Opportunities for data sharing in the northern Bering Sea

Research and data to support international and interdisciplinary analyses

Matthew Baker and Lisa Eisner

The role of the northern Bering Sea in modulating Arctic environments: towards international interdisciplinary efforts

PICES 2016 Annual Meeting, San Diego, USA

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North Pacific Research Board, Anchorage, Alaska
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Research in the Pacific Arctic

The Pacific Arctic Region is experiencing significant change in climate and reduction in seasonal sea ice. These shifts in the physical environment have impacts on system productivity, phenology, and ecology of upper trophic level species, including distribution, relative abundance, and community structure.

Understanding system interactions and potential shifts in ecosystem structure requires reference data and information exchange across the full extent of the ecosystems that connect Pacific and Arctic.

Prospects for International Collaboration

Through the Intergovernmental Consultative Committee, collaborative agreements between the US and Russia have been proposed to implement integrated ecosystem research in the Arctic to better understand system processes, regional structure, and the ecology and interactions of indicator species.

Plans include:

— survey coordination
— collaborative exchange of scientific personnel, samples and data.

The US has secured funding to conduct surveys and integrated ecosystem research in the northern Bering and Chukchi seas 2017-2021.

Prospects for International Collaboration

This presentation will review national research efforts, international research programs (e.g., NPAFC, RUSALCA), and new efforts (e.g., NPRB Arctic Integrated Ecosystem Research Program) and provide an overview of existing ecological time series observations and potential new mechanisms for data sharing and exchange.

Prospects for International Collaboration

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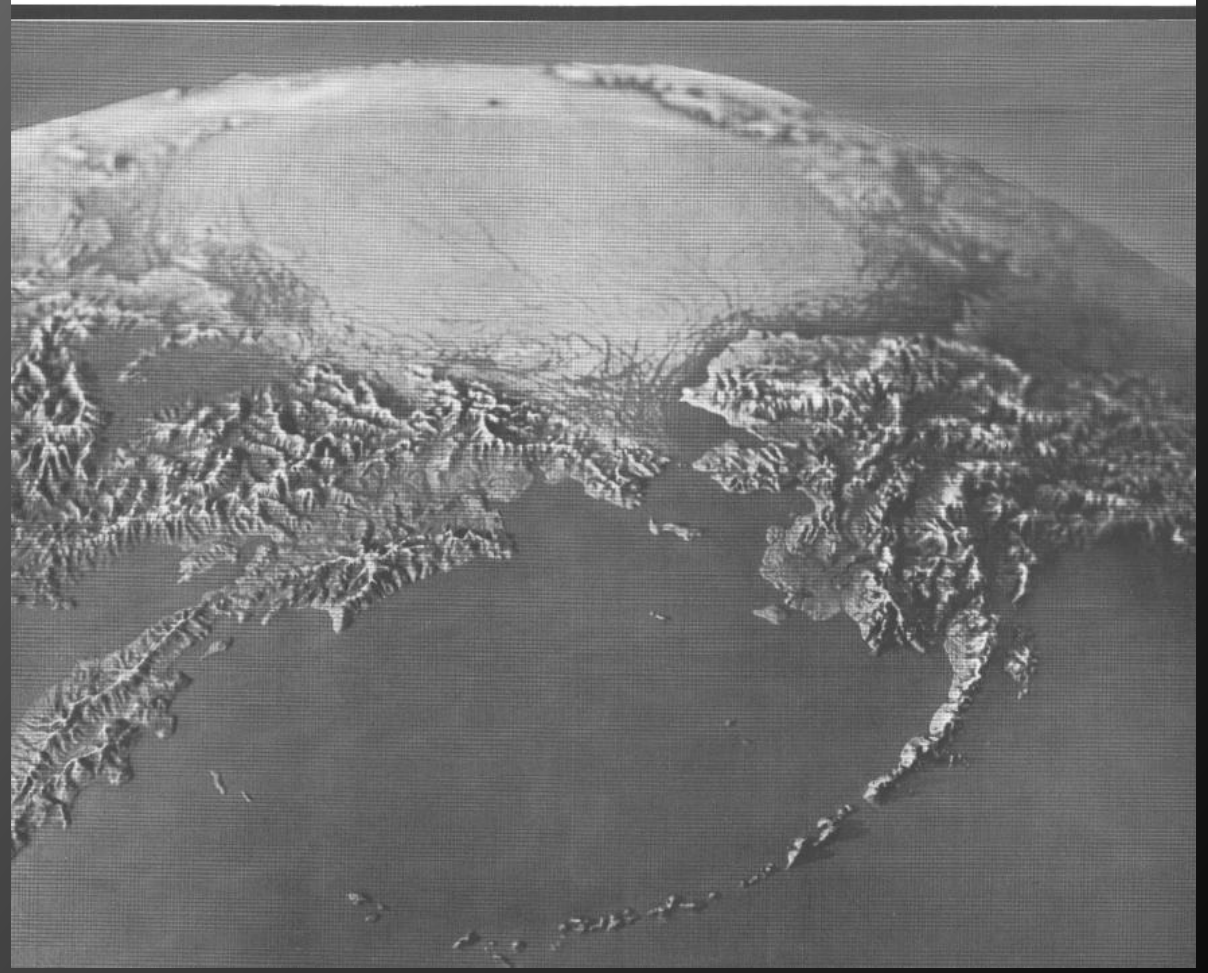
DISTRIBUTION OF BOTTOM SEDIMENTS ON THE CONTINENTAL SHELF, NORTHERN BERING SEA



Distribution of Bottom Sediments on the Continental Shelf, Northern Bering Sea

By Dean A. McManus, Venkatarathnam Kolla
David M. Hopkins, *and* C. Hans Nelson

STUDIES ON THE MARINE GEOLOGY OF THE BERING SEA

GEOLOGICAL SURVEY PROFESSIONAL PAPER 759-C

Prepared in cooperation with Department of Oceanography, University of Washington

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1977

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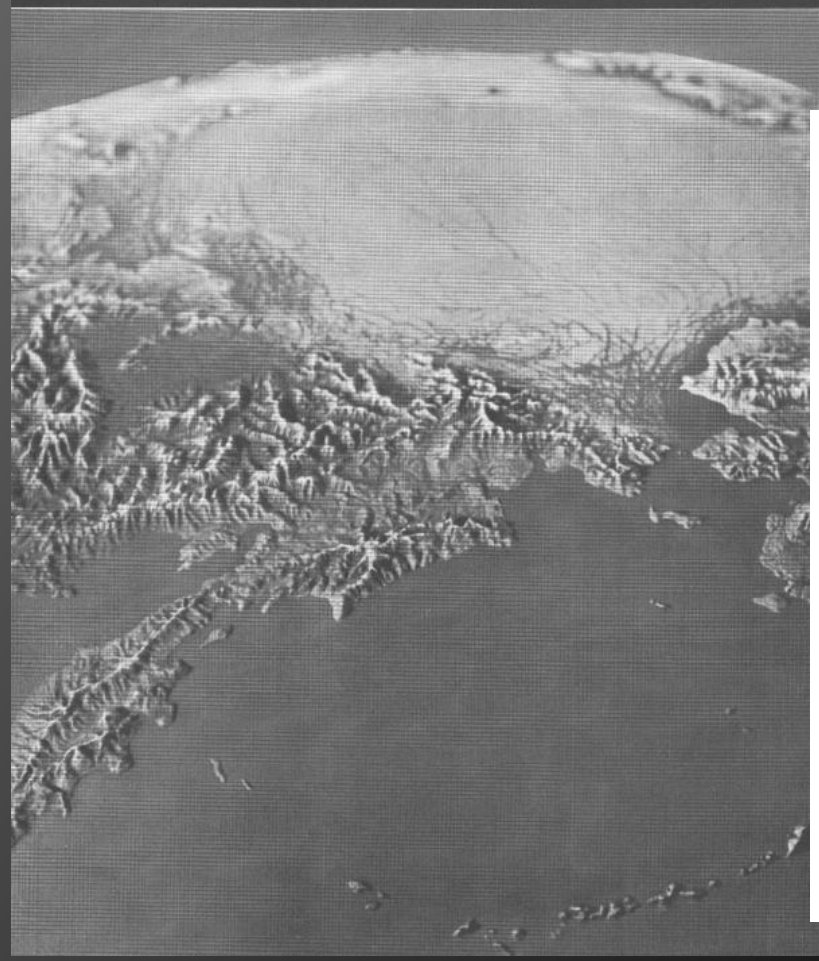

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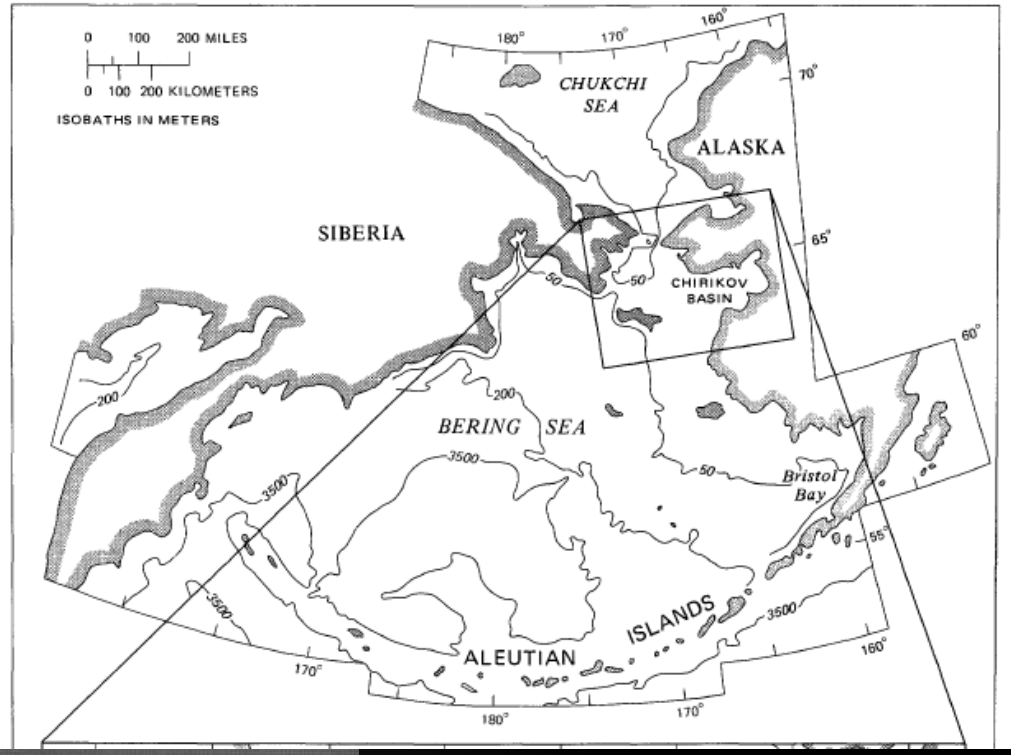

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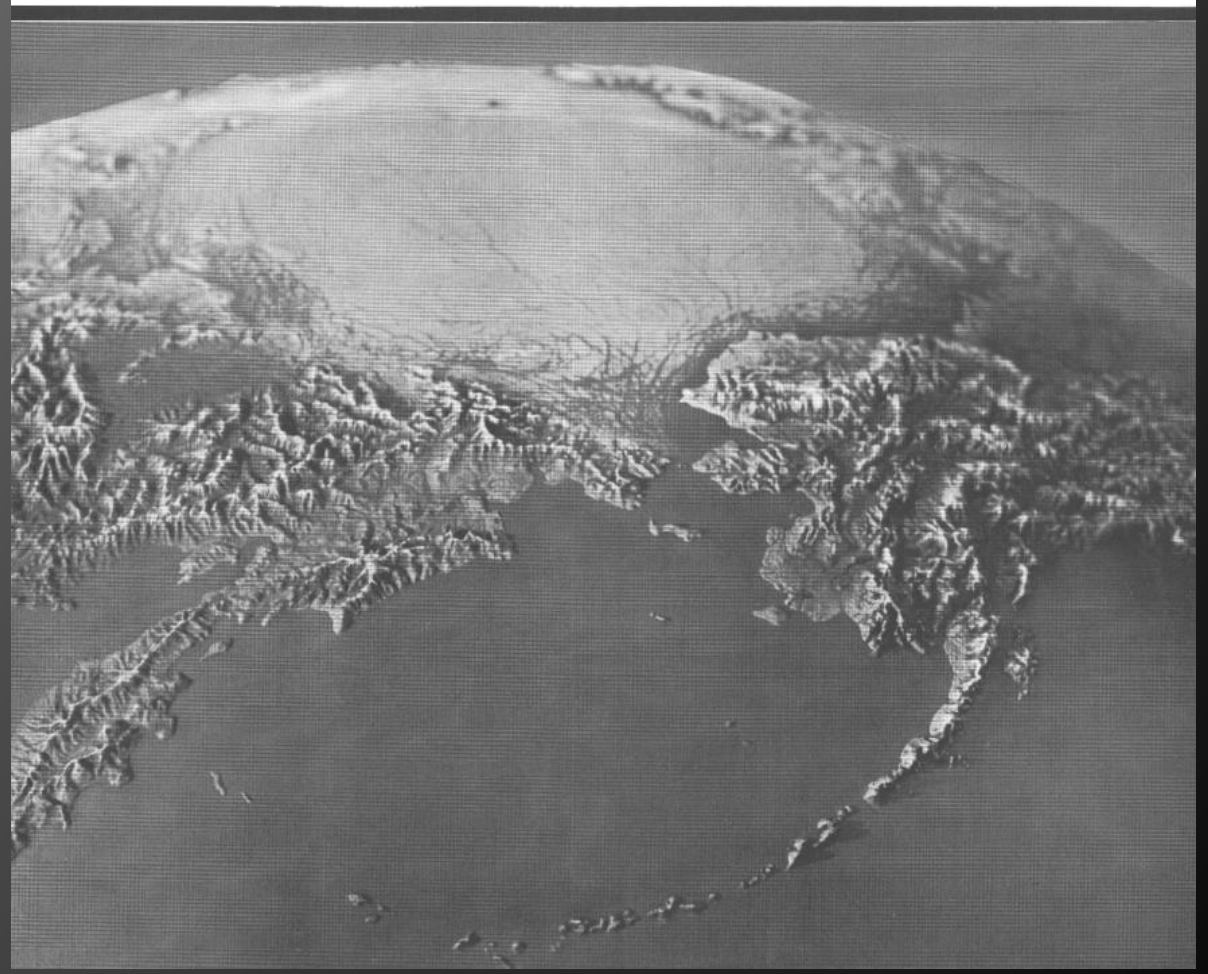

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FIGURE 3.—Current measurements during early July 1968. Sites of measurement are at bases of arrows. (After Coachman and others, 1976, with permission of University of Washington Press).

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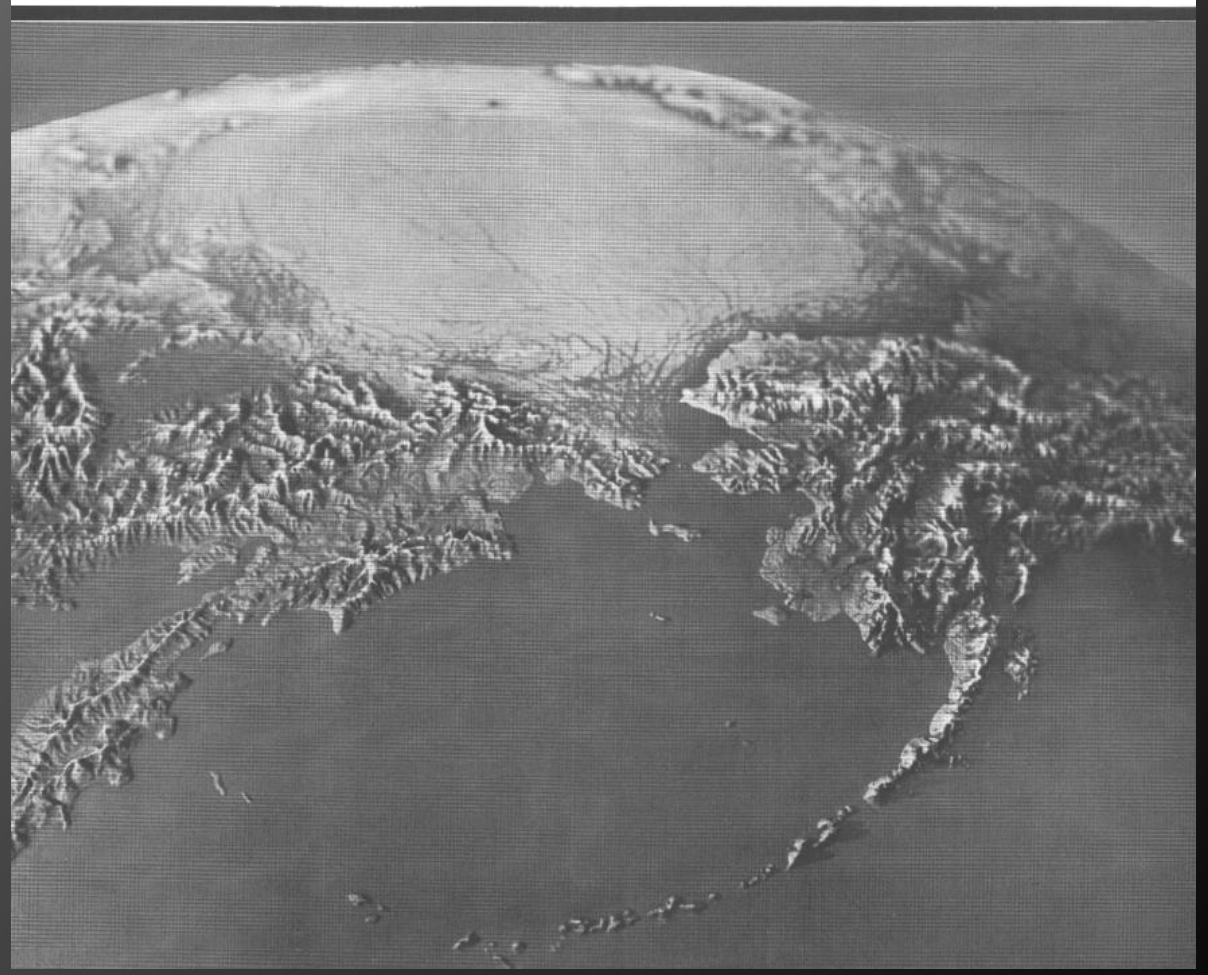

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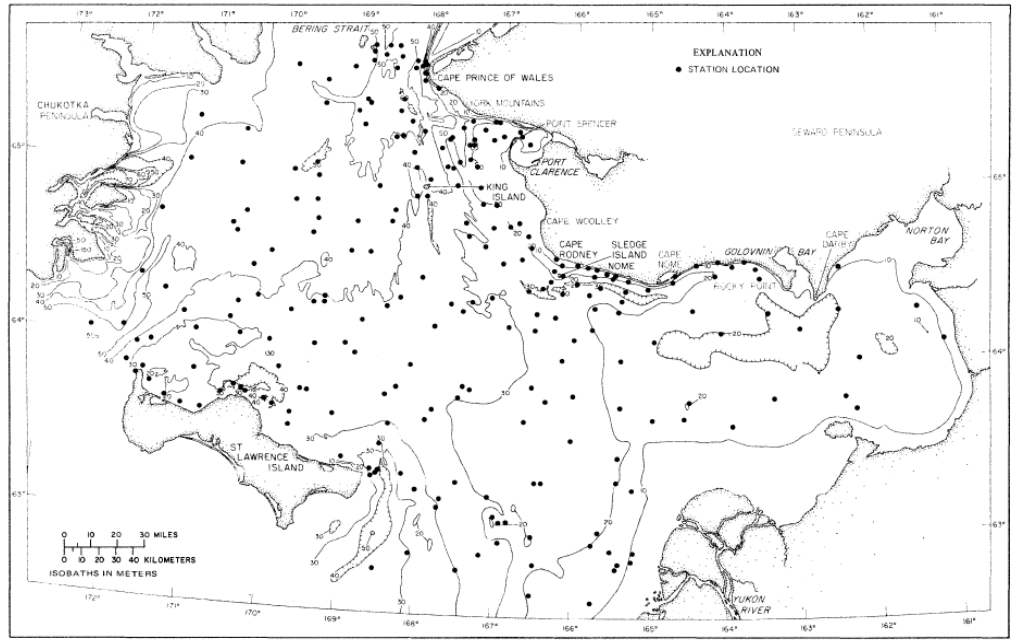

FIGURE 2.—Bathymetric chart of study area showing station locations (McManus and others, 1974). A more detailed bathymetric chart is given by Hopkins, Nelson, Perry, and Alpha (1976).

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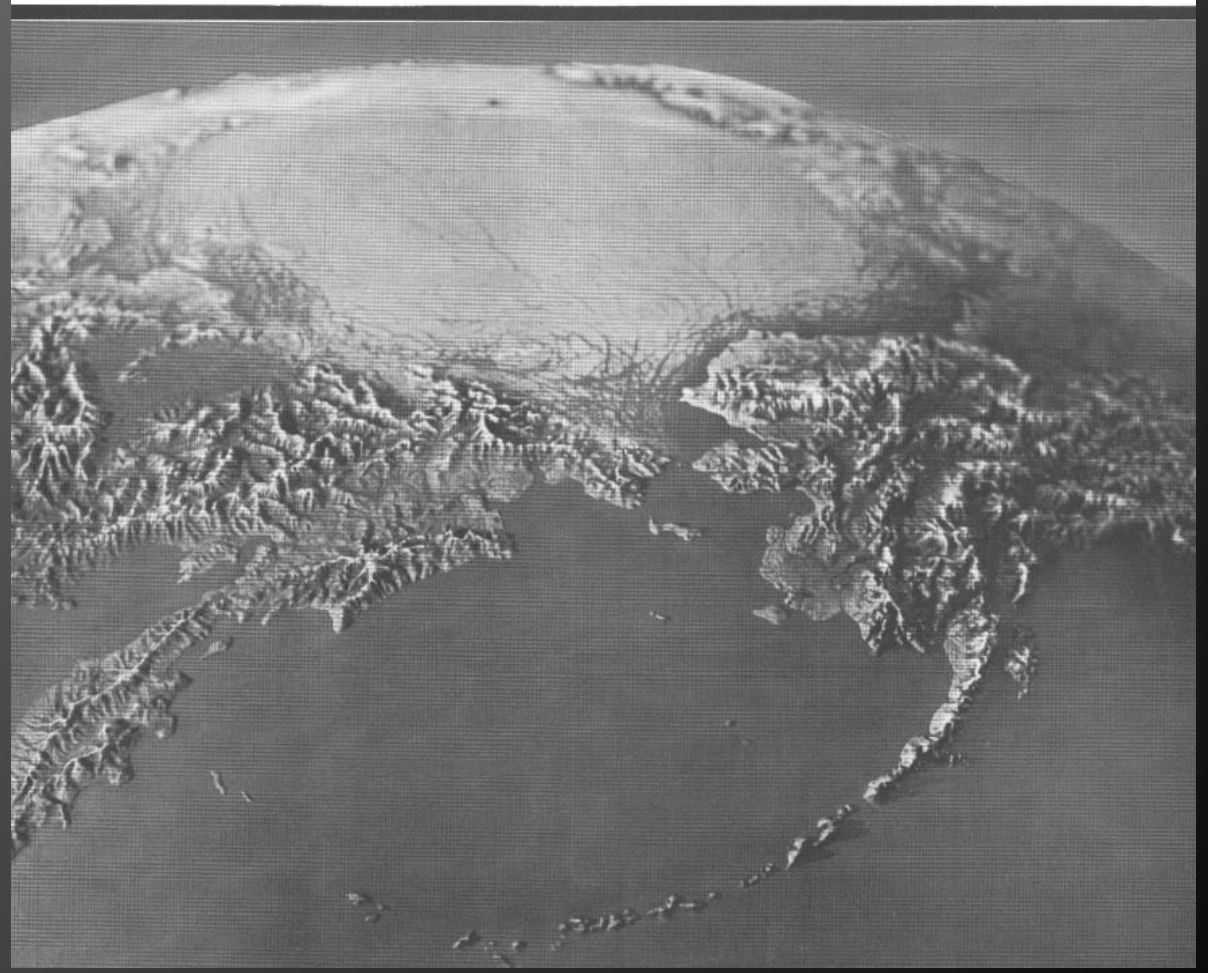

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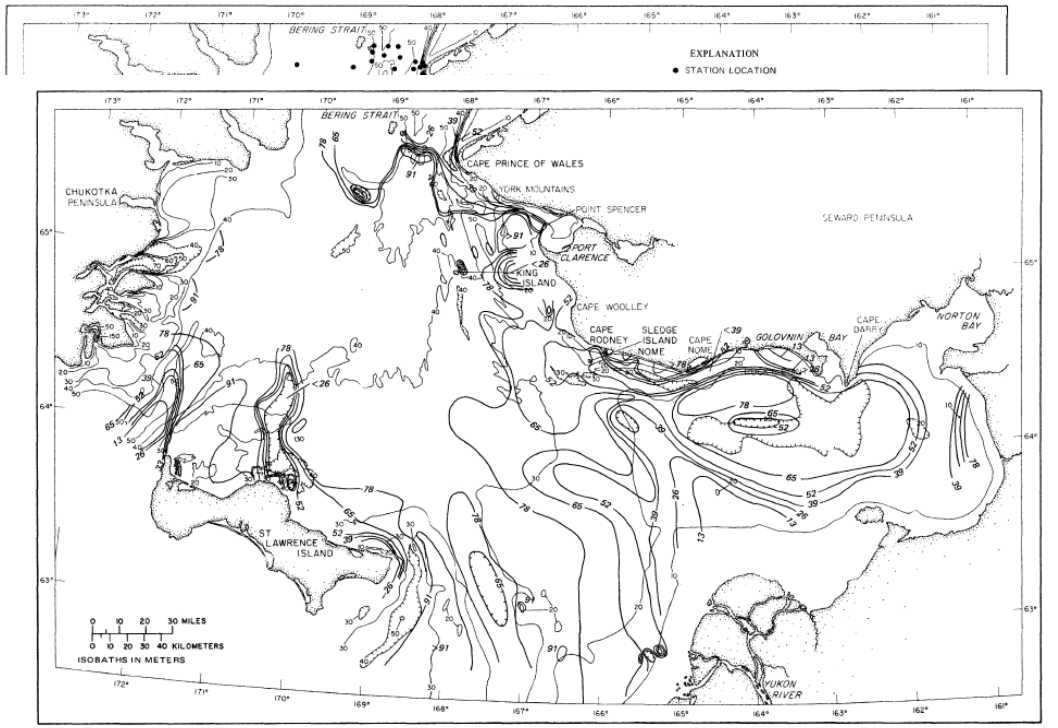

FIGURE 8.—Distribution of weight percent sand in bottom sediments. Contour interval 13 percent.

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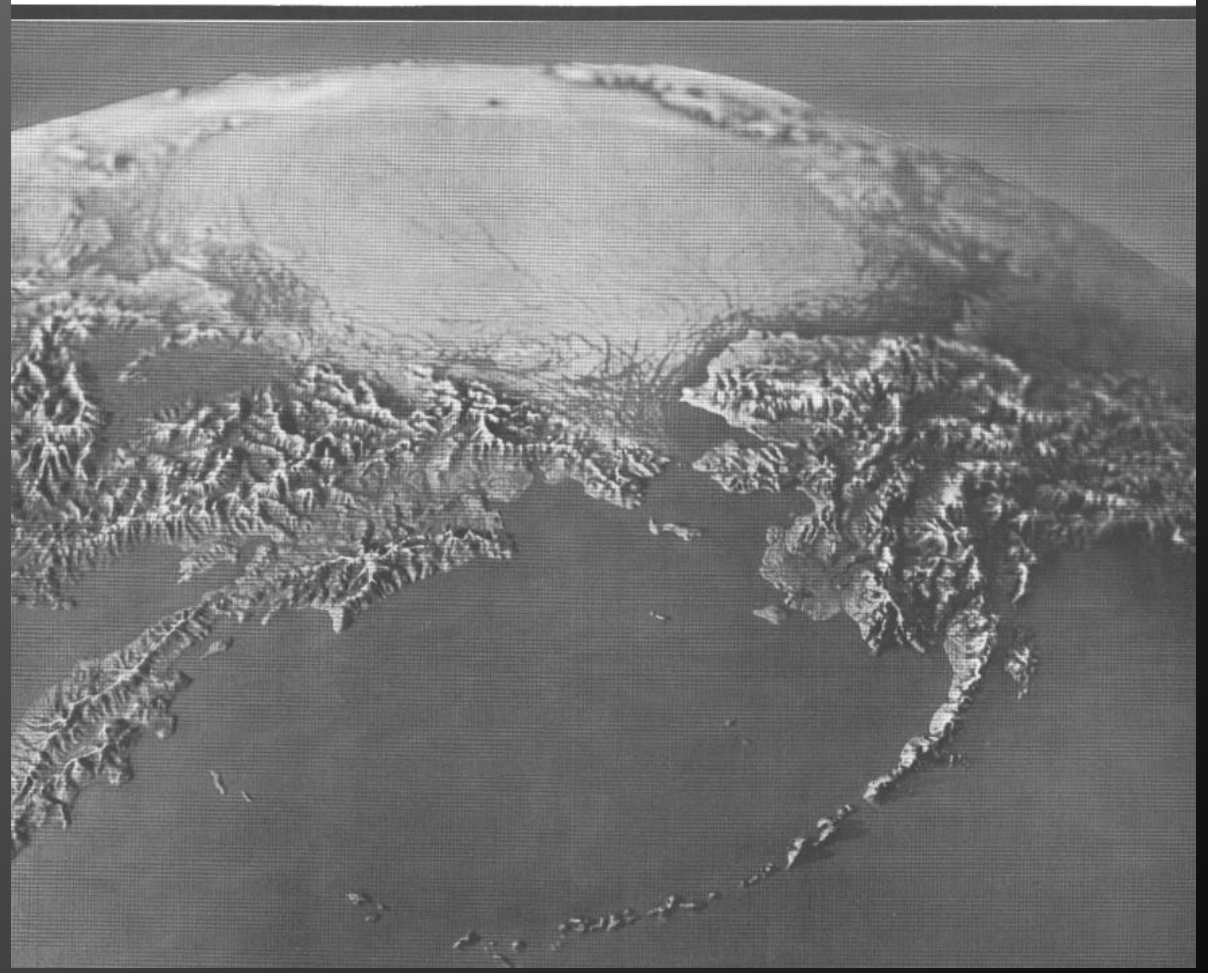

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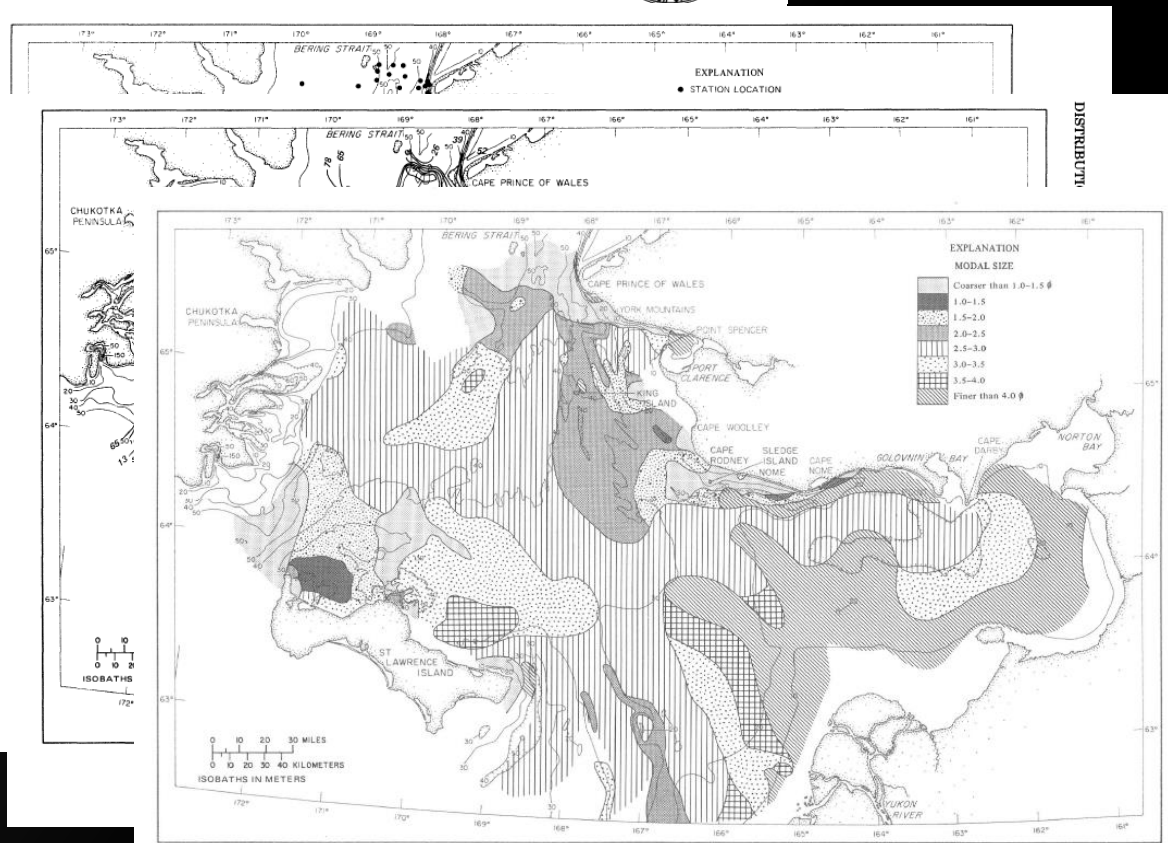

FIGURE 9.—Distribution of modal classes of sand. The class interval is less than the minimum resolvable difference.

NOAA Technical Memorandum NMFS-AFSC-298
doi:10.7289/V5V69GJ9

Smooth Sheet Bathymetry of Norton Sound

M. M. Prescott* and M. Zimmermann

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Alaska Fisheries Science Center

April 2015

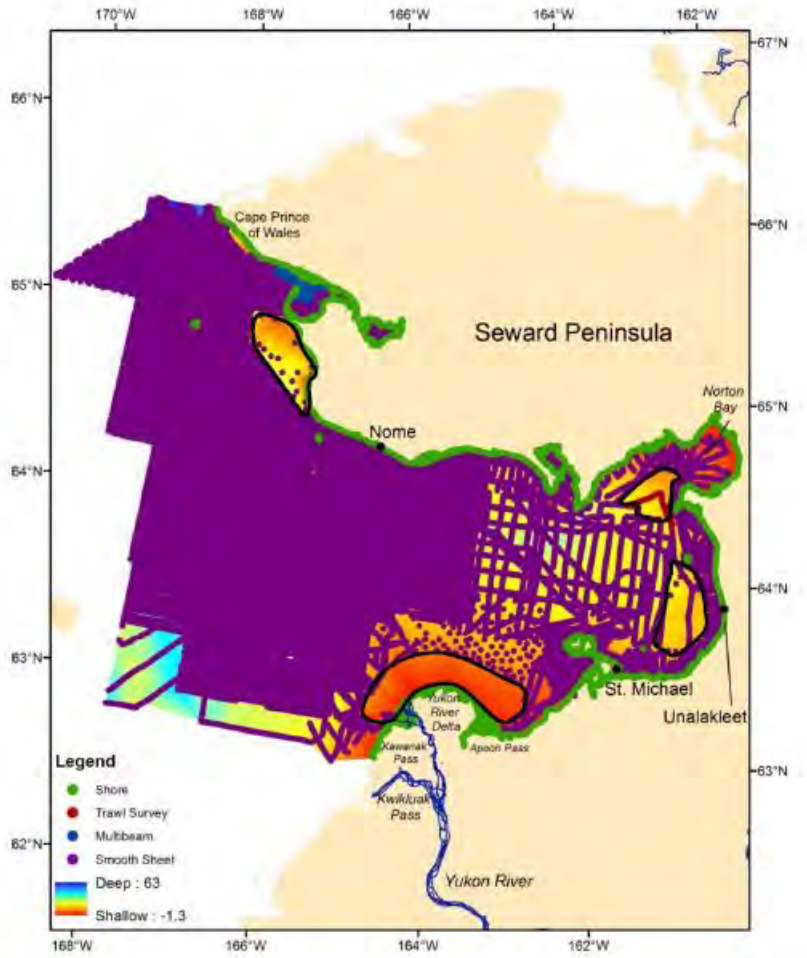

Fig. 2.--The coverage of individual data points used to build the Norton Sound bathymetry coverage. Smooth sheet data are shown in purple while the supplementary trawl data are displayed in red, multibeam in blue, and shoreline points in green; the regions circled in black are noted to be areas of missing data even though surrounding areas have dense coverage. Not to be used for navigational purposes.

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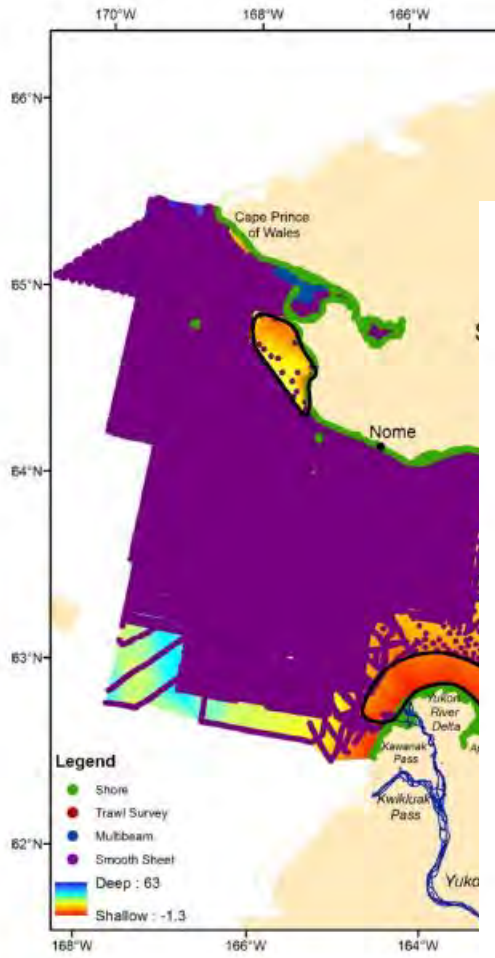

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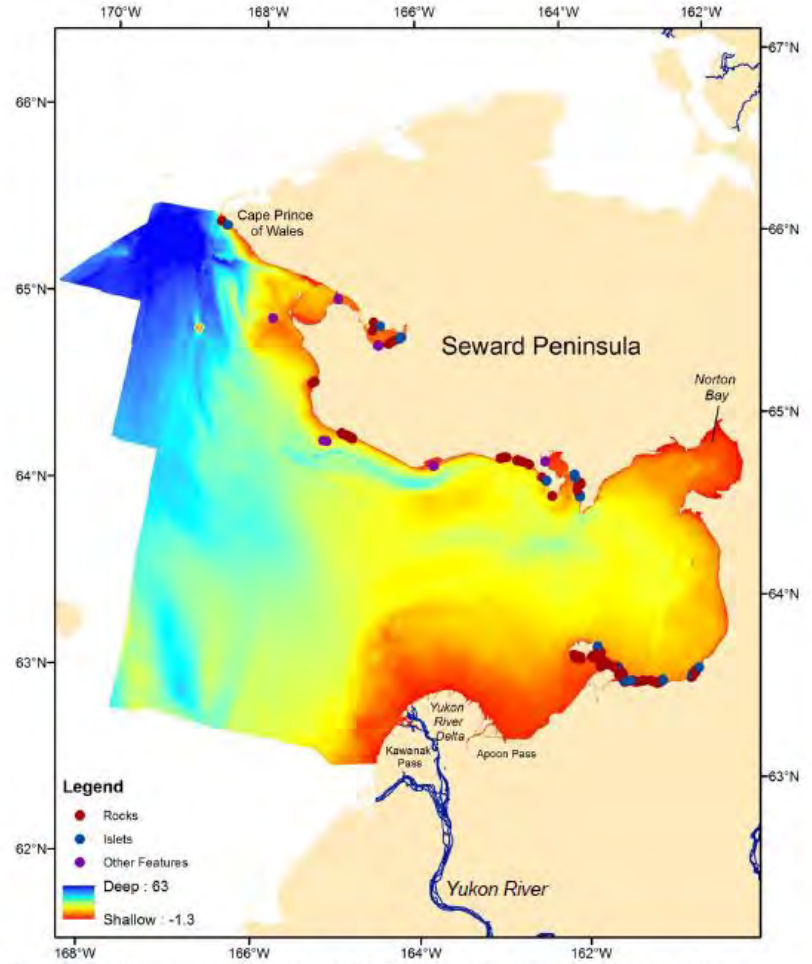

Fig.4. -- The features contained within the Norton Sound coverage. The majority of features were rocks (red), with islets (blue) being the second most common. All other features are grouped together (purple). Not to be used for navigational purposes.

NOAA Technical Memorandum NMFS-AFSC-318
doi:10.7289/V5/TM-AFSC-318

Trophic Structure of the Eastern Chukchi Sea: An Updated Mass Balance Food Web Model

G. A. Whitehouse and K. Y. Aydin

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Alaska Fisheries Science Center

April 2016

Figure 1. -- The model area in the eastern Chukchi Sea (filled with hatched lines).

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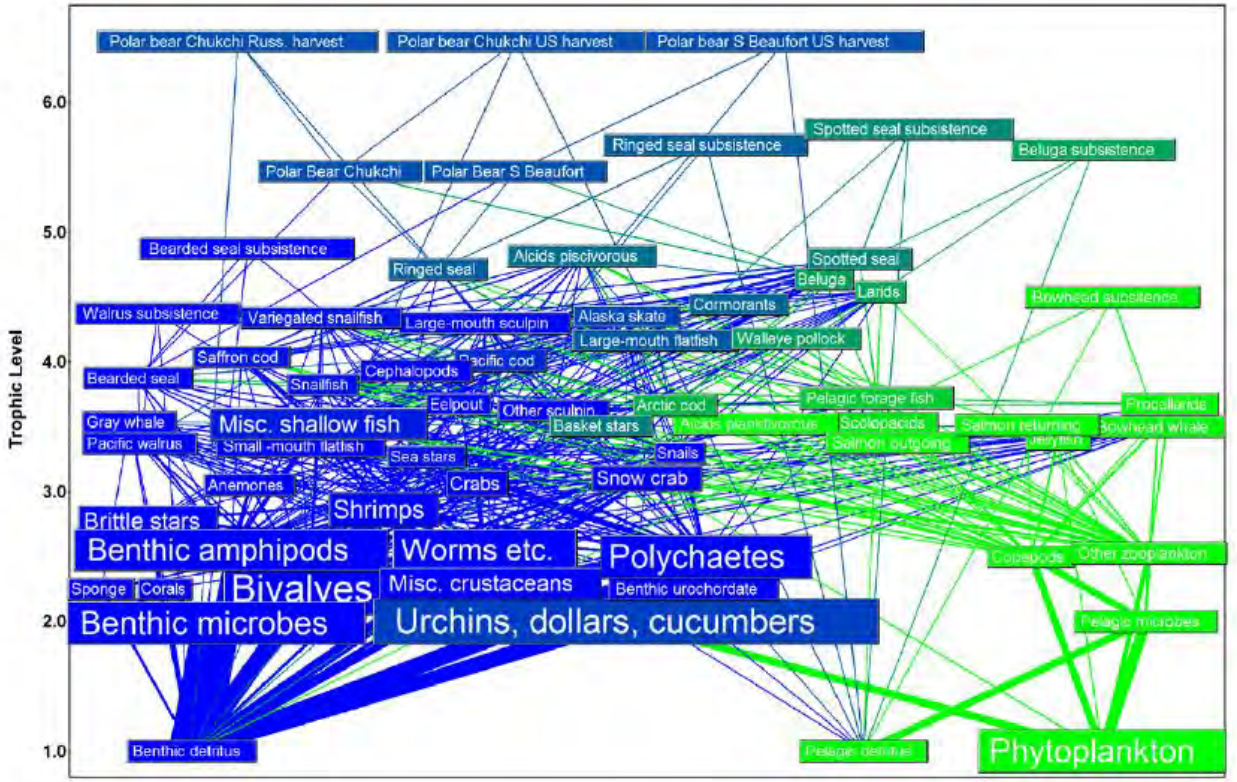

Figure 3. -- Food web diagram of the updated eastern Chukchi Sea food web (~2012). Functional groups (boxes) are arranged vertically by trophic level (a few groups are staggered up or down to improve readability). The height of the box is roughly proportional to the log biomass of the group. The width of the line between groups is proportional to the magnitude in mass flow. Blue boxes highlight benthic basal resources, and green boxes highlight pelagic sources, with a gradient of shades in between.

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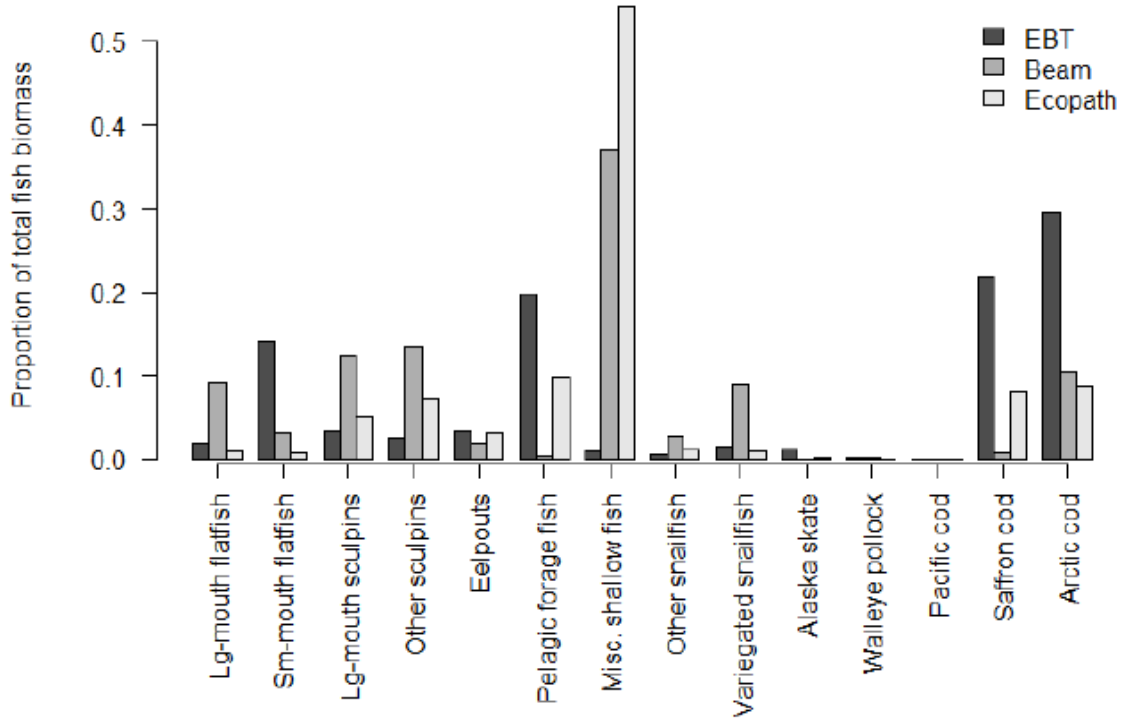

Figure 7. -- The proportional contribution of fish functional groups to the combined biomass of all fish groups (excluding salmonids) using three different estimates of biomass; the catch data from the 83-112 Eastern bottom trawl (EBT), the beam trawl, and the biomass estimates produced by Ecopath (assuming EE = 0.8).

NOAA Technical Memorandum NMFS-AFSC-130

A Comparison of the Eastern Bering and Western Bering Sea Shelf and Slope Ecosystems Through the Use of Mass-Balance Food Web Models

by
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William T. Hogarth, Assistant Administrator for Fisheries

July 2002

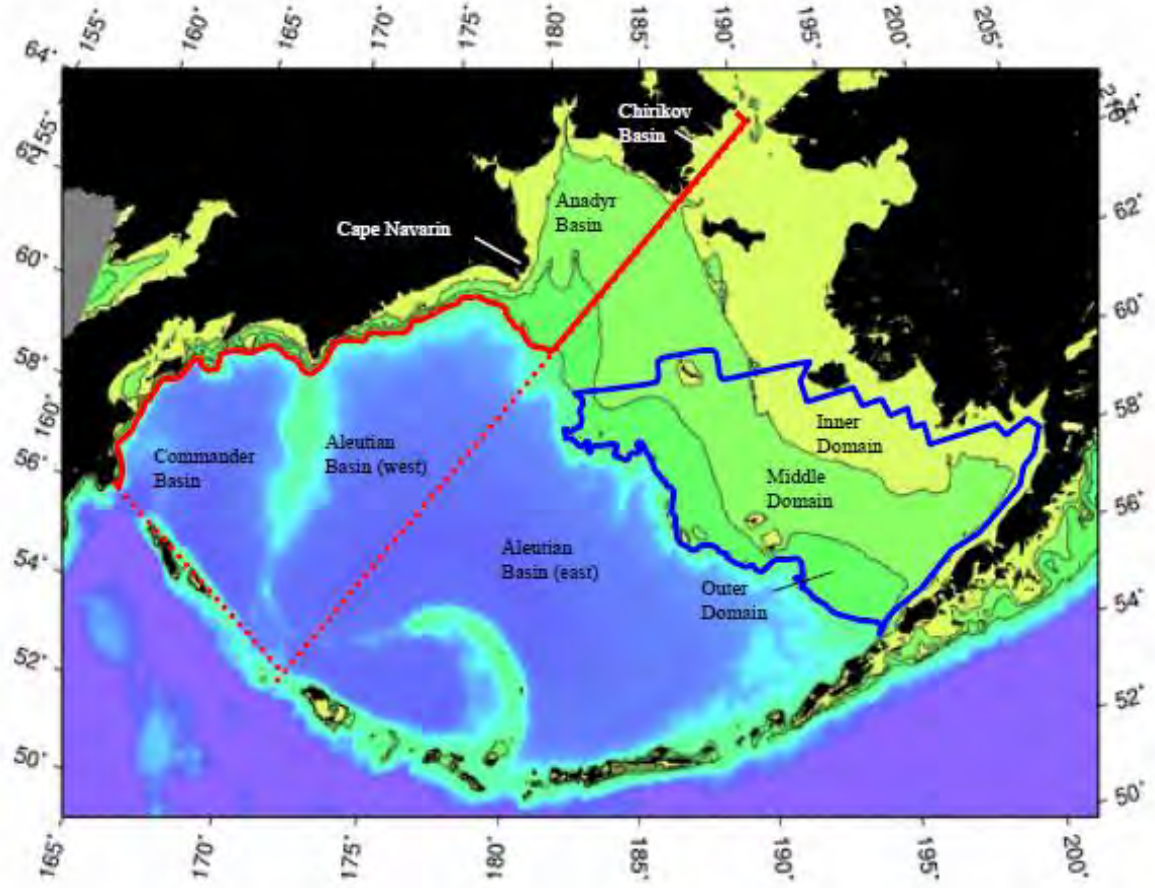

Figure 1. The Bering Sea, with boundaries of the EBS shelf model (eastern solid line), the WBS shelf model (western solid line), and the WBS shelf+basin model (dotted line). Isobaths shown are 50m (between inner and middle domains), 100m (between middle and outer domains) and 200m (between outer domain and slope/basin).

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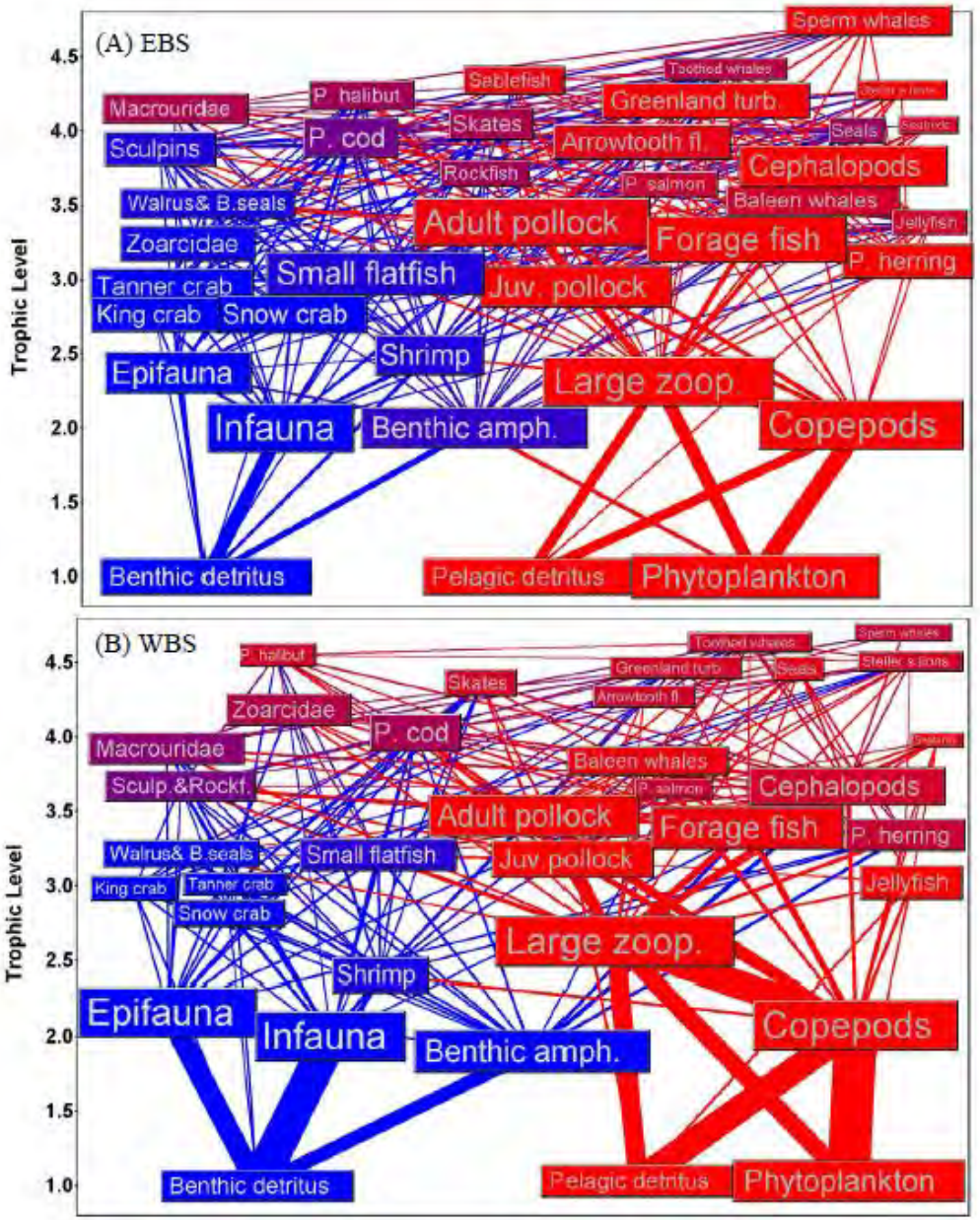

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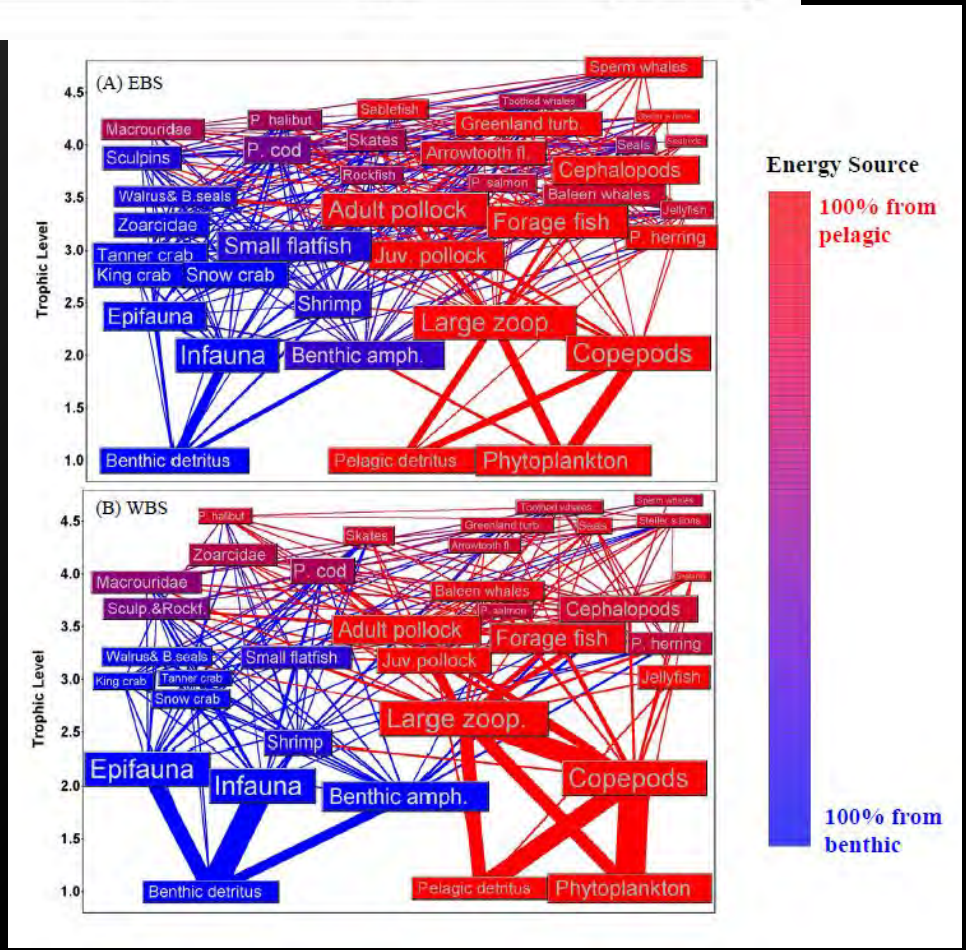
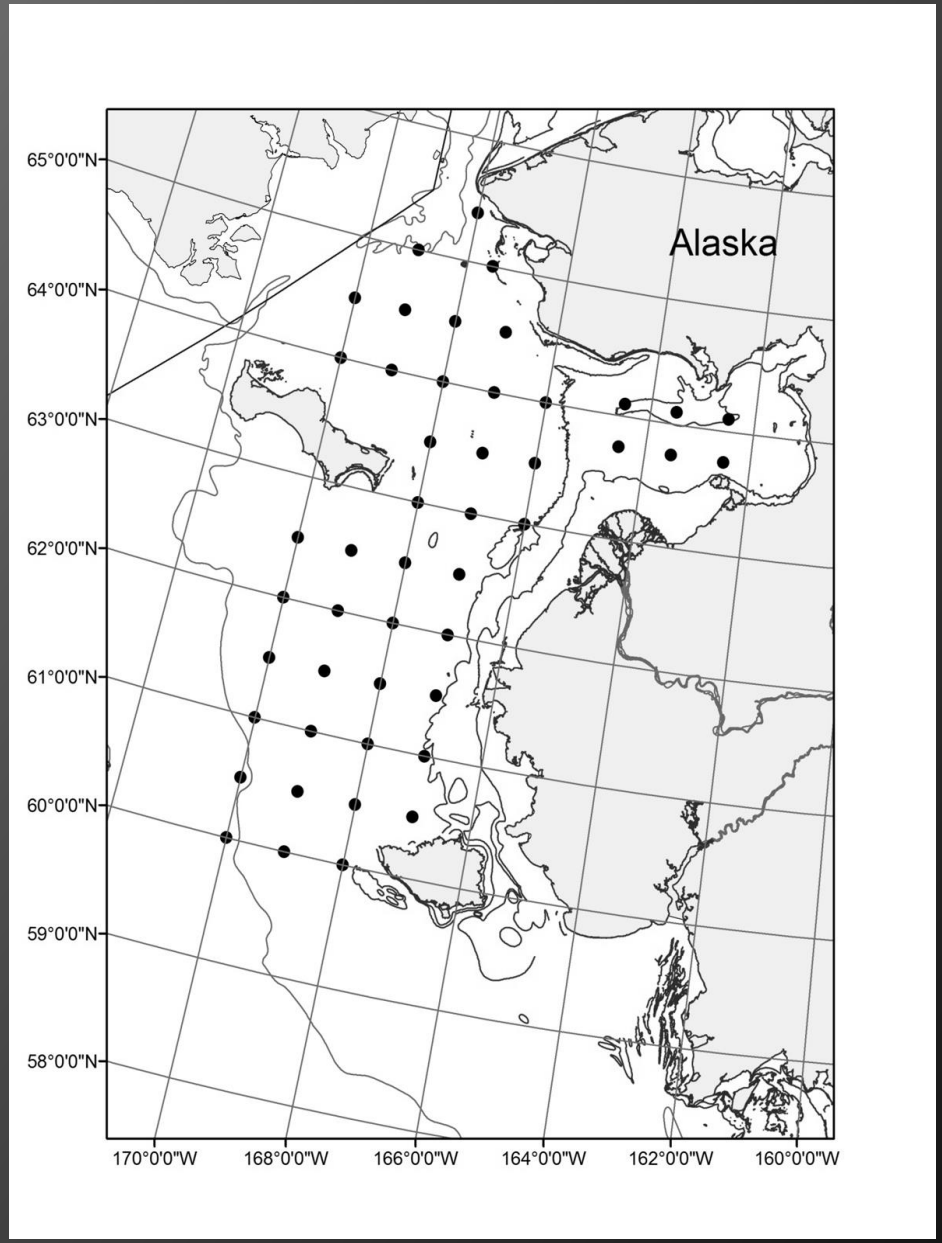
Table 2. Total biomass and primary production rates (phytoplankton + recycling) per unit area in the EBS and WBS models.

	EBS	WBS	Units
Total Biomass (excluding detritus)	240	568	t/km²
Trophic Pathway Level I (Consumed) Production			
Phytoplankton	1,468 (57.2%)	2,591 (43.0%)	
Pelagic Detritus	474 (18.5%)	1,225 (20.3%)	
Benthic Detritus	624 (24.3%)	2,214 (36.7%)	
Total TL 1 Production	2,566	6,031	t/km²/year
P(TL 1)/B(total)	10.7	10.6	1/year



North Eastern Bering Sea survey



United States Cruise Plan for Northern Bering Sea Surface Trawl Surveys, August - September 2016

by

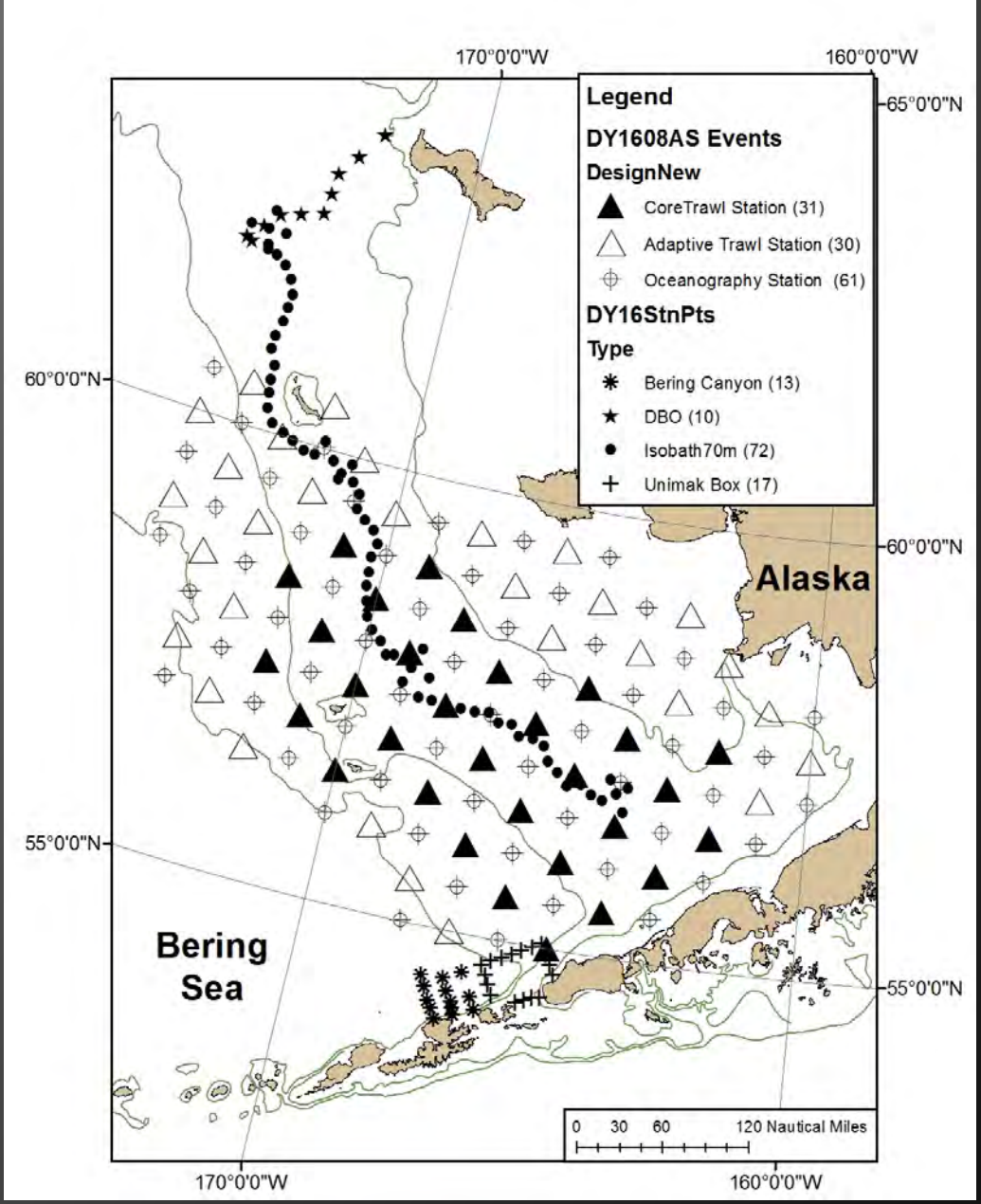
Kristin Cieciel and Edward Farley

National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Alaska Fisheries Science Center, Auke Bay Laboratories
Ted Stevens Marine Research Institute
17109 Point Lena Loop Road
Juneau, AK 99801-8626 USA

2003-2016 late summer

Marine survey
Surface trawl and oceanography
Pollock, salmon, forage fish, jellyfish
Impacts on the loss of sea ice on marine species
Juvenile Chinook salmon abundance index

2016 late summer EBS survey



2000-2012, 2014-2015
Combined surface, mid-water trawls with acoustics in 2016.

Zooplankton
Age-0 Pollock abundance
Age-0 Pollock distribution
P. cod, capelin,
herring, salmon, atka mackerel, sablefish, jellyfish

Energy density of age-0 pollock to predict over-wintering survival

Contact: Elizabeth Siddon

Bering Sea Slope Bottom Trawl Survey

31 May- 10 August, 2016

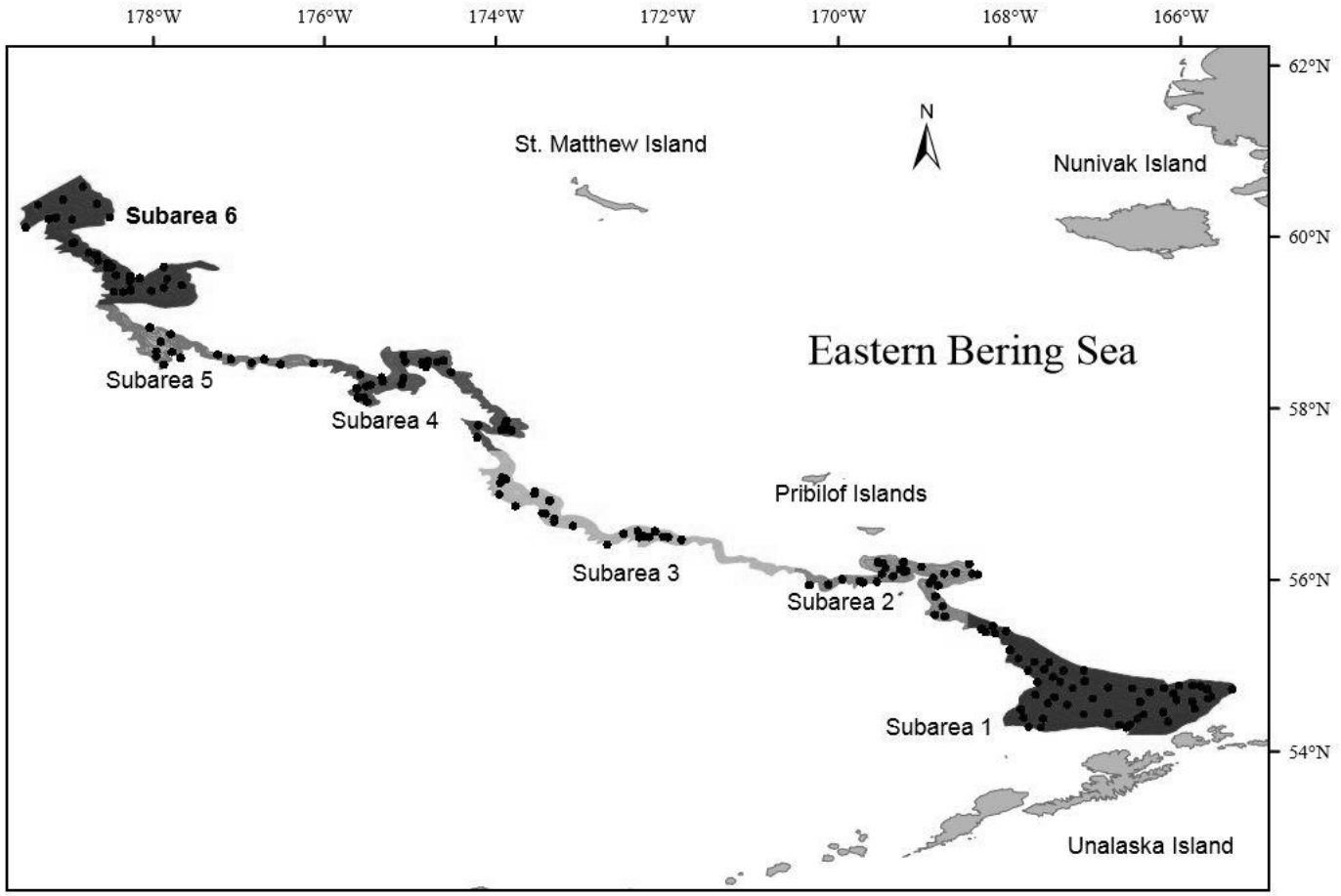
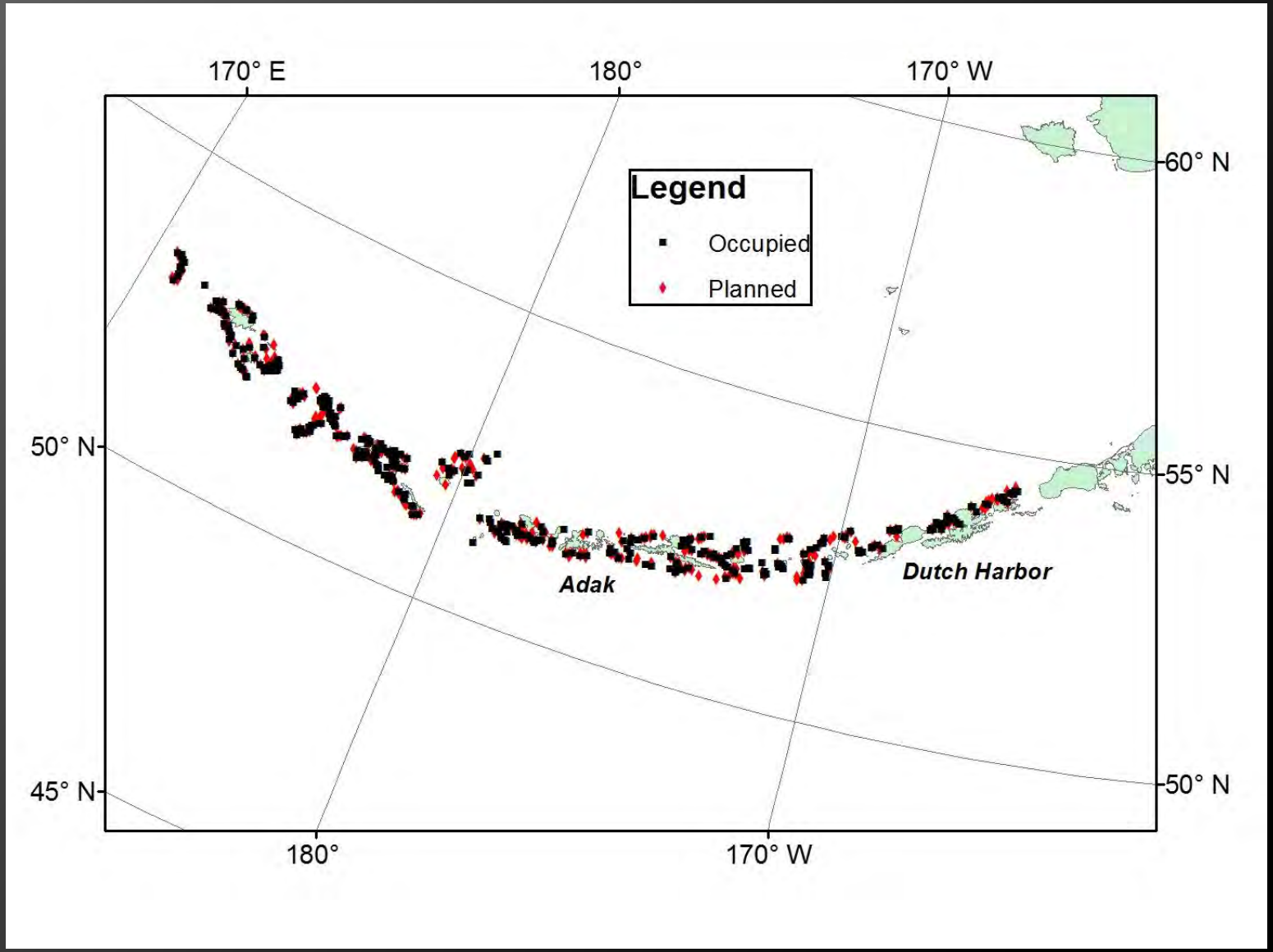


Figure 1. - - Map of standard survey area and the six subareas. Indicated are the 175 successful trawl stations (black dots) completed during the 2016 EBSS survey.

Contact: jerry.hoff@noaa.gov

Aleutian Island Bottom Trawl Survey

01 June- 12 August, 2016,



Contact: wayne.palsson@noaa.gov

Other NOAA surveys in Alaska

- Alaska fisheries Science Center (AFSC):
  - Summer eastern Bering Sea Bottom Trawl Survey: 1975-2015, annual.
- Pacific Marine Environmental Lab (PMEL) and AFSC:
  - Physical Oceanography of the eastern Bering Sea, 4 moorings, spring/fall hydrography along 70m isobath, primary production, phytoplankton taxa, zooplankton taxa, sail drone

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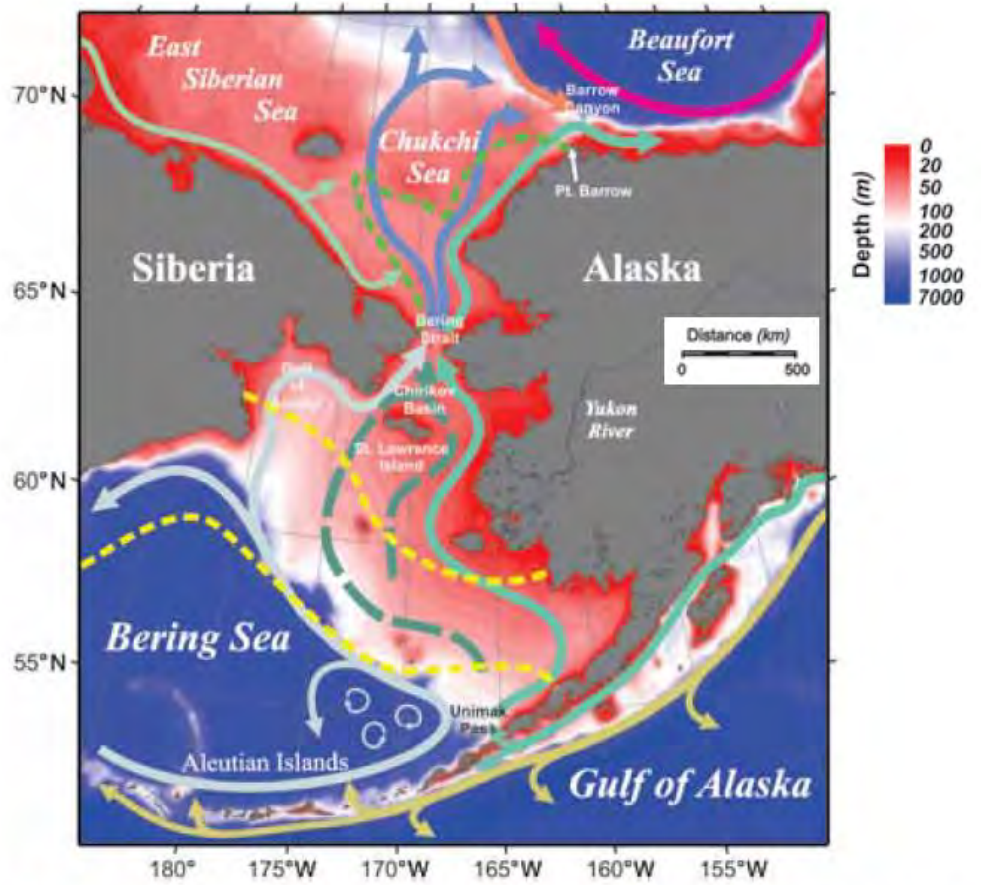

Figure 1. The Bering, Chukchi, and Beaufort Seas form a continuum between the North Pacific Ocean and the Arctic Ocean. This idealized schematic denotes some of the important water masses and currents that impact regional differences in physical habitat characteristics.

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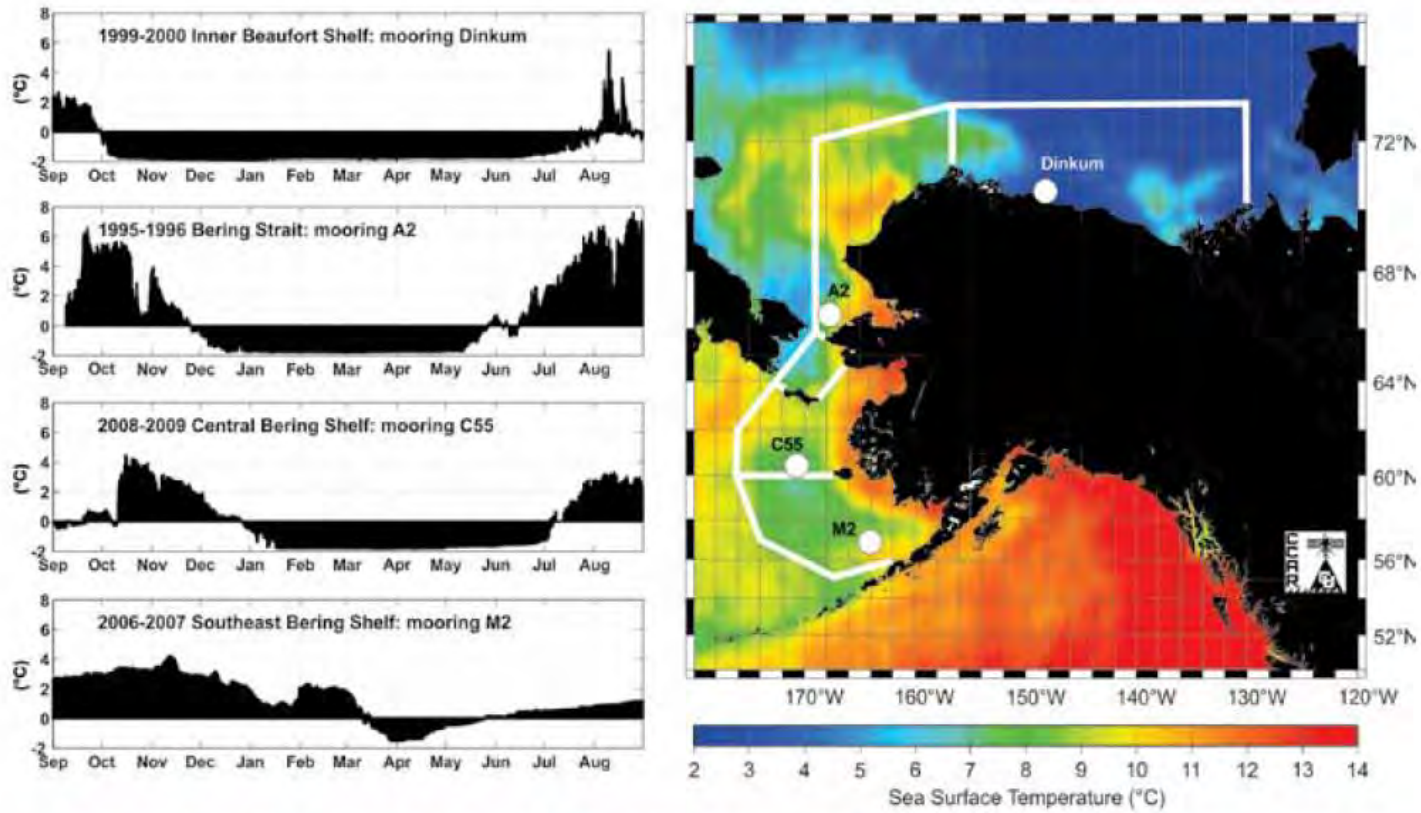

Figure 2. (left) Annual cycle of temperatures recorded at the four mooring sites denoted on the map. Data are courtesy of T. Weingartner (Dinkum and A2), K. Aagaard (C55), and P. Stabeno (M2). (right) Surface temperature (°C) for mid-September derived from satellite observation using GHRSST (Global Ocean Data Assimilation Experiment [GODAE] high-resolution sea surface temperature data [http://argo.colorado.edu/~realtime/global-sst]). White lines indicate region boundaries. From south to north, the regions are: southern, central, and northern Bering Sea (eastern shelf); Chukchi Sea; and Beaufort Sea.

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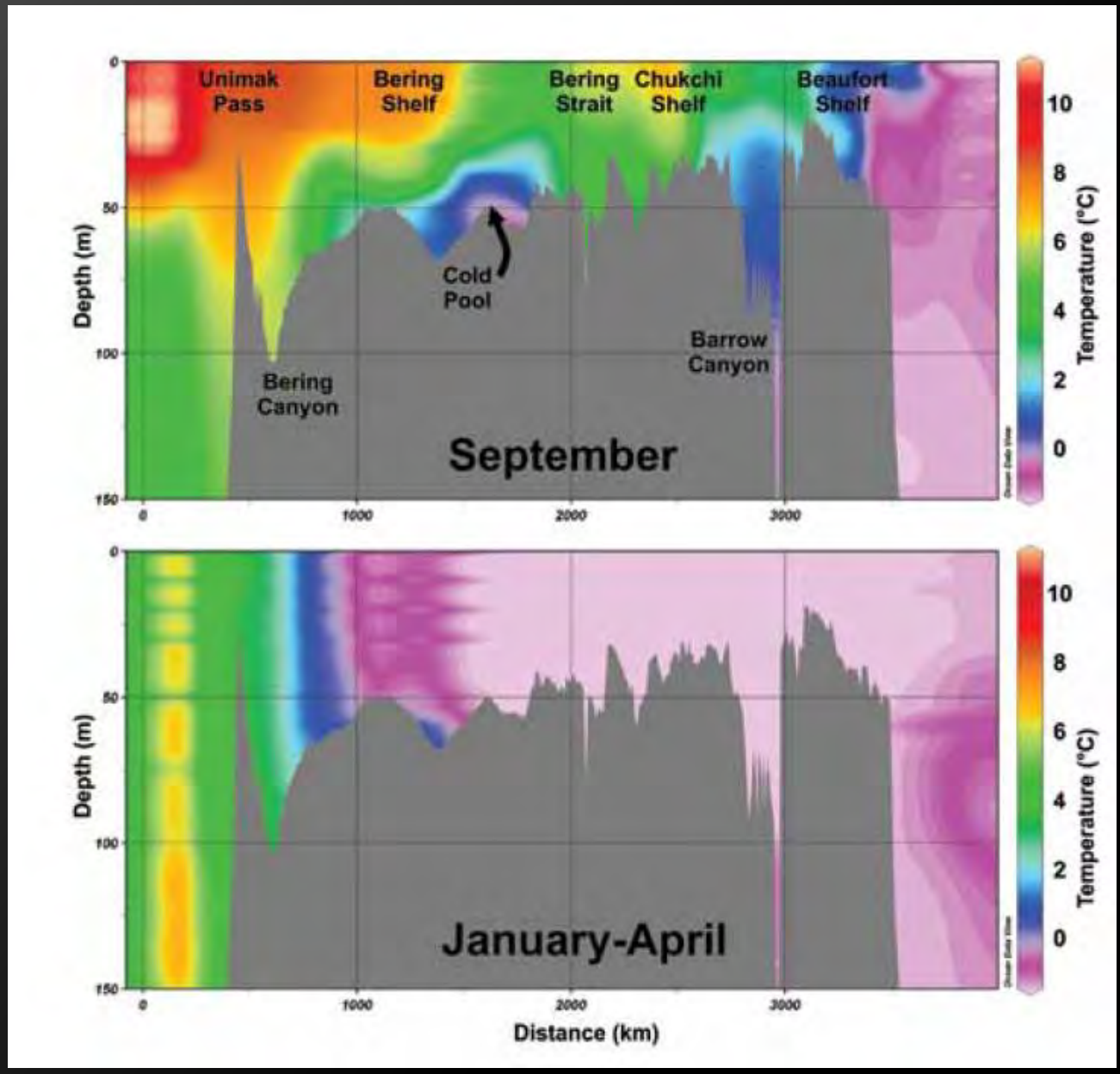
U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service



Arctic Ecosystem Integrated Survey

Distribution of Fish, Crab, and Lower Trophic Communities in the Northeastern Bering Sea and Chukchi Sea

Final Component Report:
Juvenile Chinook salmon abundance in the northern Bering Sea: Implications for future returns and fisheries in the Yukon River

Principle Investigators:
James M. Murphy and Kathrine G. Howard

Authors:
James M. Murphy, Kathrine G. Howard, Jeanette C. Gann, Kristin Cieciel, William D. Templin, Charles M. Guthrie III

Date
December 4, 2015

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Alaska OCS Region

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Bureau of Ocean Energy Management

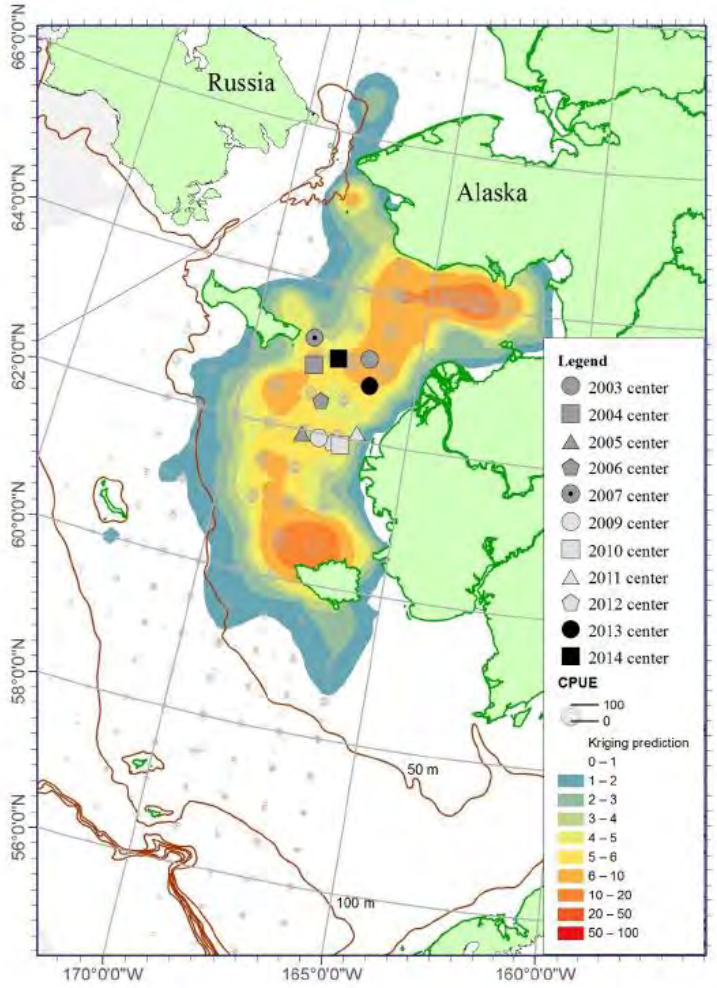

Figure 3. Spatial distribution of juvenile Chinook salmon based on catch data (CPUE, catch-per-km^2 scaled to average effort) from surface trawl surveys in the northern Bering Sea, 2003 to 2014. Color contours are from the neighborhood kriging prediction surface of CPUE (circles) and shaded symbols identify the spatial center of juvenile Chinook salmon distributions by year.

Arctic Ecosystem Integrated Survey

Distribution of Fish, Crab, and Lower Trophic Communities in the Northeastern Bering Sea and Chukchi Sea

Final Component Report:
Species and Size Selectivity of Two Midwater Trawls used in an Acoustic Survey of the Alaska Arctic

Principal Investigators:
Alex De Robertis and Christopher D. Wilson

Authors:
Alex De Robertis, Kevin Taylor, Kresimir Williams, and Christopher D. Wilson

Date:
December 12, 2015

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Alaska OCS Region

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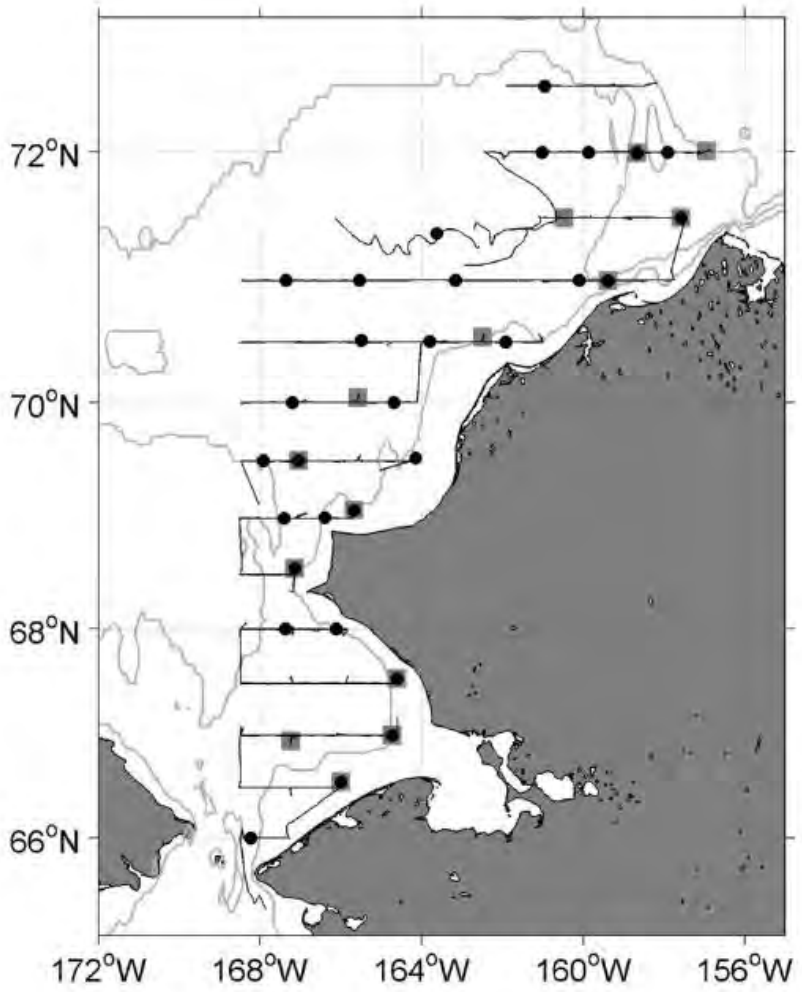

Figure 1. Estimates of trawl size and species selectivity. The locations of paired Cantrawl and mod-Marinovich trawl stations are shown as grey squares, and stations where the mod-Marinovich was fished with 8 recapture nets are given as black circles. Locations with both a circle and a square indicate the trawl stations where paired trawls and resample nets were deployed. The vessel survey track is shown as a black line and the 25, 50 and 100 m depth contours are shown as grey lines.

Arctic Ecosystem Integrated Survey

Distribution of Fish, Crab, and Lower Trophic Communities in the Northeastern Bering Sea and Chukchi Sea

Final Component Report:
Icthyoplankton Assemblages and Distribution in the Chukchi and Northern Bering Seas 2012-2013

Principle Investigators:
Morgan S. Busby and Janet T. Duffy-Anderson

Authors:
Morgan S. Busby, Janet T. Duffy-Anderson, Kathryn L. Mier, Heather M. Tabisola

Date:
30 November 2015

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Fig. 1a. Bongo stations sampled 7 August – 24 September 2012.

Fig. 1b. Bongo stations sampled 7 August – 24 September 2013.

Arctic Ecosystem Integrated Survey

Distribution of Fish, Crab, and Lower Trophic Communities in the Northeastern Bering Sea and Chukchi Sea

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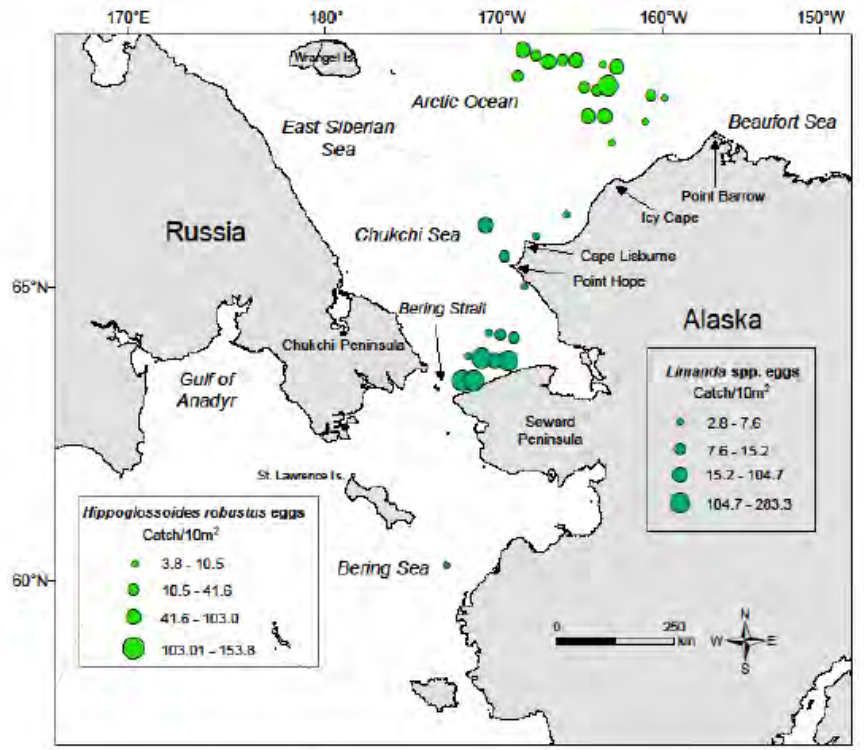

Fig. 2a. Abundance and distribution of *Limanda* spp. and *Hippoglossoides robustus* eggs 2012.

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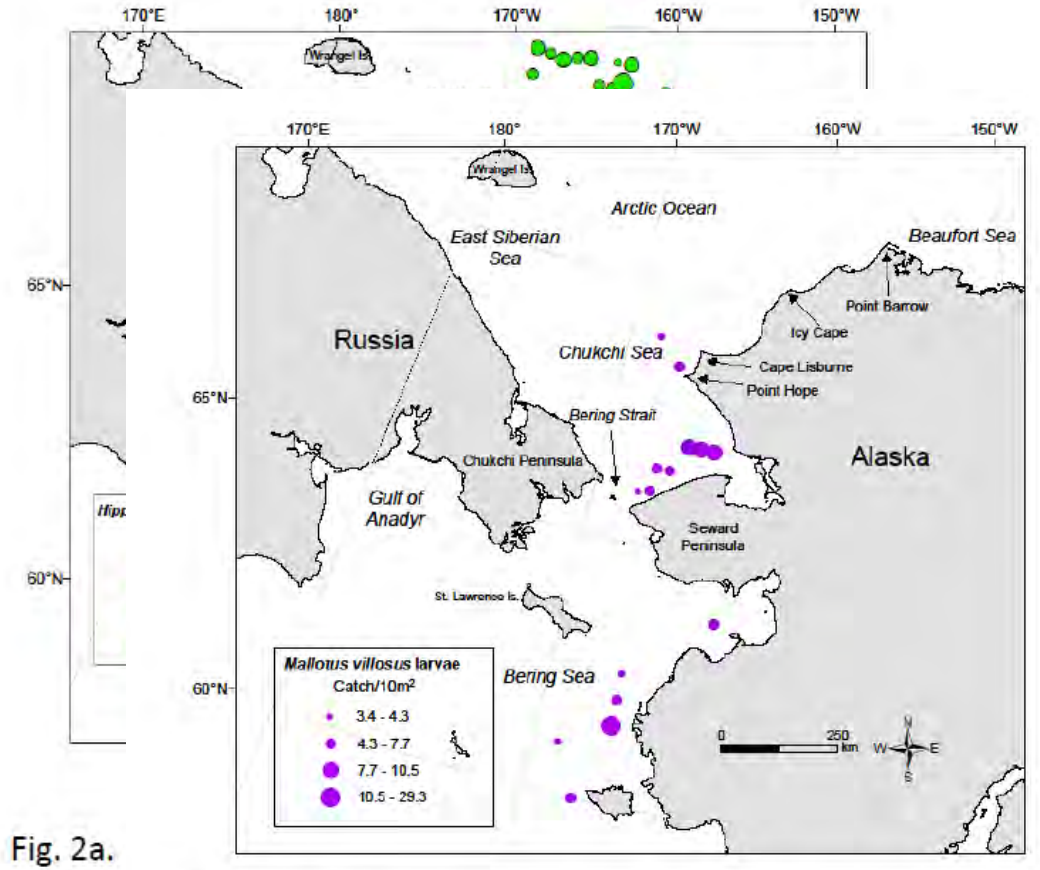

Fig. 2a.

Fig. 6a. Abundance and distribution of *Mallotus villosus* larvae 2012.

Arctic Ecosystem Integrated Survey

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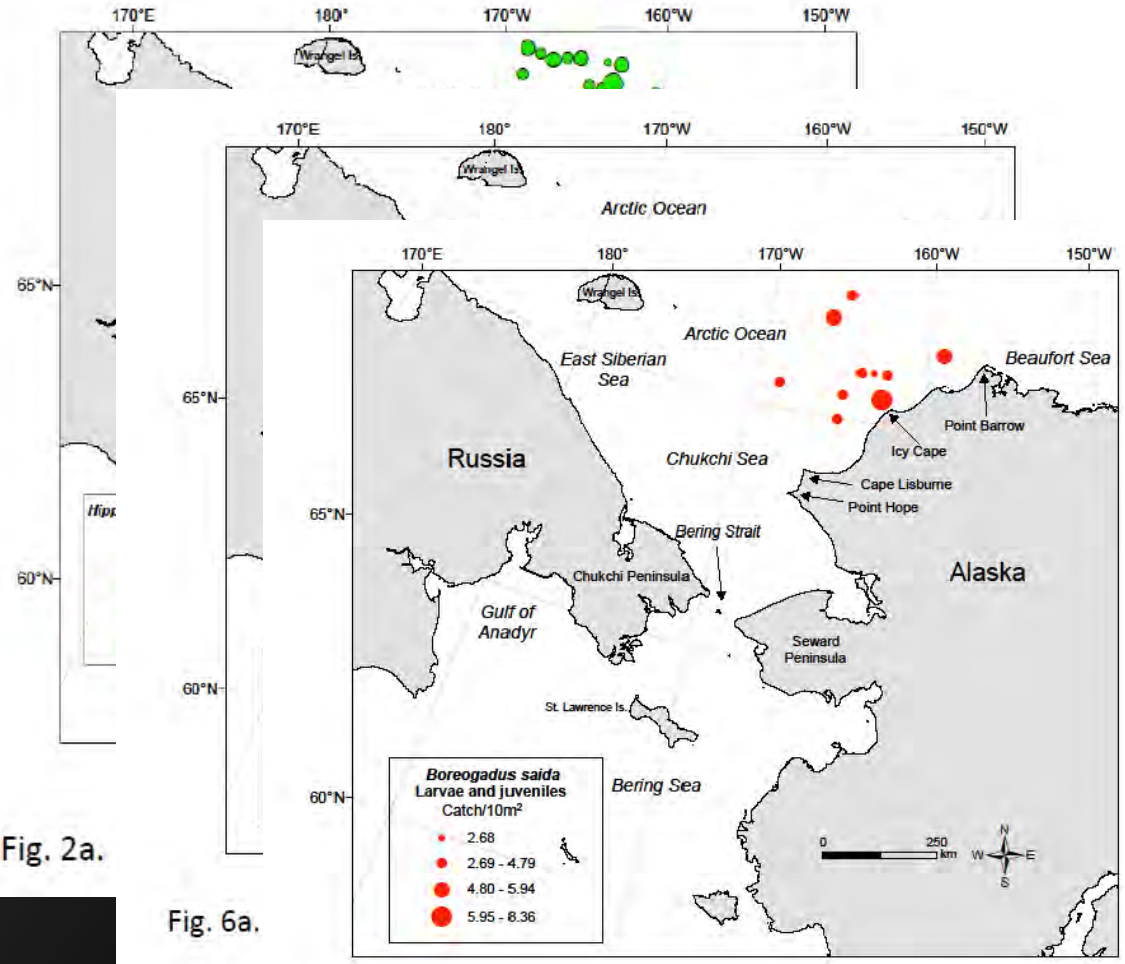

Fig. 2a.

Fig. 6a.

Fig. 5a. Abundance and distribution of *Boreogadus saida* larvae and juveniles 2012.

Arctic Ecosystem Integrated Survey

Distribution of Fish, Crab, and Lower Trophic Communities in the Northeastern Bering Sea and Chukchi Sea

Final Component Report:
A comparison between late summer 2012 and 2013 water masses, macronutrients, and phytoplankton standing crops in the northern Bering and Chukchi Seas

Principle Investigator:
Lisa Eisner

Authors:
Seth L. Danielson, Lisa Eisner, Carol Ladd, Calvin Mordy, Leandra Sousa and Thomas J. Weingartner

Date:
December 9, 2015

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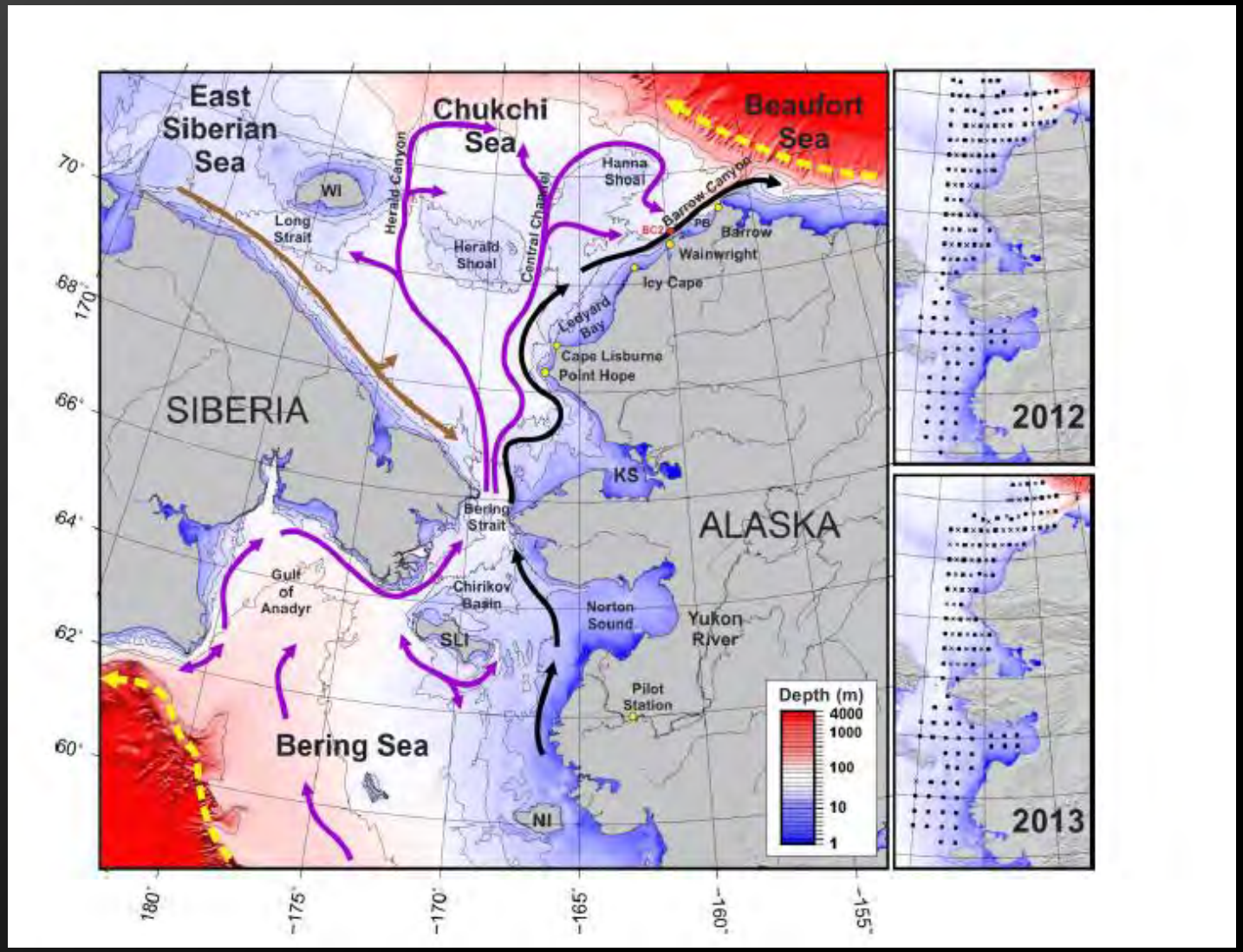

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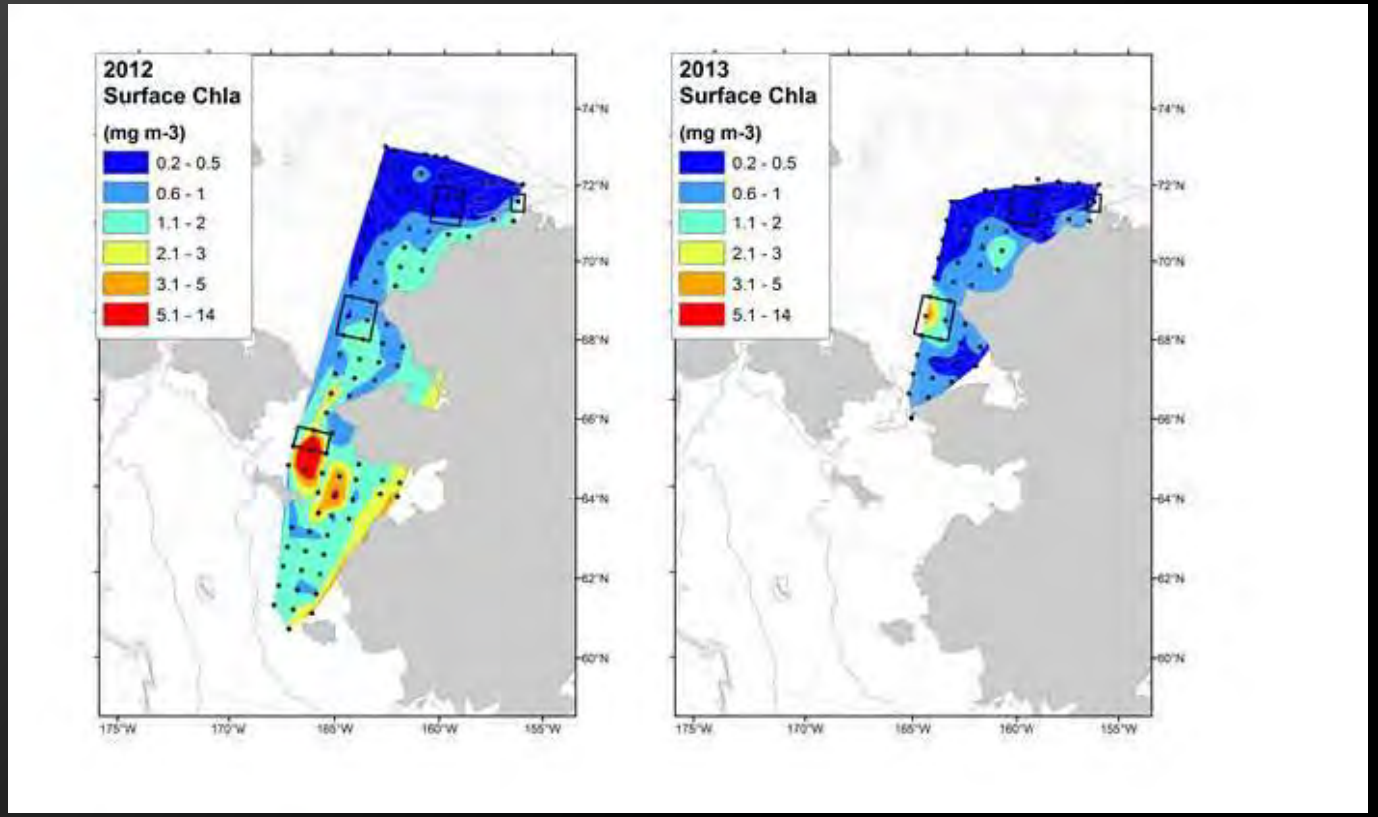

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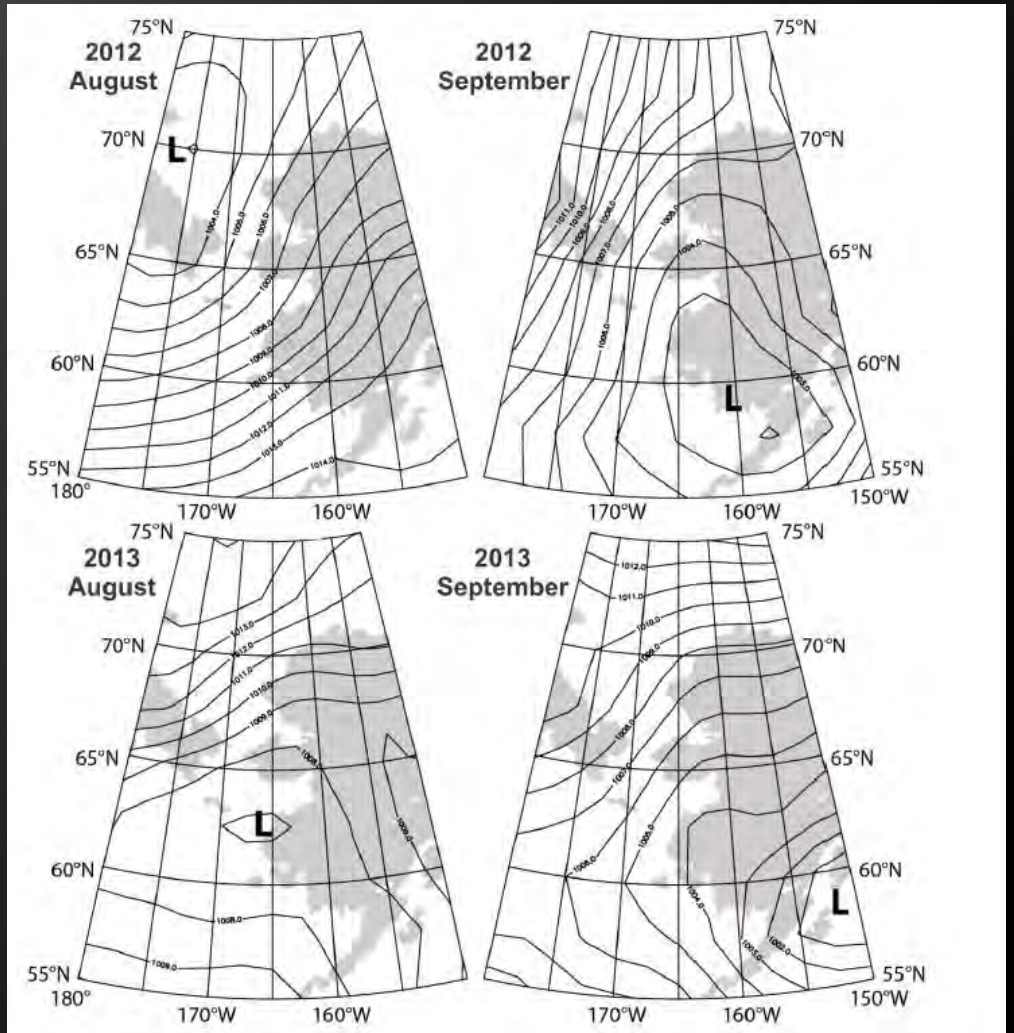

Figure 3. Monthly average sea level pressure contours (mbars) for August (left) and September (right) in 2012 (top) and 2013 (bottom) from the NCEP-NCAR Reanalysis.

Arctic Ecosystem Integrated Survey

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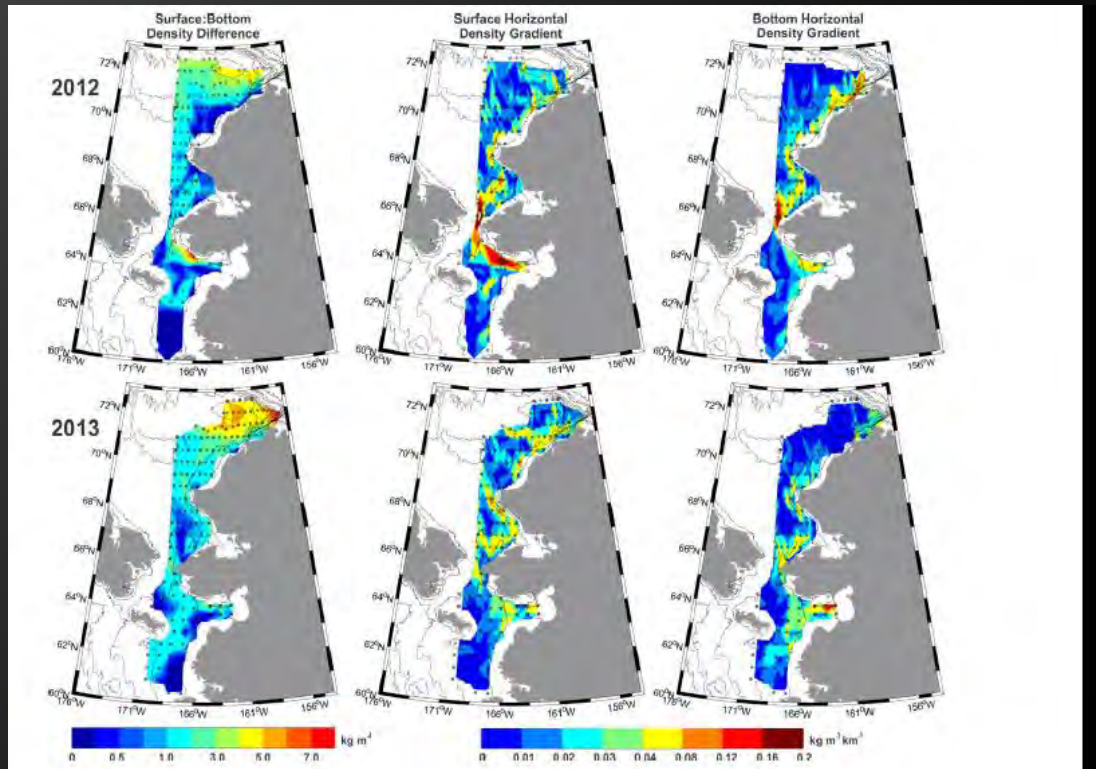

Figure 10. Stratification and fronts in 2012 (top) and 2013 (bottom). Left column shows the difference

Arctic Ecosystem Integrated Survey

Distribution of Fish, Crab, and Lower Trophic Communities in the Northeastern Bering Sea and Chukchi Sea

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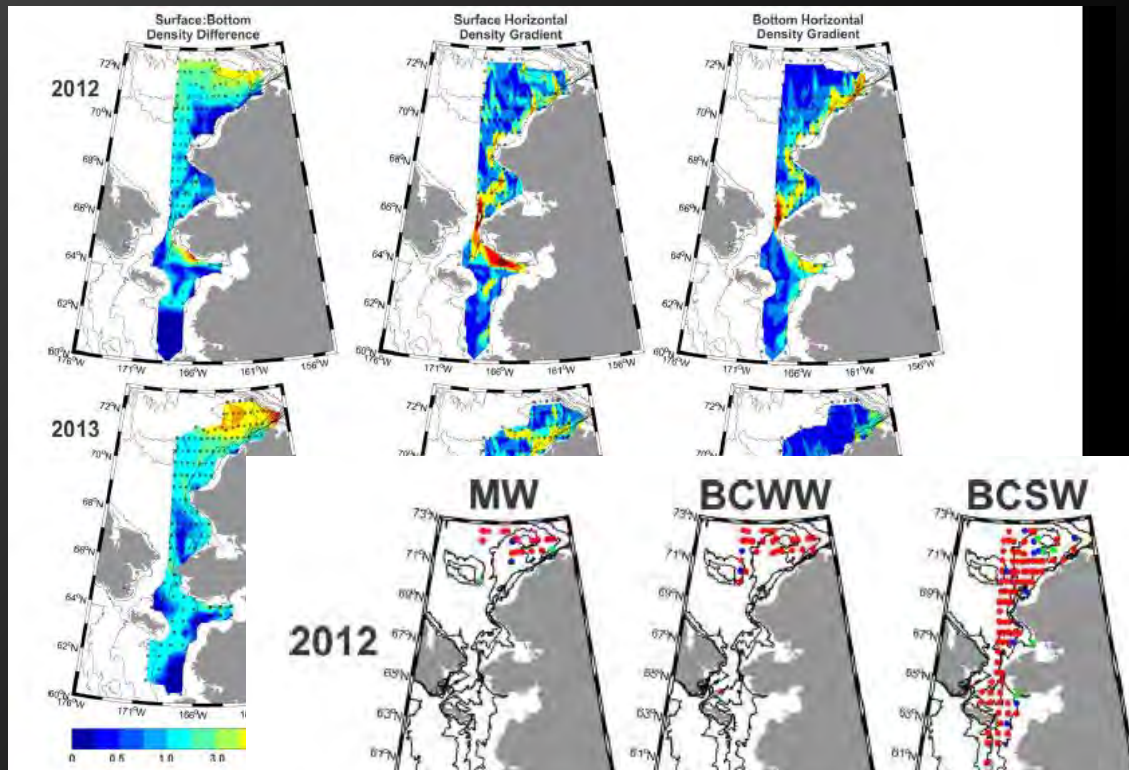

Figure 10. Stratificatior

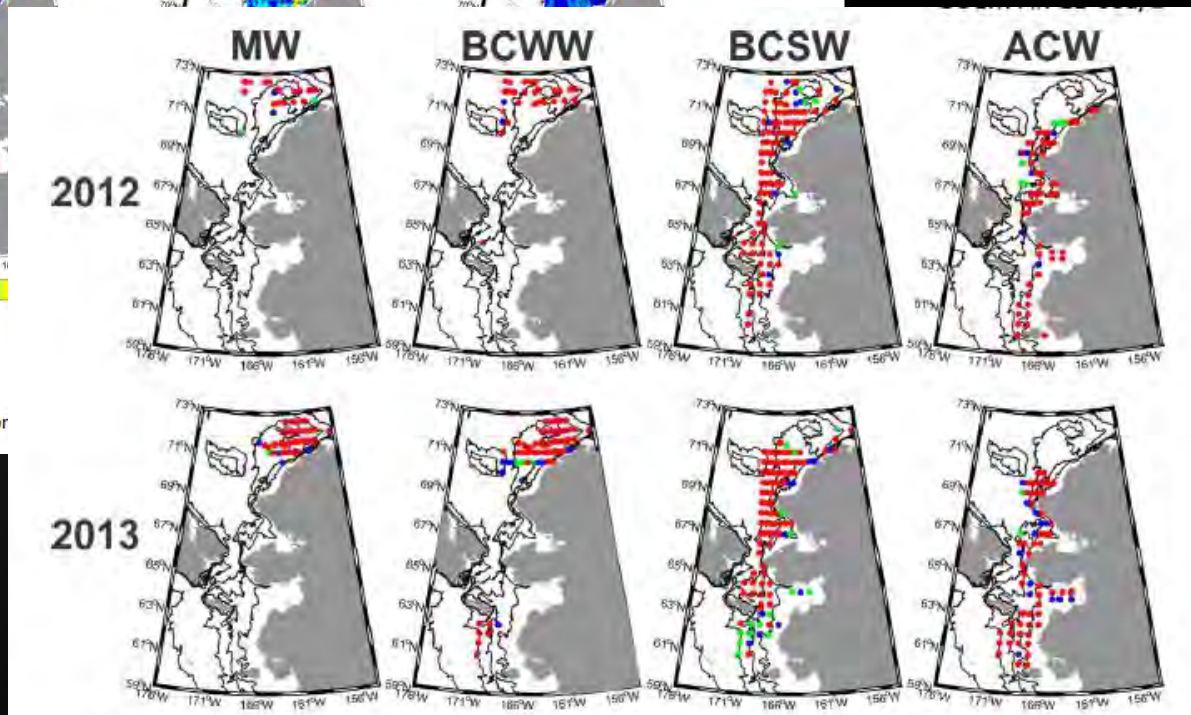

Figure 8. Distribution of water masses in 2012 (top row) and 2013 (bottom row). Colors denote the

Arctic Ecosystem Integrated Survey

Distribution of Fish, Crab, and Lower Trophic Communities in the Northeastern Bering Sea and Chukchi Sea

Final Component Report:
Abundance and Distribution of Arctic cod (*Boreogadus saida*) and other Pelagic Fishes over the U.S. Continental Shelf of the Northern Bering and Chukchi Seas

Principal Investigators:
Alex De Robertis and Christopher D. Wilson

Authors:
Alex De Robertis, Christopher D. Wilson, Kevin Taylor, Edward V. Farley

Date:
March 7, 2016

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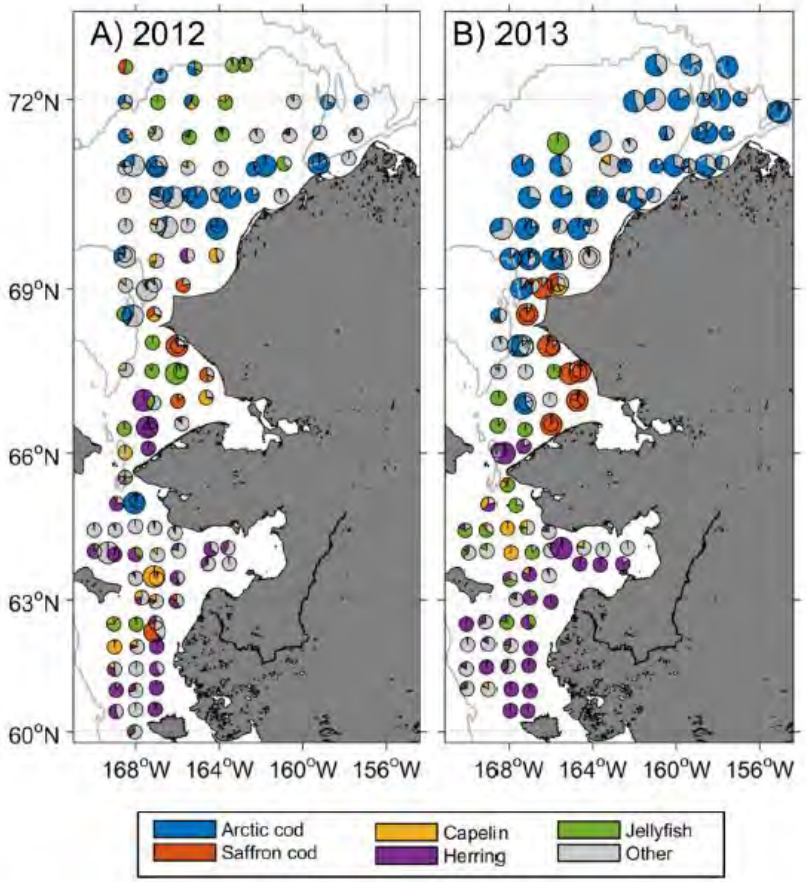

Figure 4. Estimated proportion of backscatter (*PB*, see eq. 3) attributable to key species derived by combining estimates of species composition from trawl catches and estimates of target strength listed in Table 1 for the Arctic Eis acoustic-trawl survey in A) 2012 and B) 2013. The larger pie graphs represent estimates for midwater hauls and the smaller ones represent surface hauls. The 50, and 150 m depth contours are shown as light grey lines.

Arctic Ecosystem Integrated Survey

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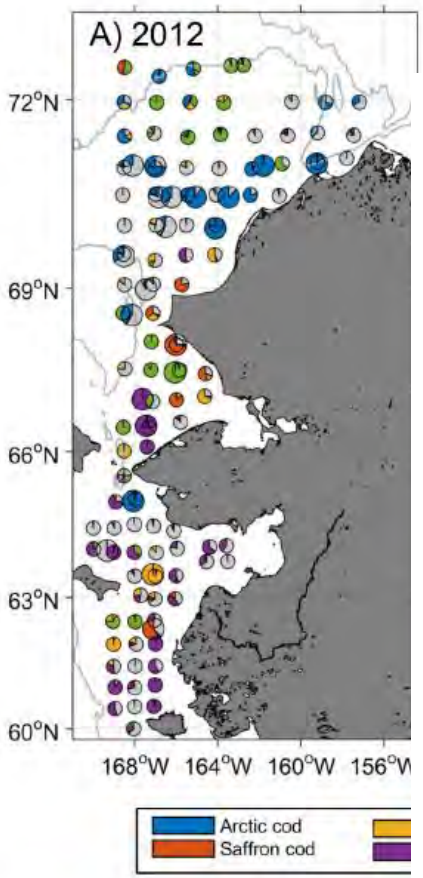

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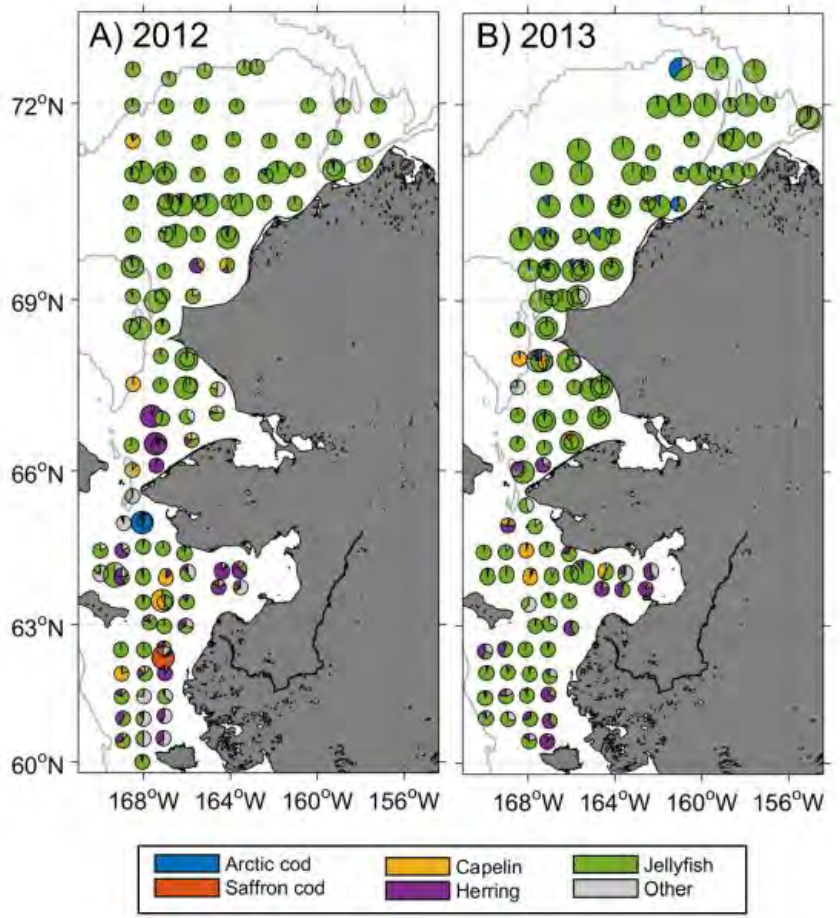

Figure 3. Catch composition expressed as proportions of trawl catch by weight in A) 2012 and B) 2013. The larger pie graphs represent midwater trawl hauls (Cantrawl in 2012, mod-Marinovich in 2013) and the smaller ones represent surface Cantrawl hauls. The 50, and 150 m depth contours are shown as light grey lines.

RUSSIAN-AMERICAN LONG-TERM CENSUS OF THE ARCTIC

Initiated in 2003 under the Cooperative Agreement with the US National Oceanic and Atmospheric Administration (NOAA) and with financial support by the Russian Academy of Sciences (RAS)

http://rusalcaproject.com/photo_2009

The program was developed to:
Monitor the changing fluxes of heat, salt, nutrients and marine life from the Bering Strait into the Pacific Arctic Ocean via the Chukchi Sea where sea ice loss was a maximum.

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Monitor the changing fluxes of heat, salt, nutrients and marine life from the Bering Strait into the Pacific Arctic Ocean via the Chukchi Sea where sea ice loss was a maximum.

Because the Bering Strait and the Chukchi Sea are shared water masses by both the USA and the Russian Federation, the coordinating parties decided that the best and most stable way to monitor this region was by the fully integrated cooperation of the science agencies in both of our countries.

North Expedition: August 16-September 30, 2015, East Siberian Sea-Makahrov Basin
South Expedition: October 9-19, 2015, Bering Strait-Chukchi Sea

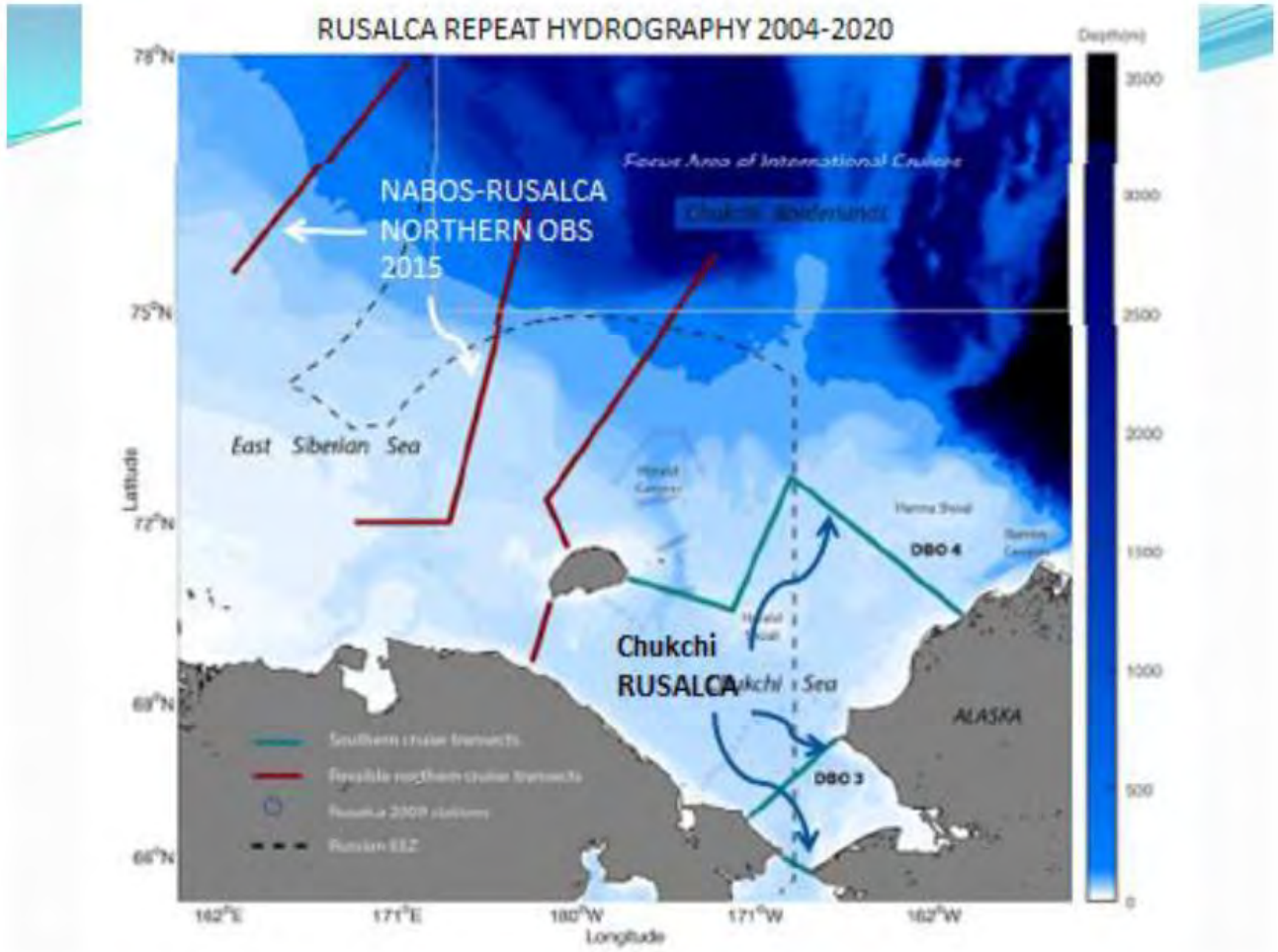
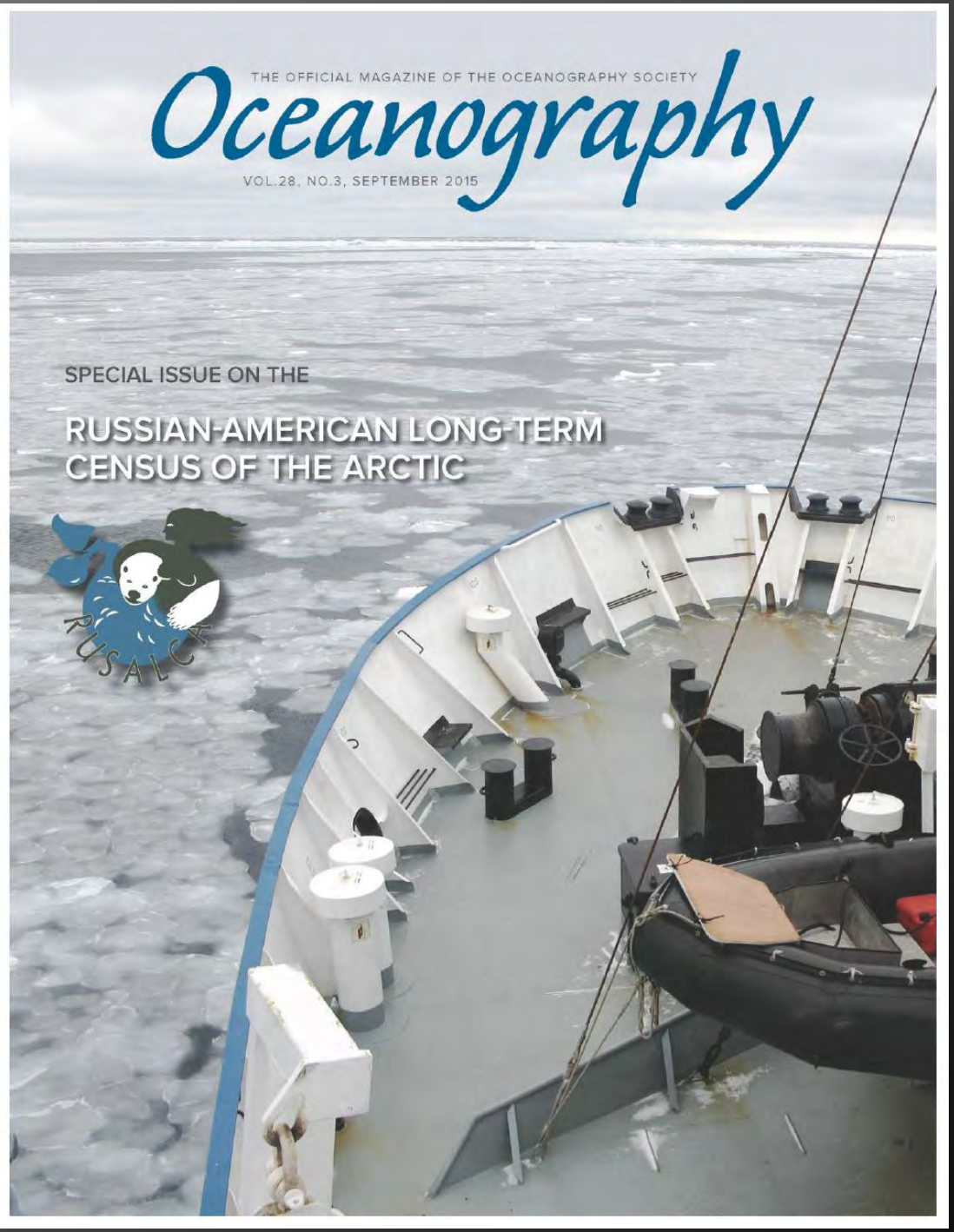
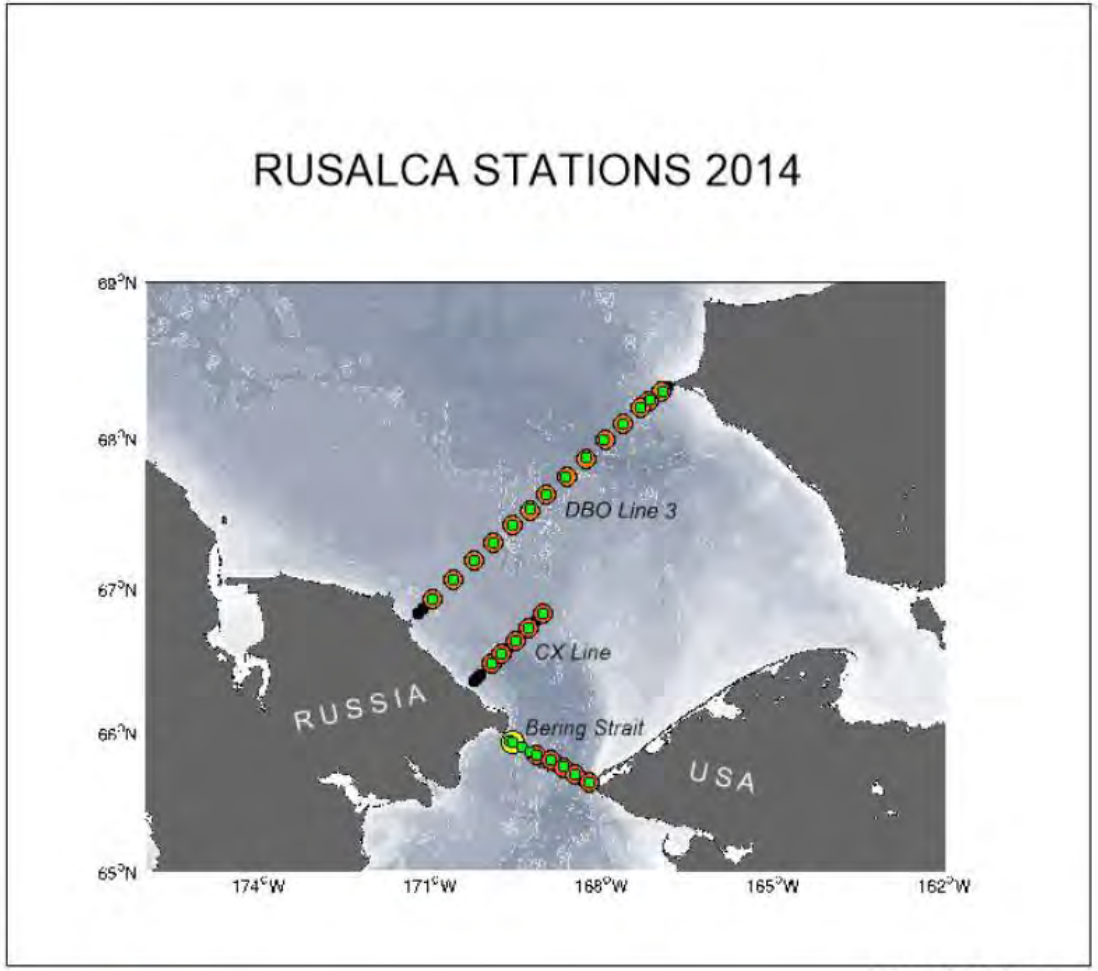
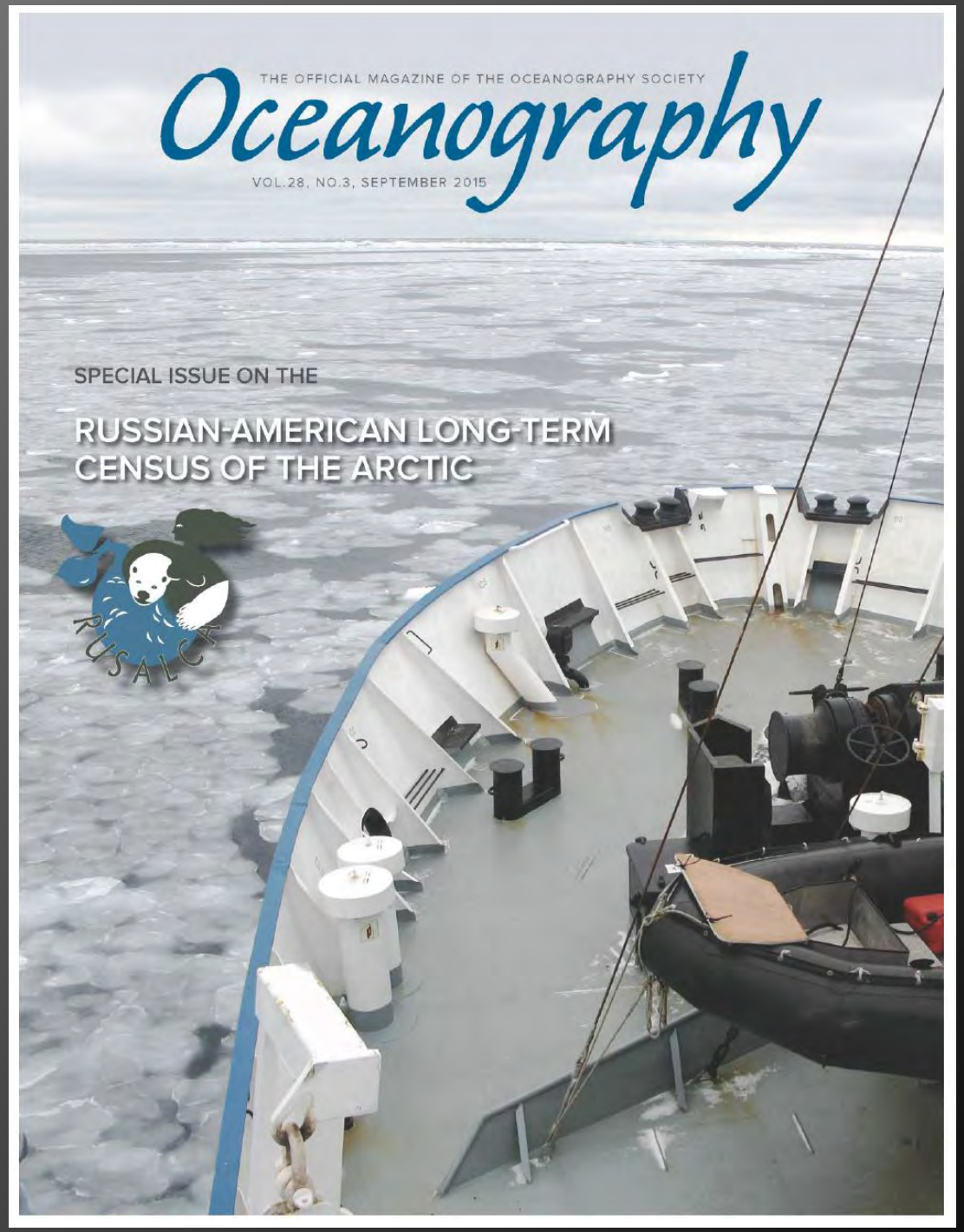


Fig 1: Proposed transects for both RUSALCA South (Chukchi) and NABOS-RUSALCA North





ARDEM bathymetry used for the base map: Danielson, S., M. Johnson, S. Solomon & W. Perrie, 2008. http://mather.sfos.uaf.edu/~seth/bathy/



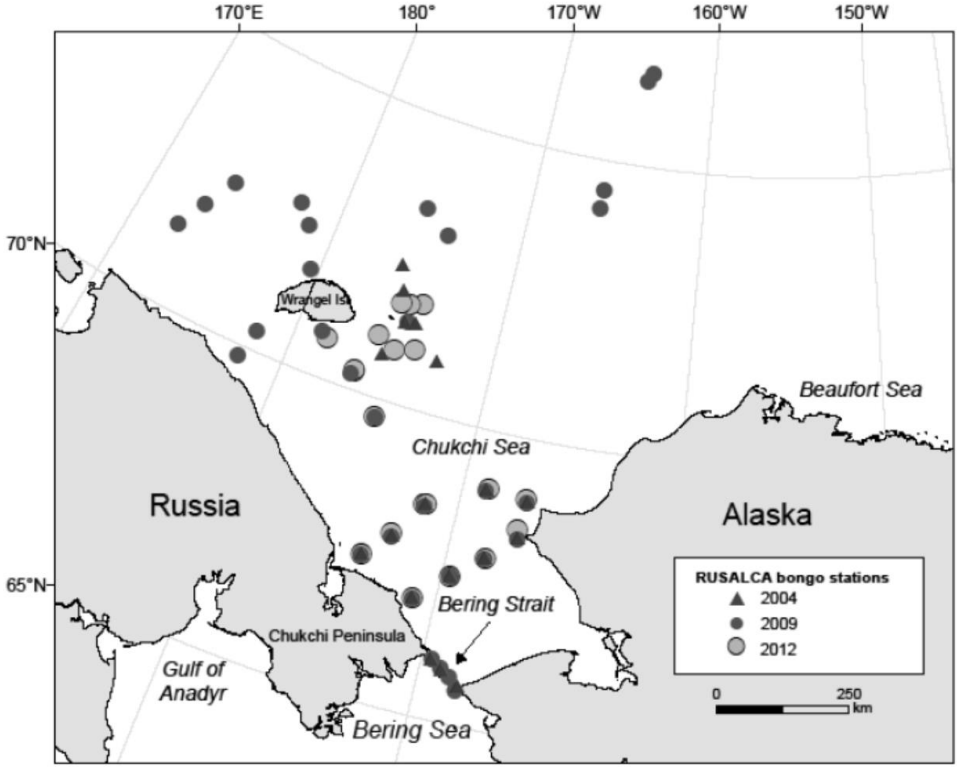
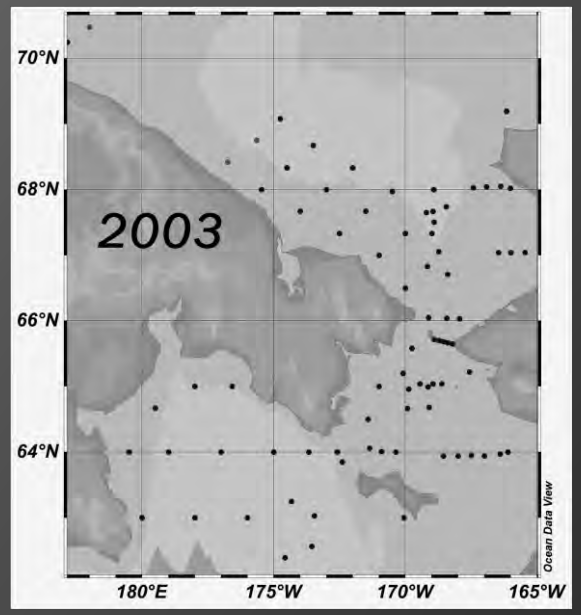
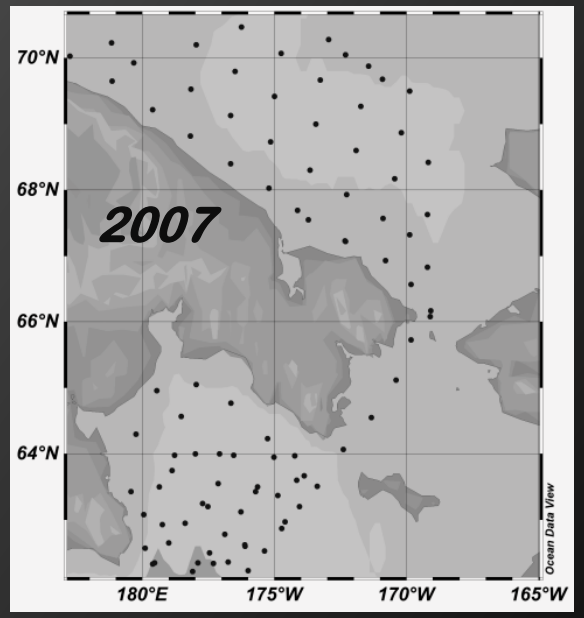
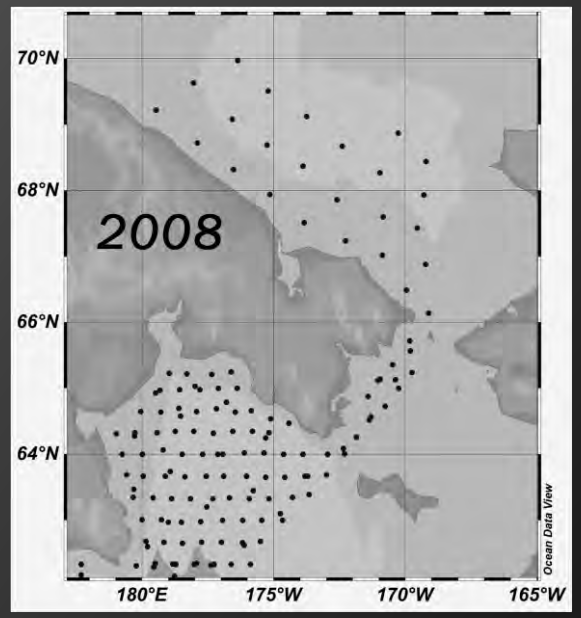


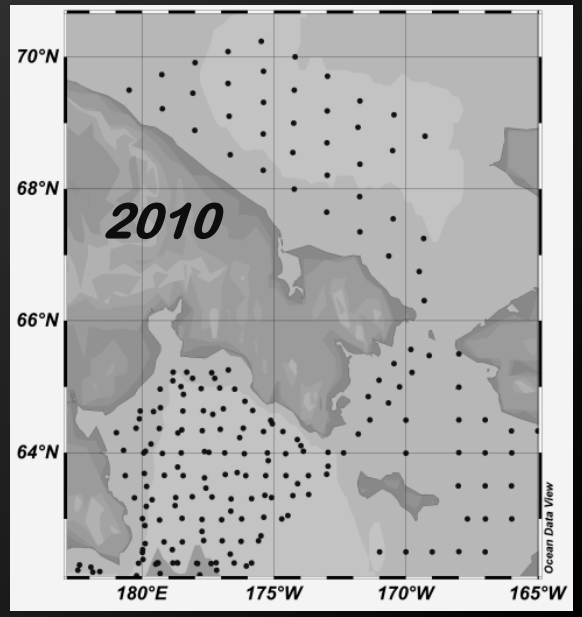
Fig. 8. Bongo station localities for RUSALCA cruises 2004-2012. (After Busby et al. in prep).

Russian Oceanographic Cruises (2003-2010)









- CTD data from both TINRO-Center (Russia) and WOD NODC (USA)
- In the Bering Sea, pelagic trawling was performed in all years, and bottom trawling in 2008 and 2010
- In the Chukchi Sea, pelagic trawling has been done in 2003, 2007, and 2008, and the bottom trawling in 2010
- In TINRO-Center cruises, CTD stations are made prior to trawling

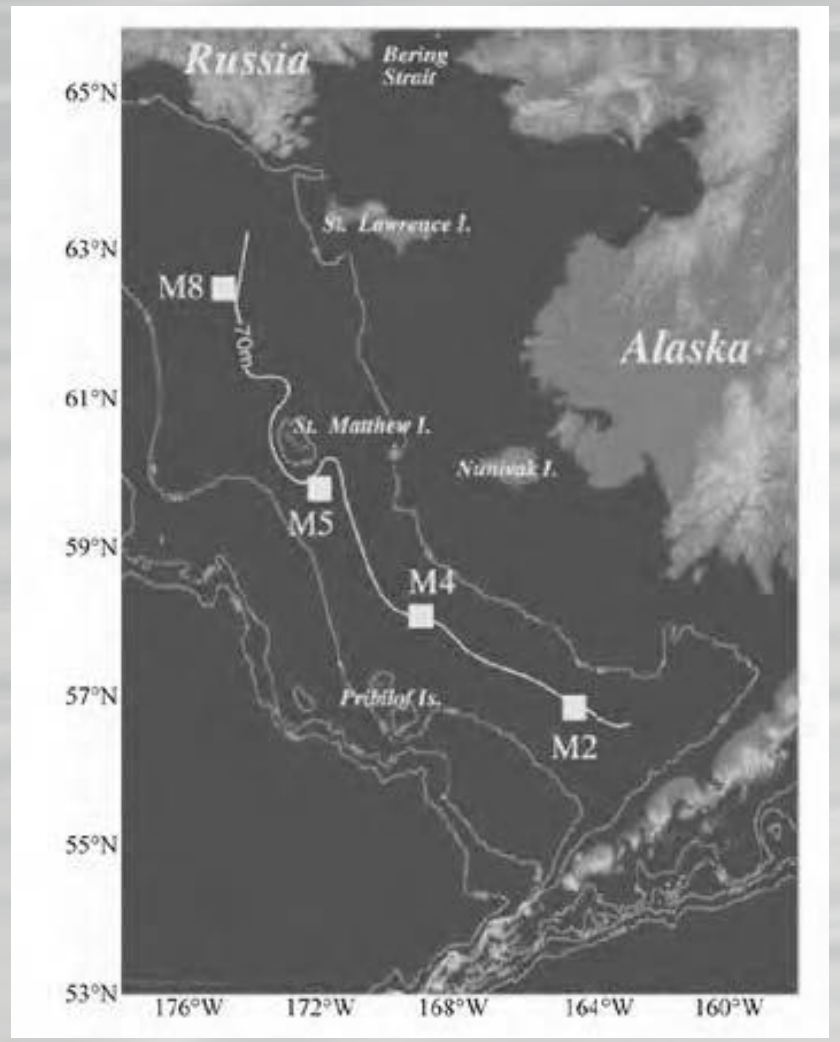
Ocean Observing Systems and Monitoring

Long-term monitoring programs - Biophysical Moorings

Measures:
temperature, salinity, nutrients, oxygen, fluorescence, currents, zooplankton

Data contributed to understanding:
Oscillating Control Hypothesis (influence of timing of ice retreat and bottom-up vs top down forcing on forage fish and pollock recruitment), timing of spring bloom, variability in nutrients

Principal Investigators:
P. Stabeno, T. Whitledge, J. Napp, J. Overland



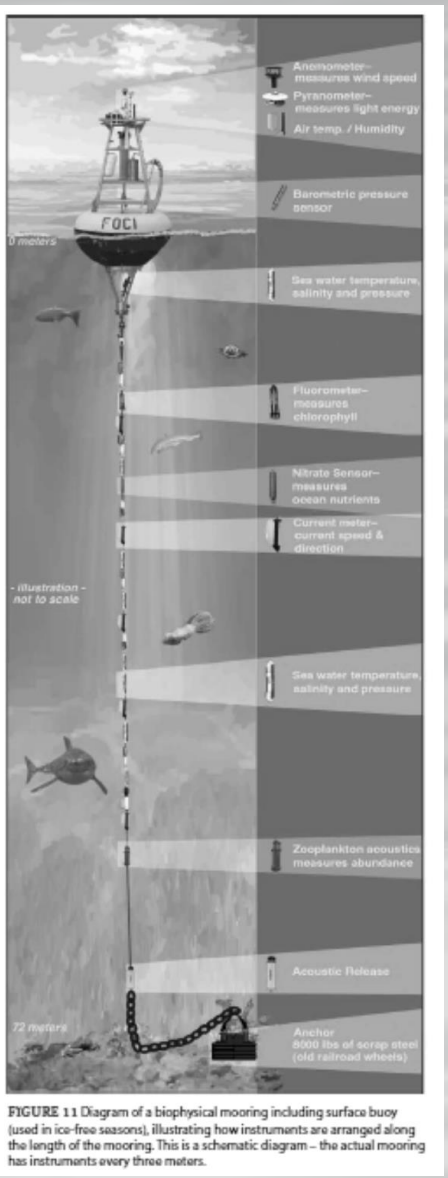


FIGURE 11 Diagram of a biophysical mooring including surface buoy (used in ice-free seasons), illustrating how instruments are arranged along the length of the mooring. This is a schematic diagram – the actual mooring has instruments every three meters.

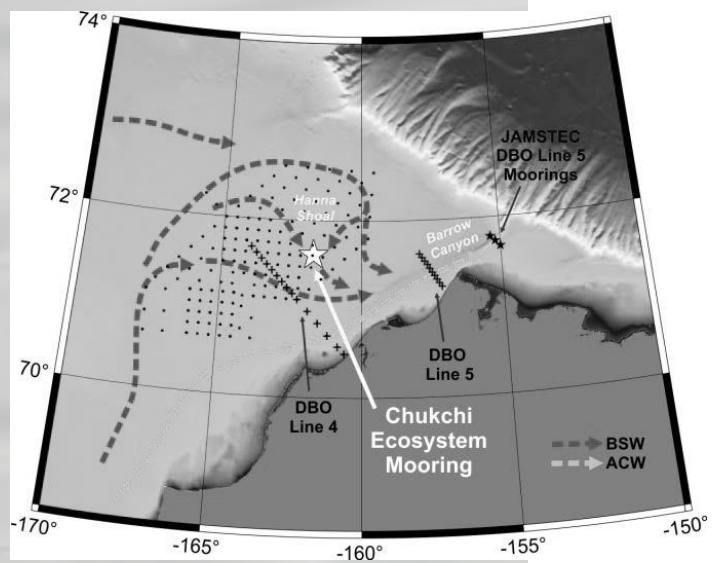
Ocean Observing Systems and Monitoring

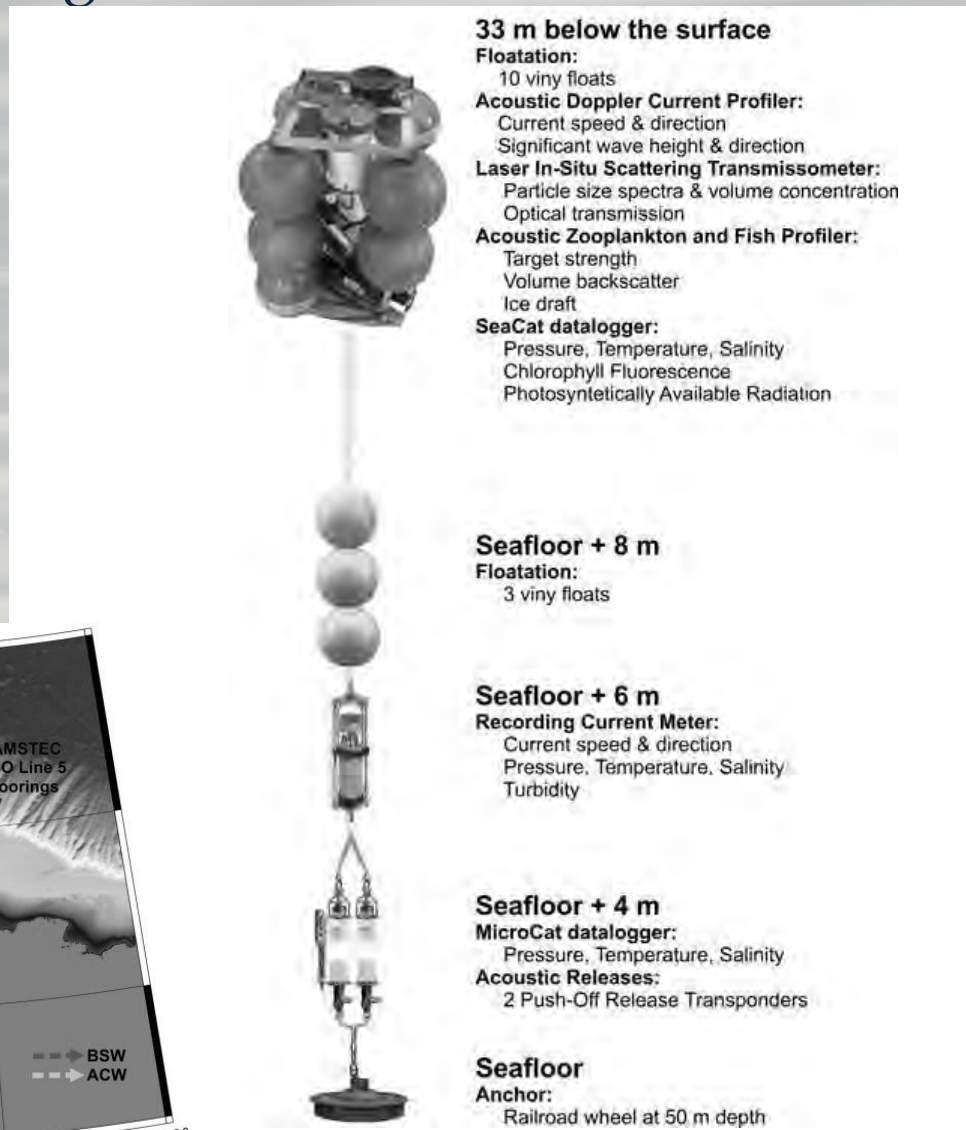
Long-term monitoring programs - Biophysical Moorings

Measures:
- Autonomous collection of physical/ biogeochemical data
- Enables analyses of wind, wave, and ice effects, nutrient cycles, particulate fluxes, carbon transfer, fish and euphausiids

- Intended to enable biogeochemical model validation and improve understanding of carbon and shelf-basin exchange.

Principal Investigators:
S. Danielson, C. Hauri,
R. Hopcroft, P. Winsor
A. McDonnell





Ocean Observing Systems and Monitoring

Alaska Ocean Observing System (AOOS)

.

AOOS Data Portal tools:

- Map with real-time sensors with links to data
- Forecasts and Models tool which displays climate and oceanographic model outputs
- North Pacific Seabird Data map of seabird colonies throughout the North Pacific coasts.

Ocean Observing Systems and Monitoring

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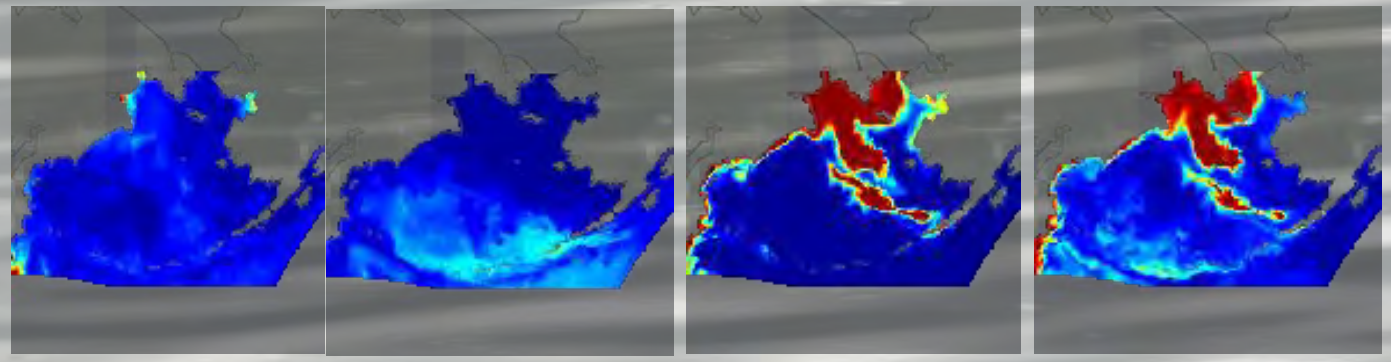
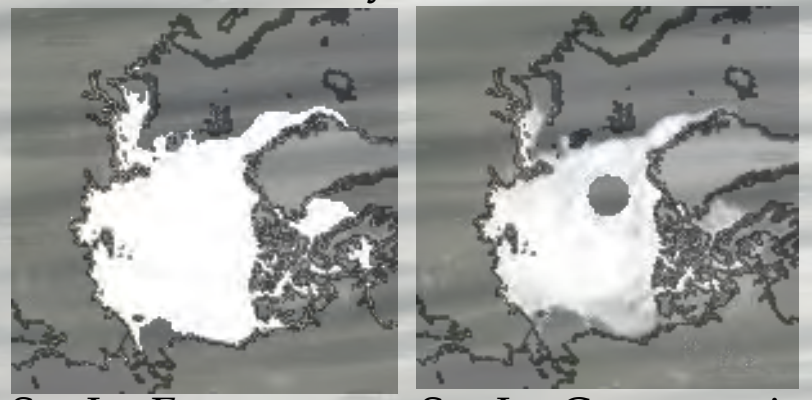
Coordinated Ocean-Ice Reference Model



Microzooplankton Phytoplankton Benthic Detritus Ice Algae

Multisensor Analyzed Sea Ice Extent Model



Sea Ice Extent Sea Ice Concentration

The North Pacific Research Board

Supporting peer-reviewed scientific research in the Gulf of Alaska, Bering Sea/Aleutian Islands, and Chukchi/Beaufort Seas that informs effective management and sustainable use of marine resources.

– Building a clear understanding of North Pacific, Bering Sea and Arctic ecosystems that enables effective management and sustainable use of marine resources
– Priority on cooperative research designed to address pressing fishery management or marine ecosystem information needs

Integrated Ecosystem Research Programs

Approach

- Link physical and biological dynamics
- Coordinate field, laboratory, and modeling approaches, integrate across scientific disciplines and ecosystem elements, and synthesize results.

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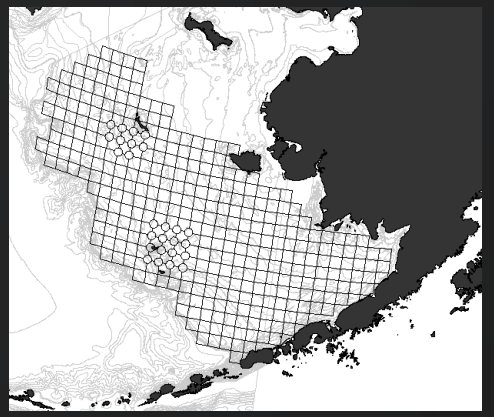
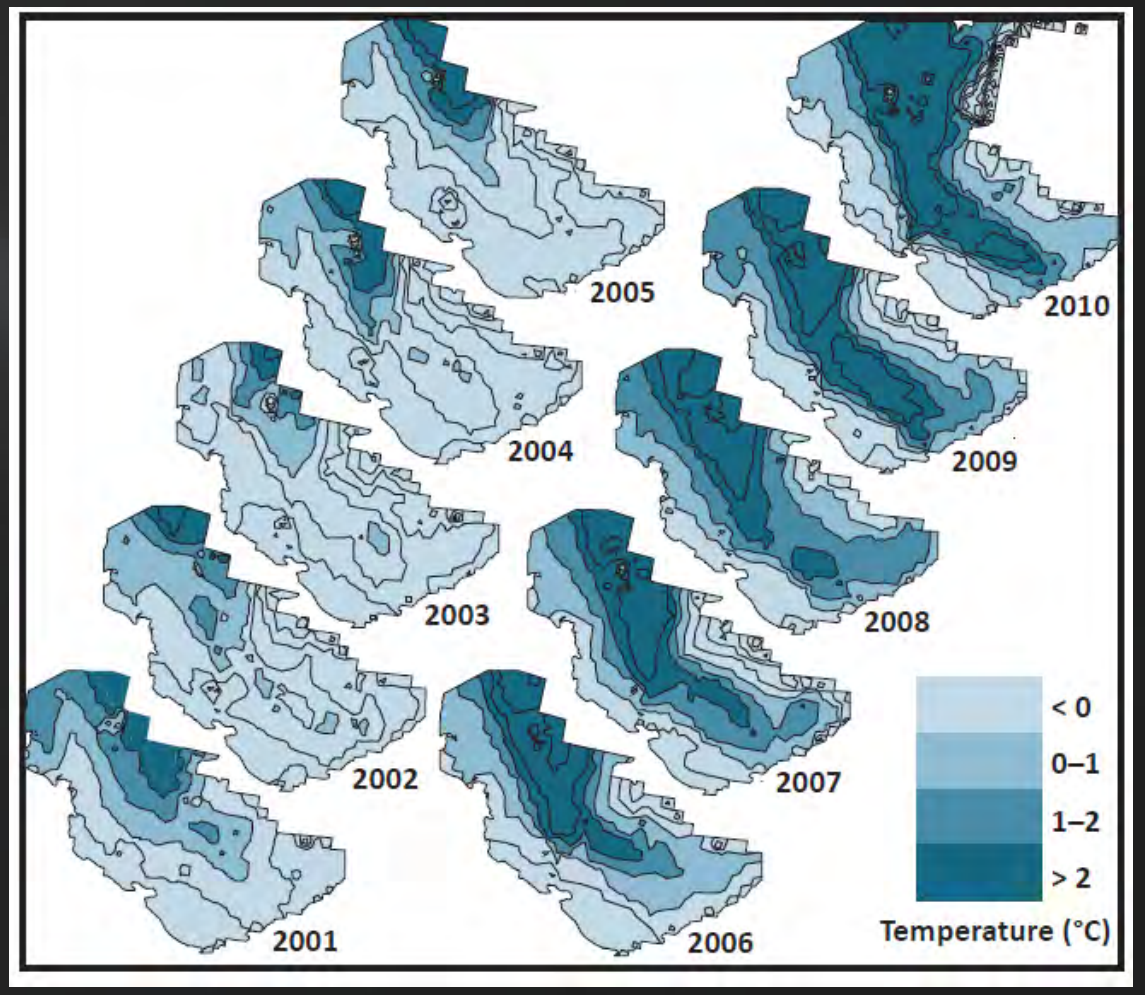
Approach

— Link physical and biological dynamics
— Coordinate field, laboratory, and modeling approaches, integrate across scientific disciplines and ecosystem elements, and synthesize results.

Intent

Mechanistic understanding of ecosystem structure and how critical processes and interactions might change given shifts in the physical environment or human pressure.




2005
2010
2004
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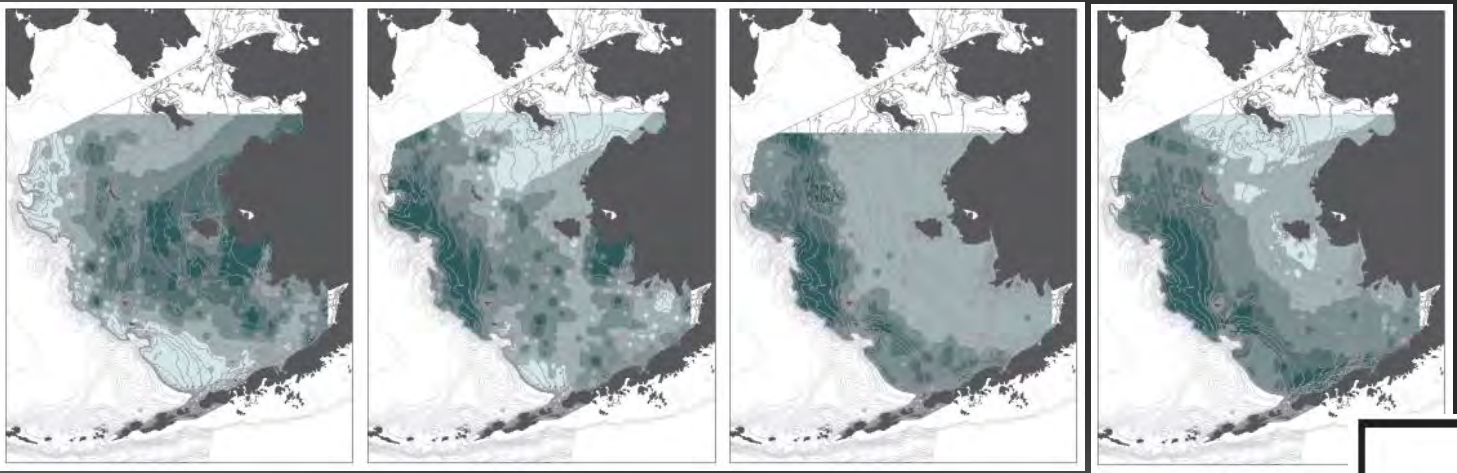
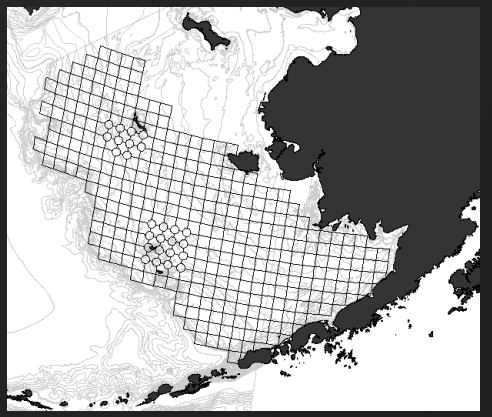
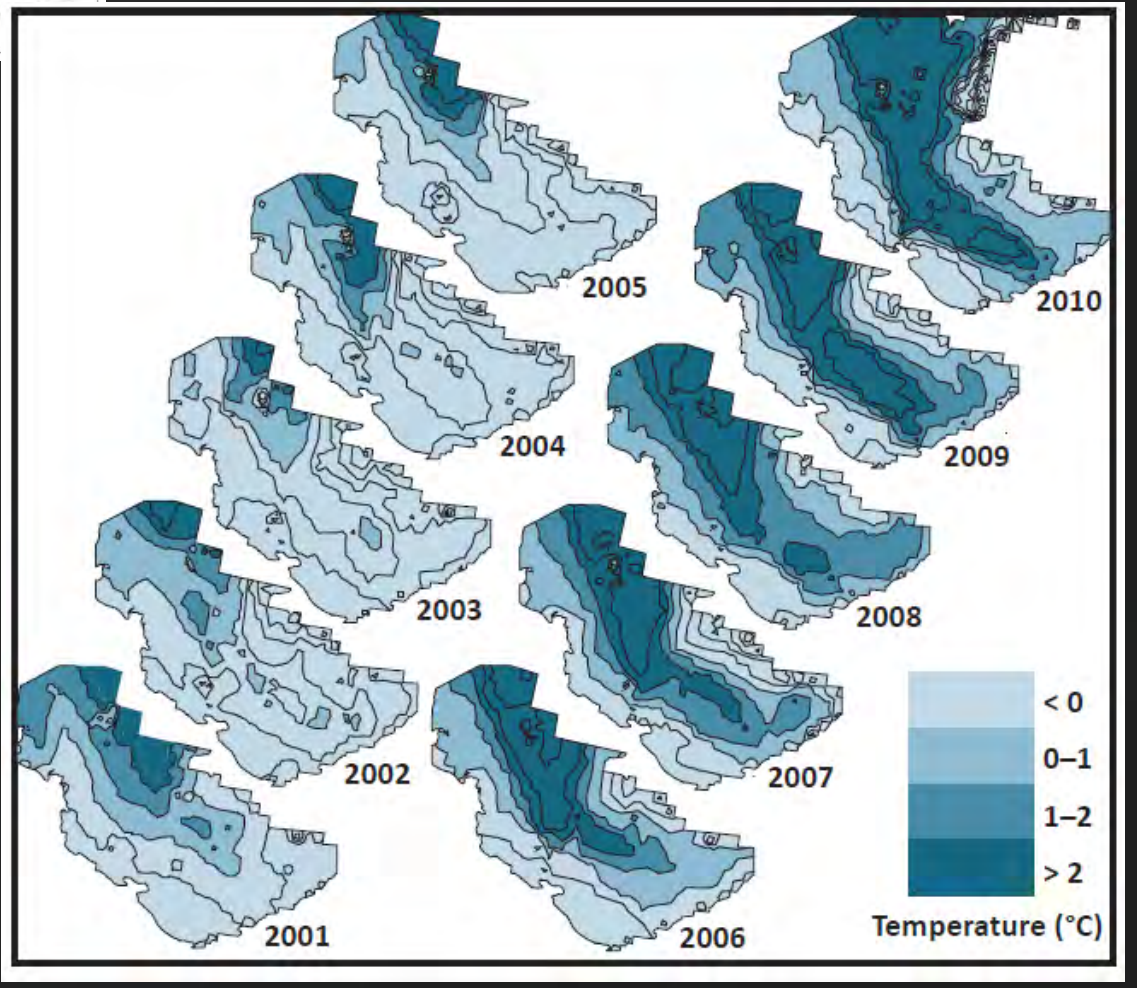
2002
2007
2001
2006
< 0
0–1
1–2
> 2
Temperature (°C)



<10cm 10-20cm 20-40cm 40+cm

WalleyePollock





Bering Sea
Integrated Ecosystem Research Program

Hypotheses:

(1) Climate-driven changes in the dominant features of the physical environment (e.g., temperature, wind, sea-ice, and currents) modify availability and allocation of prey.

http://www.nprb.org/bering-sea-project

Bering Sea
Integrated Ecosystem Research Program

Hypotheses:

(1) Climate-driven changes in the dominant features of the physical environment (e.g., temperature, wind, sea-ice, and currents) modify availability and allocation of prey.

(2) Climate and ocean conditions influencing water temperature, ocean currents, and ecological boundaries impact fish reproduction, survival, and distribution, the intensity of predator-prey relationships, and the location of zoogeographic provinces.

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Bering Sea
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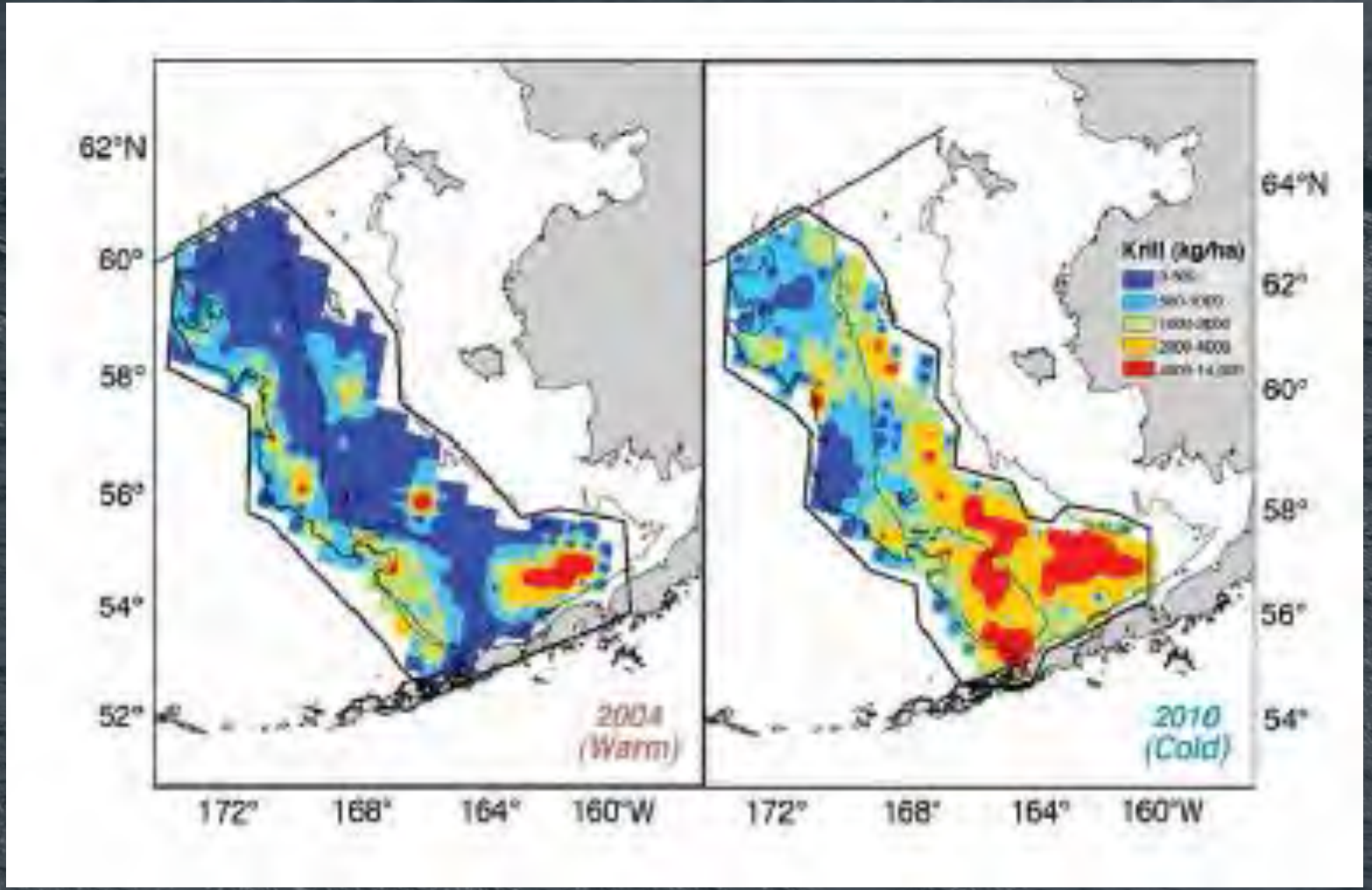
Bering Sea
Integrated Ecosystem Research Program

The spatial distribution of large zooplankton and krill differed between warm and cold years, with greater abundance over the shelf during cold periods.

In cold years, ice algae production and earlier ice-edge blooms increased survival of large zooplankton, which increased survival and growth of juvenile pollock



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Bering Sea
Integrated Ecosystem Research Program

In cold years, the summer fishery moved further north since the fish moved further offshore and north due to the presence of the cold pool in the midle shelf.

In the winter fishery, there was no movement caused by the dynamics related to the value of roe-bearing fish

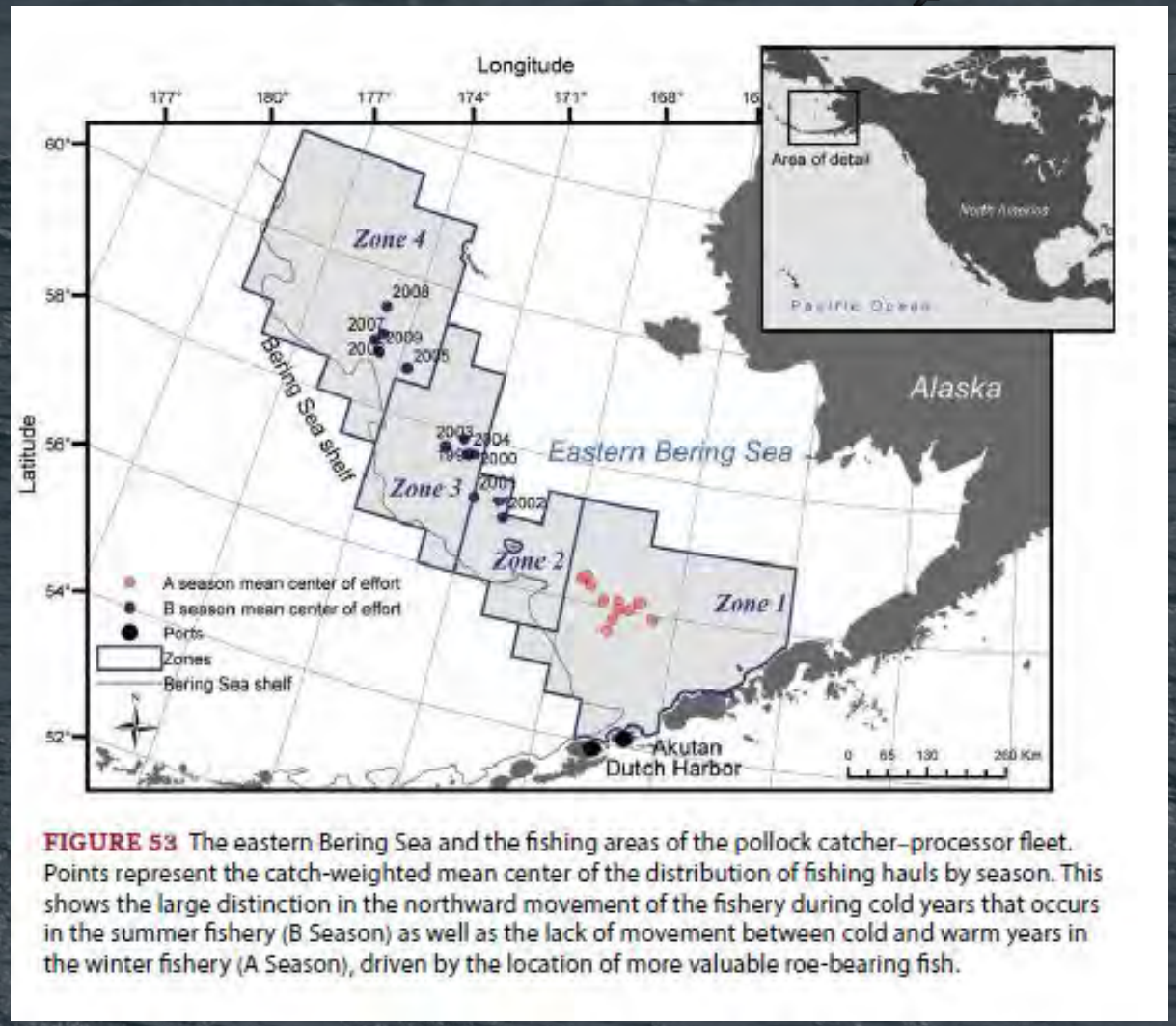


FIGURE 53 The eastern Bering Sea and the fishing areas of the pollock catcher–processor fleet. Points represent the catch-weighted mean center of the distribution of fishing hauls by season. This shows the large distinction in the northward movement of the fishery during cold years that occurs in the summer fishery (B Season) as well as the lack of movement between cold and warm years in the winter fishery (A Season), driven by the location of more valuable roe-bearing fish.

Arctic Integrated Ecosystem Research Program

Investment of approximately $16 million in the northern Bering and Chukchi Seas in 2017-2021.

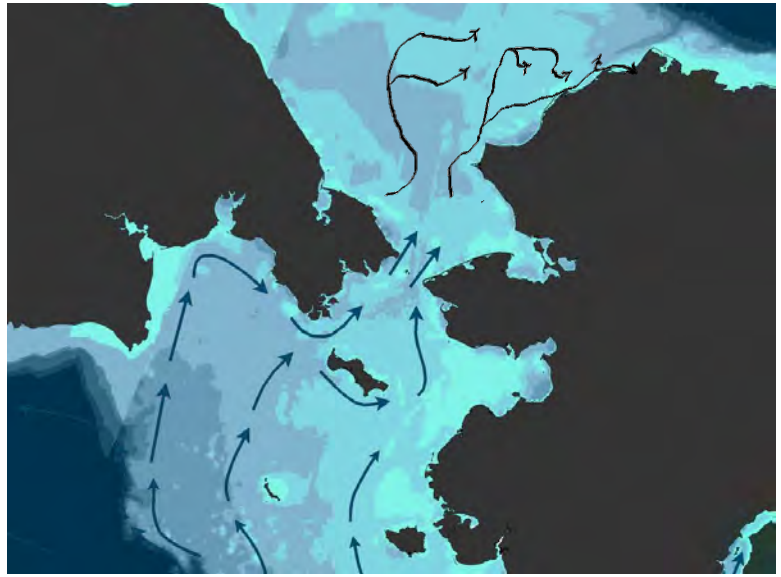
Sponsors:
- North Pacific Research Board (NPRB)
- Collaborative Alaskan Arctic Studies (North Slope Borough/Shell)
- Bureau of Ocean Energy Management
- Office of Naval Research

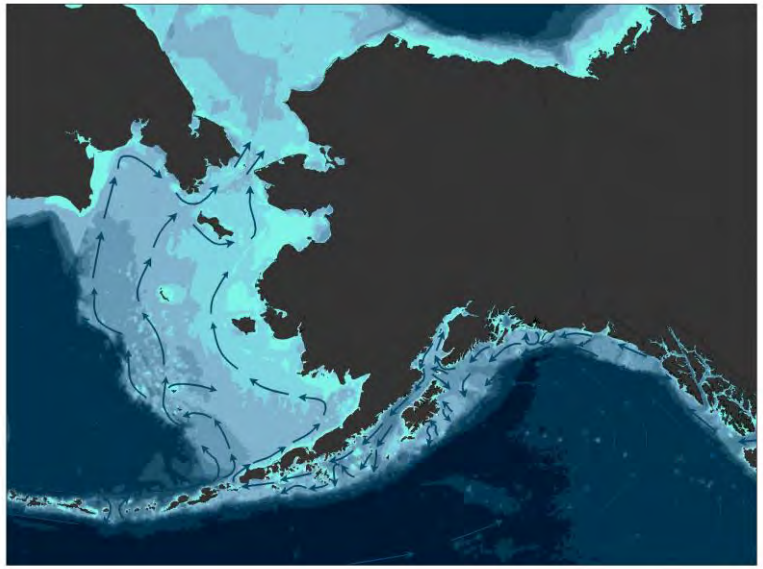
In-kind support
- National Oceanic and Atmospheric Administration
- University of Alaska Fairbanks.

Integrate observations in spring, summer, and fall 2017-2019

Late spring and early summer sampling 2017-2018

Late summer and early fall sampling in 2017 and 2019





Late Spring Season Cruises | 2017 & 2018 (June)

Who is conducting the research?

Scientists with the University of Alaska Fairbanks and the University of Washington with guest collaborators from Hokkaido University, the U.S. Fish and Wildlife Service and the National Oceanic and Atmospheric Administration.

What is the objective?

To better understand changes to the regional marine ecosystem resulting from the changing sea ice environment.

What and where?

Late spring expeditions will take place on the UAF-based R/V *Sikuliaq* between St. Lawrence Island and Cape Lisburne (*Figure 1*) over a 3-week period from mid or late June in 2017 and 2018.

In the first half (approx. 10 days) of each expedition, we plan on working at ten research "*process station*" locations from south to north (yellow squares on Figure 1), setting up experiments for plankton and sediment growth and respiration incubations. As the ship visits these research locations, we would service six sets of submerged moorings (yellow stars on *Figure 1*) that carry underwater instruments, retrieving the sound and data recordings and changing batteries. The ship will next transition to a "*survey station*" mode of operation for the remaining 10 days, returning south again.

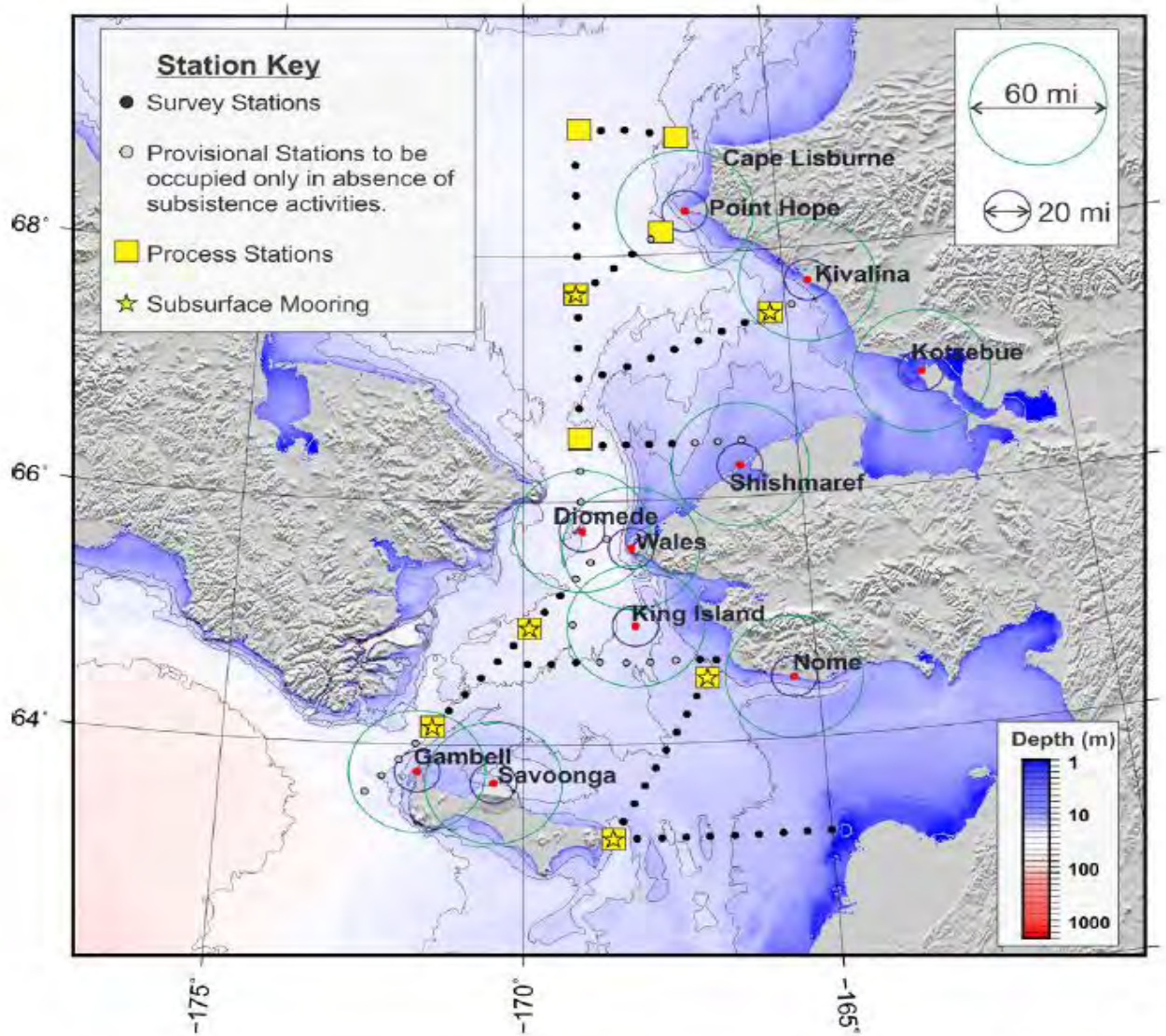


Figure 1: Map showing proposed ship stations and mooring locations of the Arctic Shelf Growth, Advection, Respiration and Deposition (ASGARD) measurements.

(continued on back)

Late Summer Season Cruises | 2017 & 2019 (July 31 - Oct. 5)

Who is conducting the research?

Scientists with the Alaska Fisheries Science Center, University of Alaska Fairbanks, University of Oregon, U.S. Fish and Wildlife Service, and the Pacific Marine Environmental Laboratory.

What is the objective?

To understand how climate change will affect the distribution and abundance of marine mammals, fish, seabirds, and the food they depend upon throughout the Chukchi and Beaufort seas.

What and where?

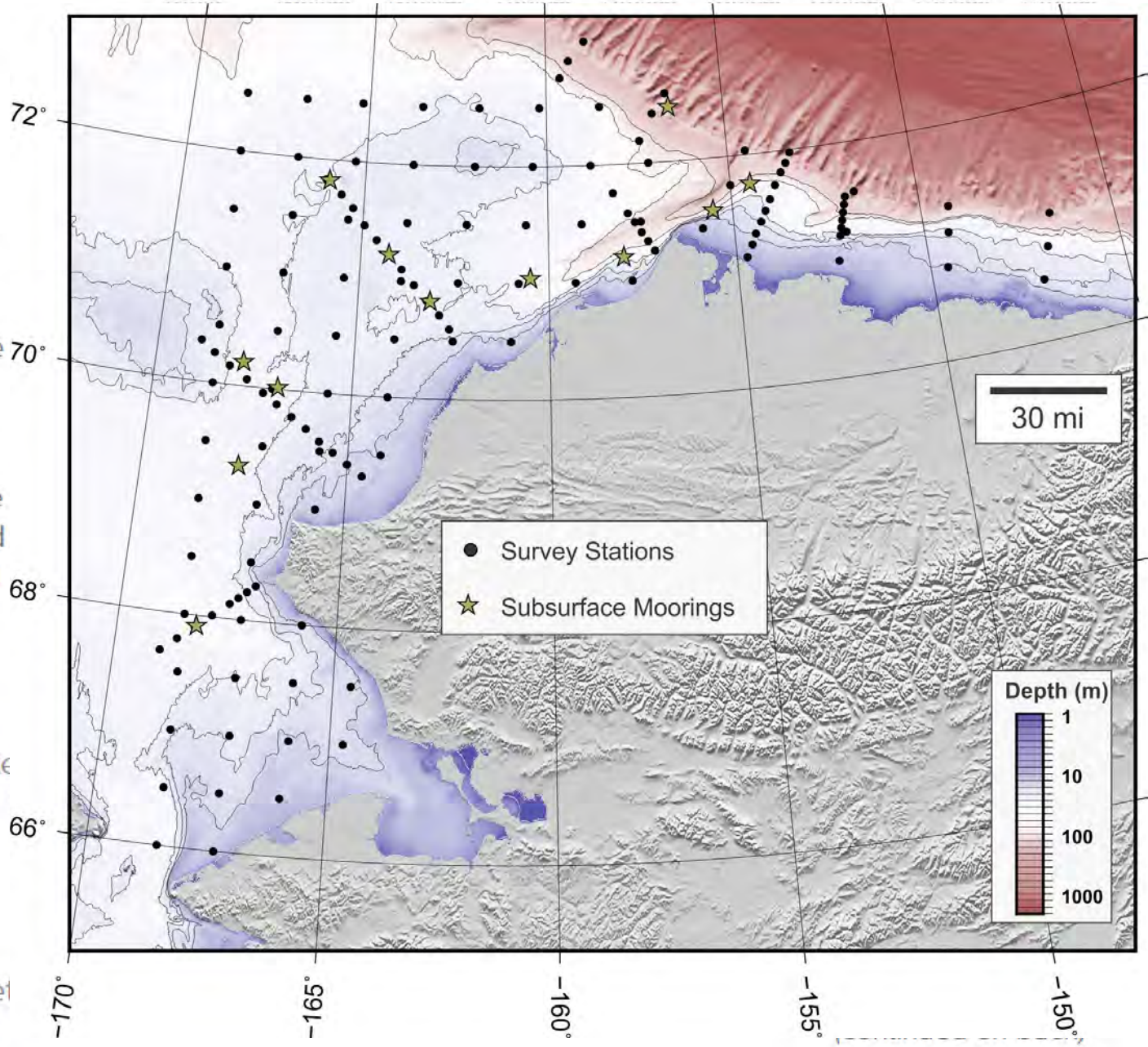
We plan to sample ocean conditions, fishes, and observe seabirds during a research survey on a to-be-determined chartered fishing vessel in the Beaufort Sea and Chukchi Sea during August to October 2017 and 2019 (*Figure 1; Table 1*).

How close to shore will you get?

The research will be conducted in bottom depths greate than 100 feet; the closest stations to shore are within miles.

What kind of gear will be used?

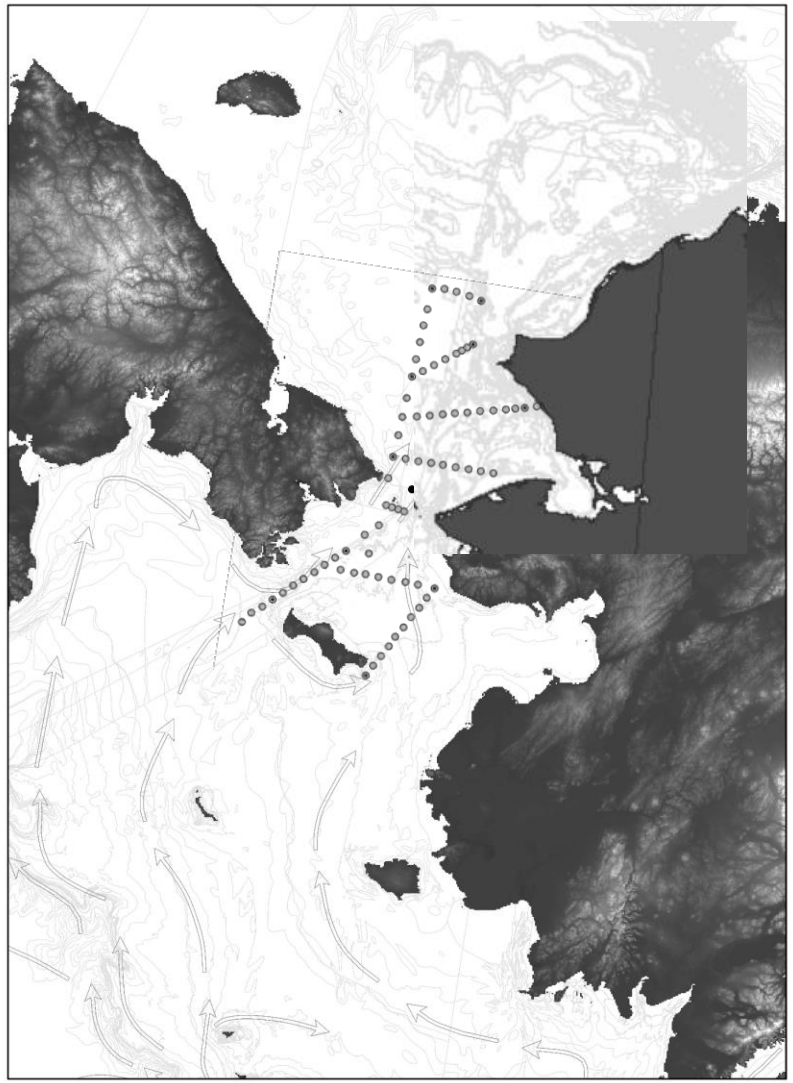
Surface - A research rope trawl (150 feet across) to fish for juvenile salmon, herring, and capelin in the top 50 feet of the water column (approx. 0.05 square miles per tow);



Spring Dynamics

Process studies of oceanography and lower trophic levels in the northern Bering and southern Chukchi

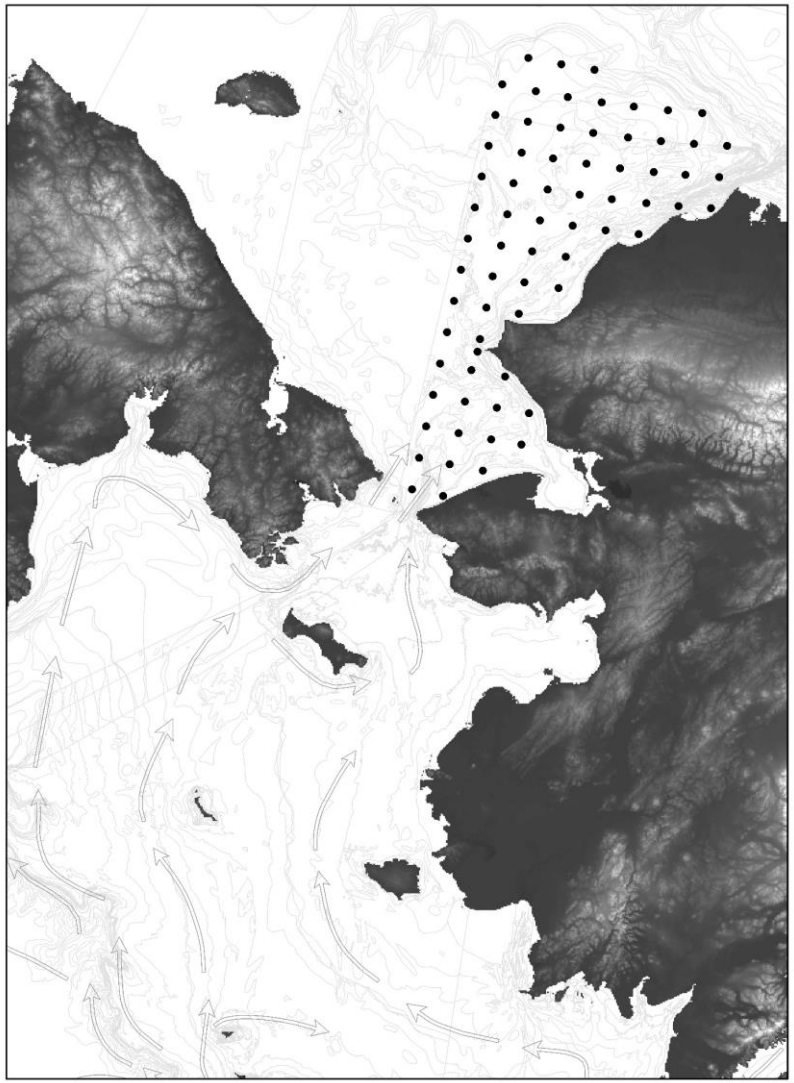
- Focus on the period of spring sea ice retreat
- Collect measurements to parameterize a model of carbon flow on pelagic-benthic coupling
- Provide insight to mechanisms that drive summer and fall seasonal observations in the Chukchi Sea



Summer and Fall Dynamics

Oceanography, lower trophic levels, fish and seabirds in the Chukchi, from Bering Strait to Barrow

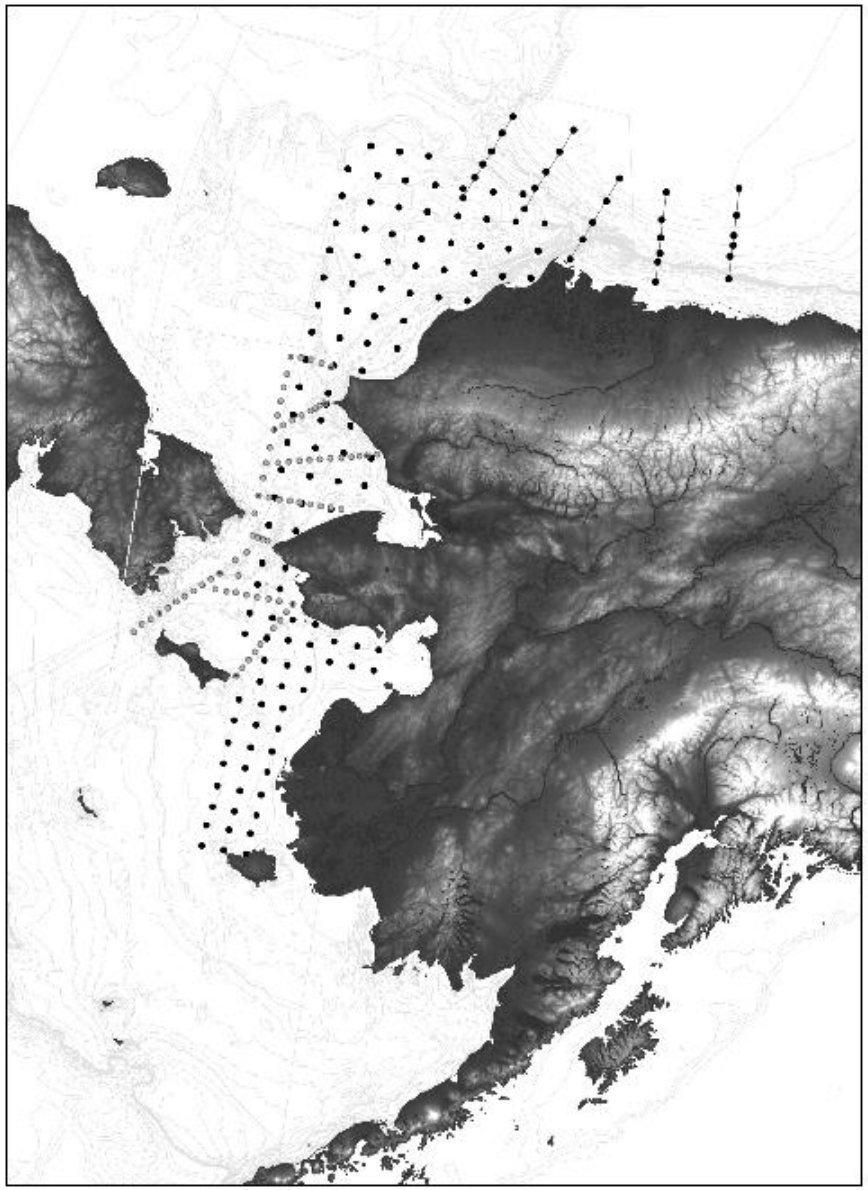
- Summertime observations over the Chukchi Sea shelf
- Oceanographic measurements
- Fish sampling using acoustics, surface and midwater trawls, and demersal beam trawls to quantify the abundance and distribution of demersal and pelagic fishes
- Leverage existing time series data
- International collaboration



Integrated Program

What regulates variations in energy transfer pathways and how will the changing ice environment alter these pathways, subsistence resources, and ecosystem structure in the Pacific Arctic?

- seasonal composition, distribution and production of phytoplankton, zooplankton, fishes, invertebrates, seabirds, marine mammals;
- timing, magnitude and fate of primary and secondary productivity;
- partitioning between pelagic and benthic production;
- distribution large crustacean zooplankton;
- assemblages, distributions, and abundances of larval and early juvenile fishes.



Arctic Integrated Ecosystem Research Program

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Integrated Partnerships

The program will also include several existing NPRB projects, including:

- Climate change impacts on the eggs and larvae of Arctic gadids [NPRB 1403]
- Tracing sea ice algae in Arctic benthic food webs [NPRB 1503]
- Assessing the role of oceanic heat fluxes on ice ablation in the Chukchi [NPRB 1504]
- Growth and dispersal of early life history of Arctic and saffron cod [NPRB 1508]
- Glider based real-time monitoring of marine mammals in the Arctic [NPRB 1515]
- Sustainability of critical areas for eiders and subsistence hunters in an industrializing nearshore zone Northern Sea Ice Project Jukebox [NPRB 1528]

Arctic Integrated Ecosystem Research Program

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Integrated Partnerships

The program will include several existing projects in the Arctic, including:

- Marine Arctic Ecosystem Study (MARES)
- Russian-American Long-Term Census of the Arctic (RUSALCA)
- Bering Strait mooring program
- Arctic Marine Biodiversity Observing Network (AMBON)
- Aerial Survey Arctic Marine Mammals (ASAMM)
- Chukchi Acoustic, Oceanography and Zooplankton Study (CHAOZ)
- Characterization of the Circulation in the Chukchi and Beaufort Seas
- Hanna Shoal Project
- Chukchi Sea Moored Ecosystem Observatory
- Northern Bering Sea bottom trawl survey
- Northern Bering Sea BASIS (Bering-Arctic Subarctic Integrated Survey)
- Chukchi Ecology and Seal Survey (CHESS)
- Influence of sea ice on ecosystem shifts – USGS Changing Arctic Ecosystems
- Arctic Coastal Ecosystem Survey (ACES)

Arctic Integrated Ecosystem Research Program

All Partners have committed to data sharing and will support representatives to participate in annual planning and integration meetings and to work collaboratively towards common research priorities and objectives.

NPRB is actively pursuing opportunities for additional partnerships, including international collaborations and comparative studies on other regional Arctic seas.

Thank You

Acknowledgements:
Alaska Fisheries Science Center, TINRO, VNIRO, University of Alaska Faribanks, Lisa Eisner, Kirill Kivva, Ed Farley, Seth Danielson, Danielle Dickson, Wayne Palsson, Patrick Ressler, Mike Sigler, Bob Lauth, Janet Duffy-Anderson, Anne Hollowed, John Horne, Stephani Zador, Alex, Elizabeth Siddon, Jerry Hoff, Kerim Aydin, Ellen Yasumiishi

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Matthew.Baker@nprb.org; www.nprb.org; http://www.nprb.org/arctic-program

Opportunities and Challenges to Data Sharing in the northern Bering Sea

The intent is to communicate existing efforts and foster discussion on new opportunities for international exchange relevant to understanding processes, structure, and interactions in the northern Bering Sea and associated ecosystems

What are the data and data streams that are available and accessible

- What is available but not widely known or referenced
- What is available but not utilized

What are the data and data streams that are not currently shared that could be made available

What are the opportunities for further data collaboration and exchange

What are the important mechanisms to facilitate that exchange