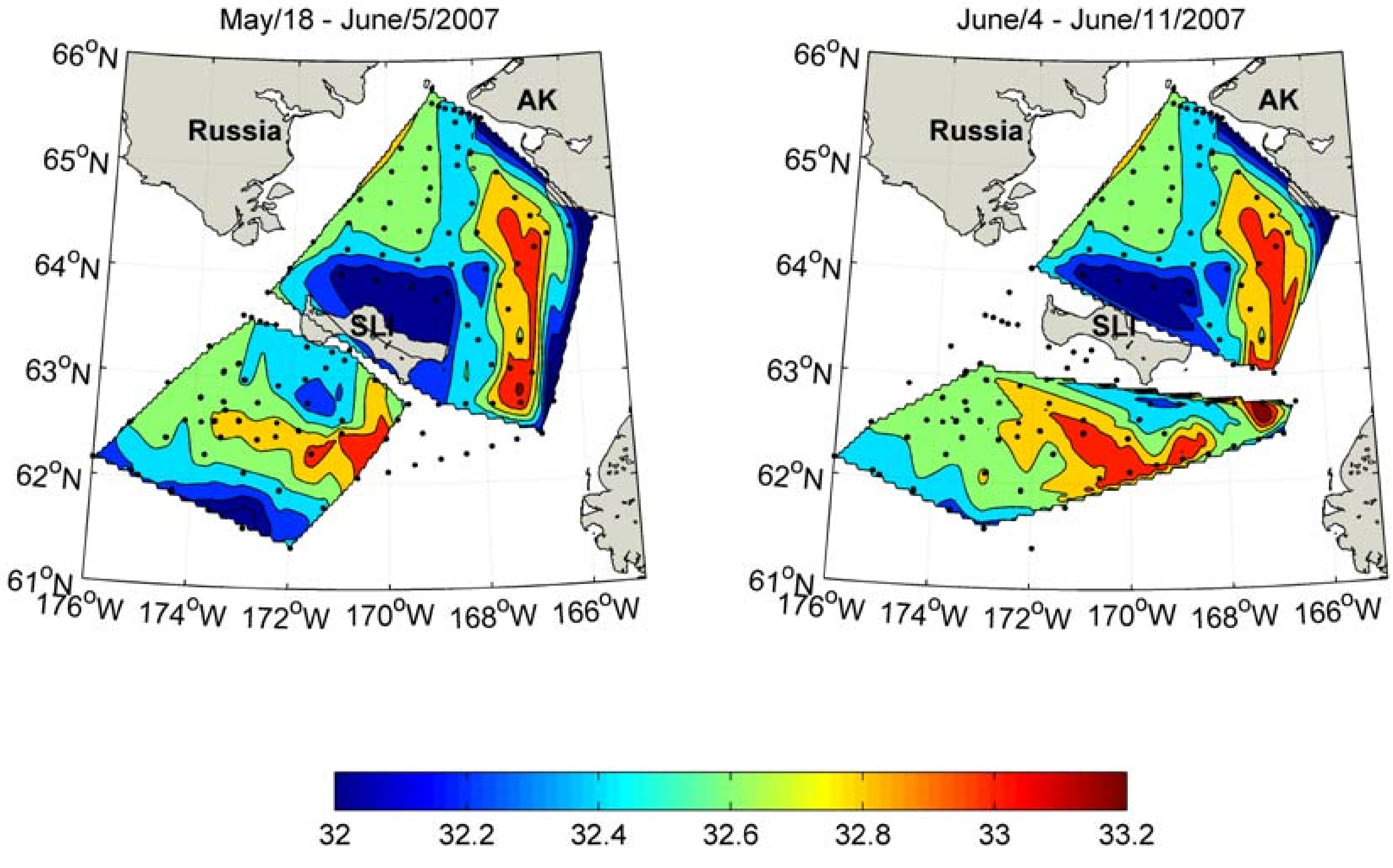
Pass 1 Pass 2



-shows interactions with benthos

High salinity (>33) water observed in 2007 (but not in 2006) from April brine injection events

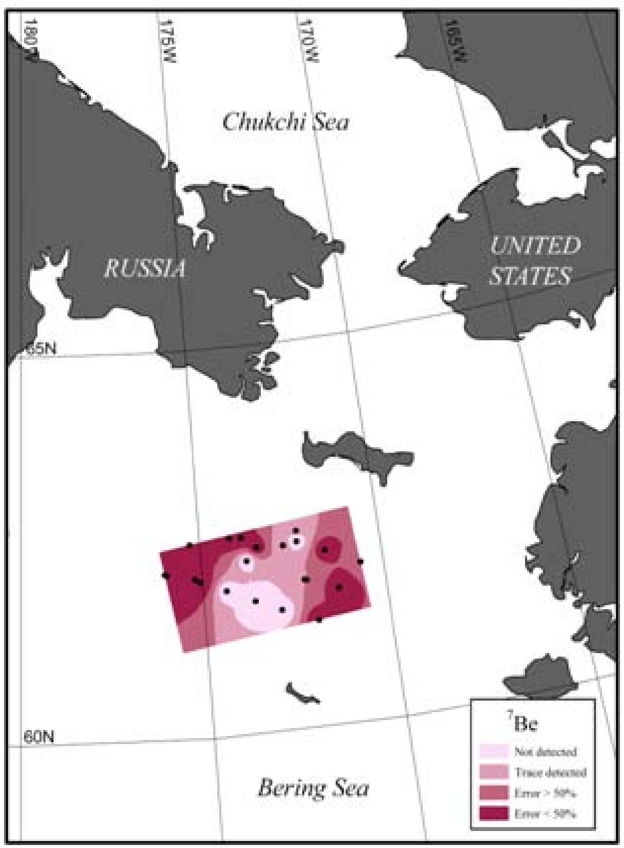
Results: better water column ventilation, possibly more intense spring bloom development than in 2006



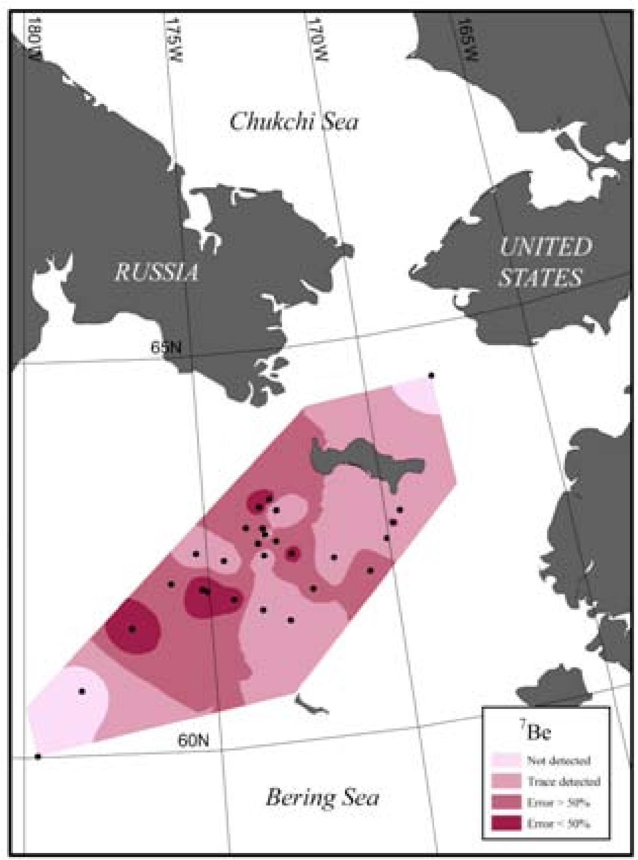
Short-term particle accumulation tracer

Beryllium-7 (53 d half-life) distributions on surface (0-1 cm) sediments

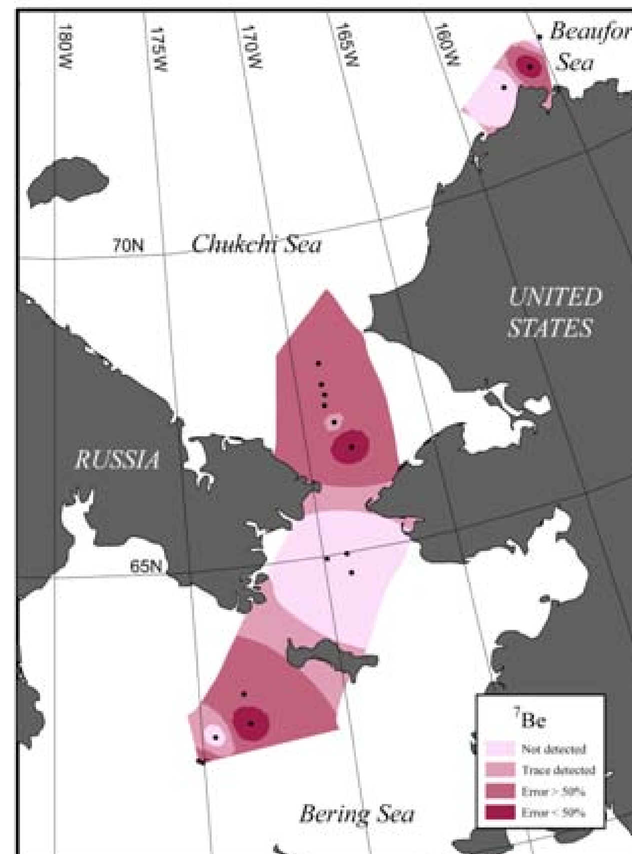
18-29 May 2007



6-15 June 2007



13 -20 July 2007



Sampling Dates *Alpha Helix* 1994 *Healy* 2006 *Healy* 2007	Mean Integrated chlorophyll (mg m^{-2} ±SE)	Mean bottom water nitrate (µM ± SE)	Significant paired t-test differences (<0.05)
26 May-6 June 1994	556.6±52.5	10.7 ±1.0	n=30
11-19 May 2006	246.0±50.0	6.4 ±0.8	n=30
28 May-2 June 2006	395.2±61.8	8.3 ±1.0	Pass 2 (11 stations)
19-27 May 2007	400.4±21.3	12.0 ±0.6	n=30
6-13 June 2007	256.1±74.3	12.3±1.4	Pass 2 (13 stations)

Conclusions

- Opportunities for International Collaborations duirng BSIERP- BEST Programs
- Significant benthic biomass and community structure changes since 1970
- Chlorophyll biomass significantly different in each of three years during ice-melt (1994, 2006, 2007) that had similar ice retreat timing but significantly different oceanographic conditions
- Repeat sampling shows that even within-season variation is large and blooms highly localized
- Water mass and nutrient variation, wind-mixing and late winter brine formation are potentially important variables that will also impact spring productivity in addition to the timing of ice retreat