Science, Service, Stewardship

Update on United States Research Activities in the Bering Sea and Gulf of Alaska Relevant to the PICES FUTURE Program

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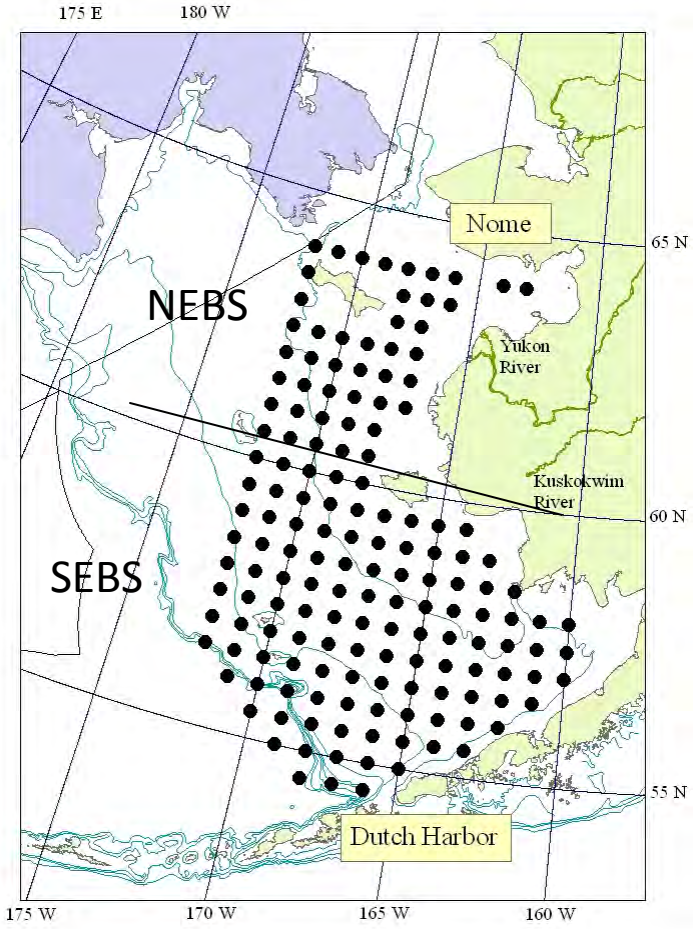
NOAA FISHERIES SERVICE

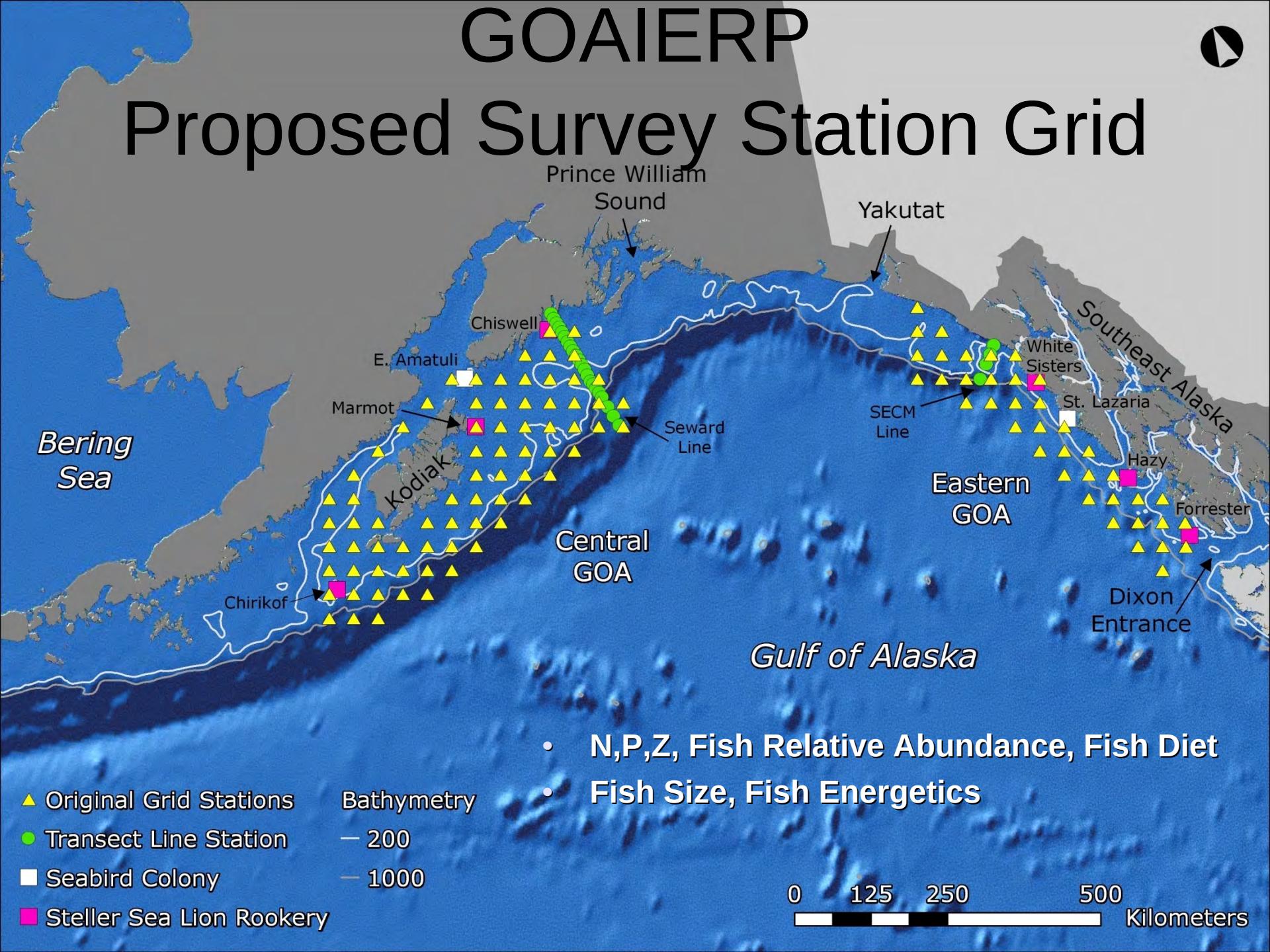
- Loss of Sea Ice, LOSI (NOAA/AFSC)
- Bering Arctic Subarctic Integrated Survey, BASIS (NOAA, ADFG)
- Ocean acidification (NOAA/AFSC/PMEL)
- Bering Sea Integrated Ecosystem Research Program, BSIERP (NPRB, NSF, NOAA) ending 2012
- Gulf of Alaska integrated Ecosystem Research Program, GOAIERP (NPRB, NOAA) started 2009

US BASIS Survey Area

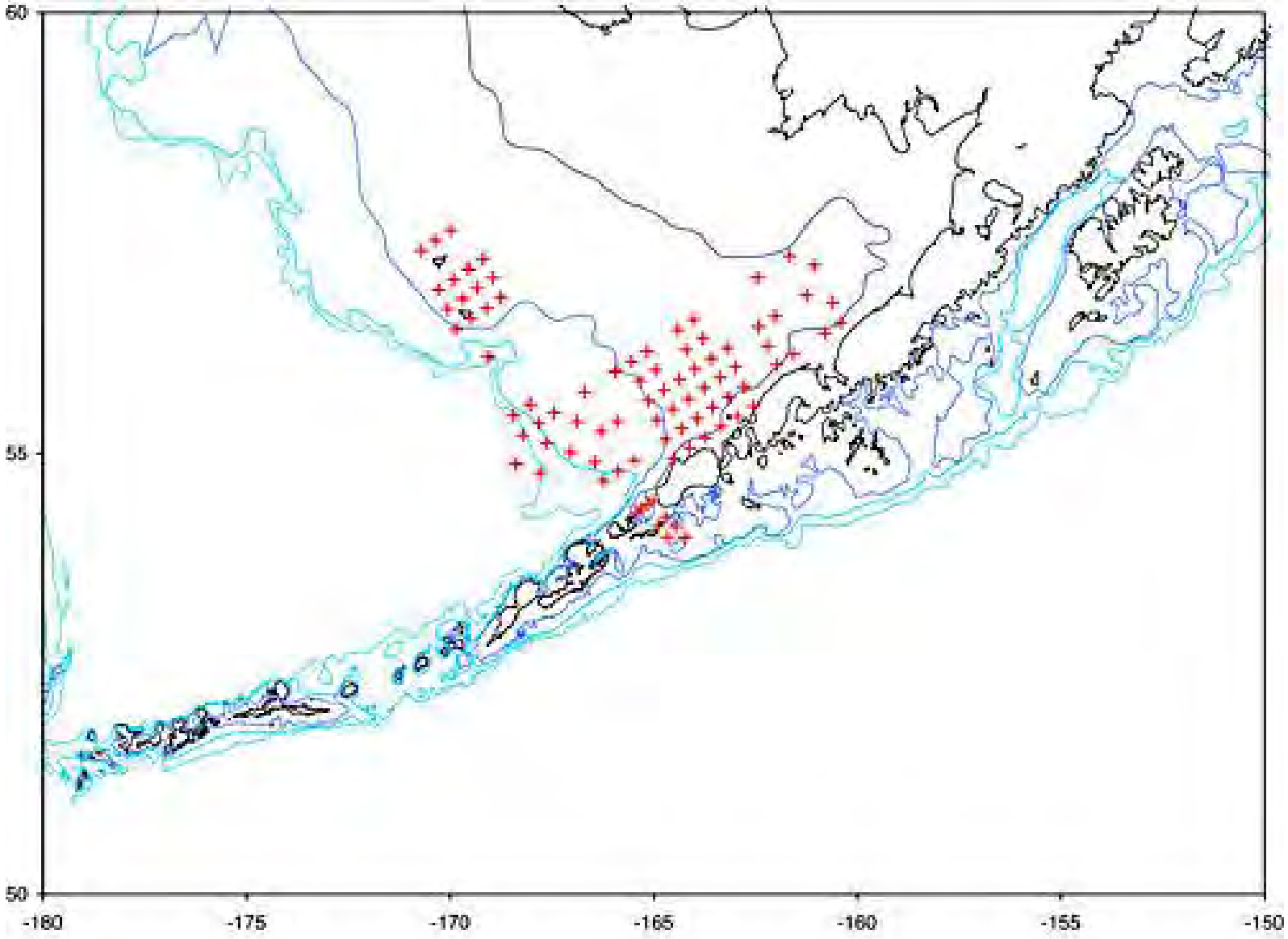
Ecosystem Indicators

- Physical Oceanography
- Biological Oceanography
  - Zooplankton species comp and biomass
  - Phytoplankton species comp etc.
- Relative Abundance
- Fish Diet
- Size
- Energetics



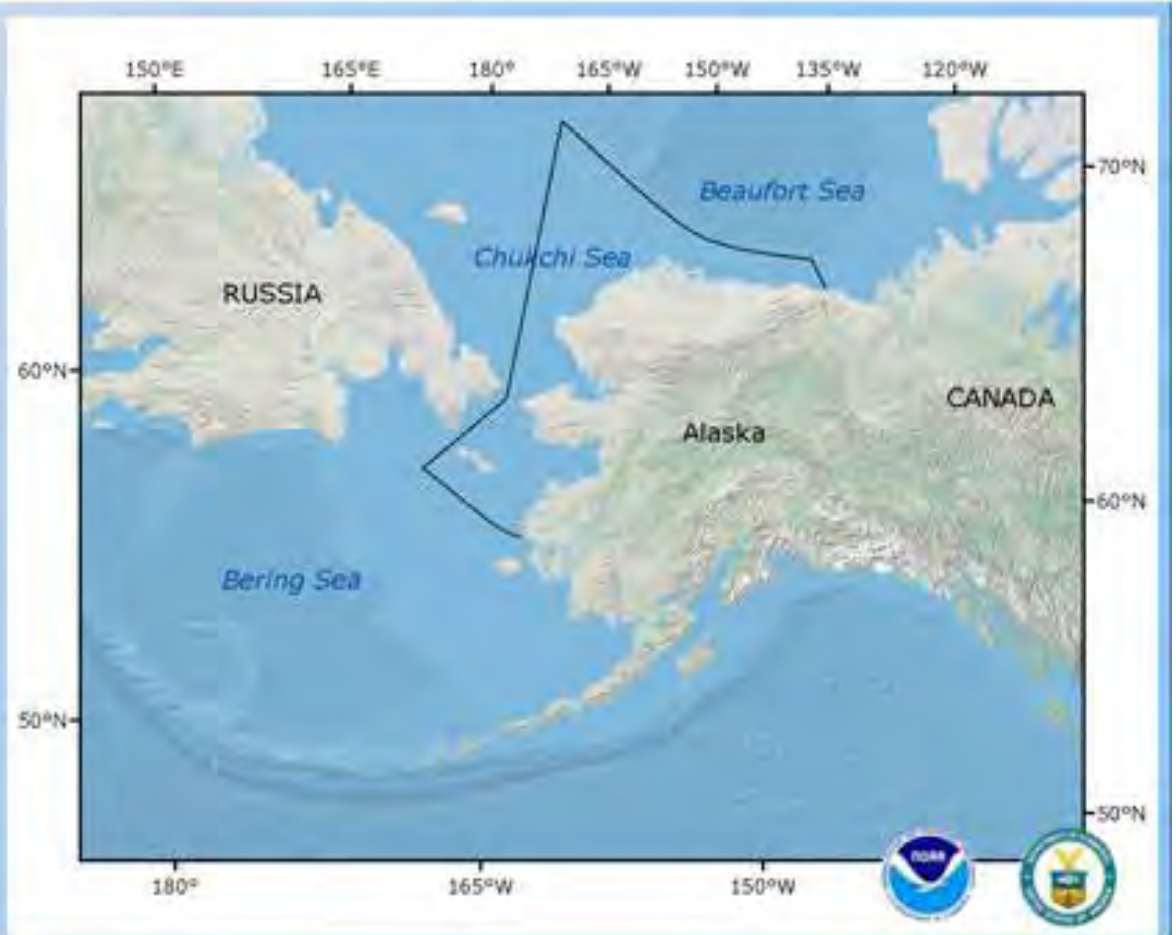

GOAIERP
Proposed Survey Station Grid
Prince William Sound
Yakutat
Southeast Alaska
Chiswell
E. Amatuli
Marmot
Seward Line
Bering Sea
Kodiak
Central GOA
Eastern GOA
SECM Line
White Sisters
St. Lazaria
Hazy
Forrester
Chirikof
Dixon Entrance
Gulf of Alaska
• N,P,Z, Fish Relative Abundance, Fish Diet
• Fish Size, Fish Energetics
Original Grid Stations
Transect Line Station
Seabird Colony
Steller Sea Lion Rookery
Bathymetry
200
1000
0 125 250 500
Kilometers

BSIERP Spring Cruise 2009



T, S, NPZ, epipelagic trawl, hydroacoustics 2011
T, Benthic trawl, 2010

Goal: Extend existing surveys in the southeastern Bering Sea to all or part of the outlined area of the northern Bering, Chukchi and Beaufort Seas in order to periodically monitor fish and shellfish abundance using standard NOAA survey methods (bottom and surface trawls, acoustics, beach seines).



Significant northward displacement within the Bering Sea

Bering flounder 76 km

Greenland halibut 98 km

Snow crab 89 km

Arrowtooth flounder 46 km

Eulachon 34 km

Flathead sole 57 km

Pacific halibut 55 km

Plus 8 other species

Mueter, F.J. and M.A. Litzow. 2008. Sea ice retreat alters the biogeography of the Bering Sea continental shelf. Ecol. Appl. 18: 309-320. Significant defined as $p < 0.05$. 1982-2006 Bering Sea bottom trawl surveys.

Five species have extended their range from the Bering or Chukchi Seas to the Beaufort Sea

Bering flounder

Pacific cod

Walleye pollock

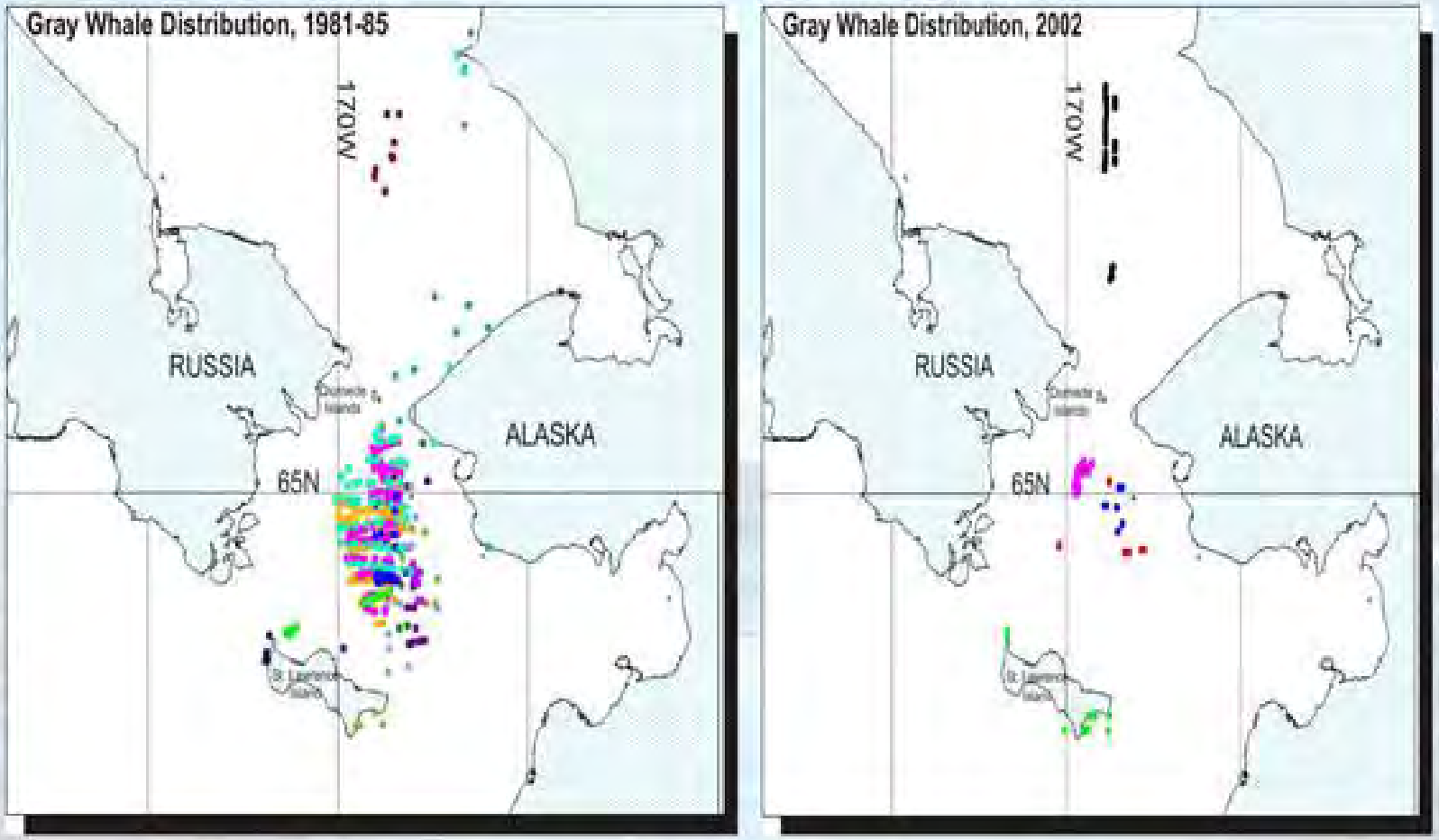
Plus 2 other species:
Eyeshade sculpin;
Festive snailfish

Logerwell, L. 2009. Personal communication.

LOSS OF SEA ICE

- **Bering Sea**
- Some commercially important species have shifted outside current survey areas in the Bering Sea and thus are incompletely monitored. Furthermore, several marine mammal species depend on sea ice and only limited baseline abundance information is available. NOAA needs to expand research to fill these gaps.

Gray whale feeding grounds have changed



Moore, S.E., Grebmeier, J.M., and Davies, J.R. 2003. Gray whale distribution relative to forage habitat in the northern Bering Sea: current conditions and retrospective summary. Can. J. Zool. 81: 734-742.

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THE END

LOSS OF SEA ICE

- ***Current Research***
- Distribution and movement (aerial surveys, satellite telemetry) of ice seals (2007-10)
- Abundance and distribution of fish and plankton (acoustic surveys) in relation to seasonal sea ice cover (2007-10)
- ***Research Needs***
- Monitor ocean conditions and fish, shellfish (acoustic, bottom trawl and surface trawl surveys), cetacean (acoustic and visual surveys) and ice seal (satellite telemetry) species.
- Assess whether spatial shifts are creating new biological communities, thus altering food webs and impacting vital rates (growth, maturity, and feeding) and movement.
- Forecast distribution and abundance of managed species and the economic and sociological impacts of LOSI on commercial and subsistence fisheries.

Bering-Aleutian Salmon International Survey (BASIS) : Chukchi Sea Survey (2007)

- Location: Chukchi Sea
- Principle Investigator: Lisa Eisner
- Study the effects of climate change (loss of sea ice) on the oceanography and pelagic/benthic fish communities. Conducted aboard the R/V Oscar Dyson in 2007. Sampling at each station included measurements of vertical profiles for oceanography, net tows to determine biomass and species composition of zooplankton, surface trawl to capture pelagic fishes, and a beam trawl to capture benthic fish species.
- Funding Source: AFSC
- Funding amount: $100 K
- Collaborators: University of Alaska, North Pacific Anadromous Fish Commission, WHOI, RUSALCA (AFSC, UAF, California Academy of Sciences), USFWS, Evergreen State College

LOSI FY 2010 Funded

- The Alaska Fisheries Science Center (AFSC) received $1.2 million for loss of sea ice research in FY 2010. These new funds will be used to expand the southeast Bering Sea bottom trawl survey northward to the Bering Strait and to conduct ice seal research.
- The AFSC's Groundfish Assessment Program will complete the northward expansion of the trawl survey. With this expansion, all of the eastern Bering Sea shelf within U.S. waters will be surveyed. The full sampling capabilities of the existing trawl survey will be replicated on the northern extension including bottom trawling and plankton and oceanographic sampling. The project also will support development of an annotated checklist of epibenthic marine invertebrates for the Bering Sea and Arctic Ocean because these species are more common farther north.
- The AFSC's Polar Ecosystems Program will begin a 5-year plan to conduct aerial abundance surveys for ribbon, spotted, and bearded seals in the Bering Sea and in the Sea of Okhotsk and for ringed seals in the Beaufort, Chukchi, and northern Bering Seas. The abundances of these species, protected under the Marine Mammal Protection Act and considered for listing under the U. S. Endangered Species Act , are very poorly documented. Preparation and detailed survey design will be conducted in 2010 and 2011 for the ribbon, spotted, and bearded seal surveys. These surveys will be conducted in both U.S. and Russian waters in 2012 and 2013, and the data will be analyzed in 2014. In addition, a design for surveys for ringed seals will be developed and implemented to commence in 2014.

BASIS

Canada Japan Korea Russia U.S.A.

Bering-Aleutian Salmon International Survey

Ed Farley Jim Murphy Lisa Eisner Jamal Moss Markus Janout

Kris Cieciel Ellen Martinson Alex Andrews Jeneatte Gann Katy Echave

Alaska Fisheries Science Center

NATIONAL MARINE FISHERIES SERVICE

- **Ocean Acidification Funding Received**
- The AFSC received $380,000 for ocean acidification research in FY 2010. These new funds primarily will be used to conduct species-specific physiological research. The species-specific physiological response to ocean acidification is unknown for most marine species. Lacking basic knowledge, research will be directed toward several taxa including king crab, euphausiids, coldwater corals, walleye pollock, and Pacific cod. The research will be conducted at the Kodiak, Auke Bay, and Newport Laboratories. Work also will begin on incorporating results into a king crab bioeconomic model; this work will be completed by the AFSC's Socioeconomics Assessment Program in Seattle.

BSIERP 2007 - 2012

- IN 2007, THE NORTH PACIFIC RESEARCH BOARD (NPRB) AND THE NATIONAL SCIENCE FOUNDATION (NSF) entered into a historic partnership to support a comprehensive $52 million investigation of the eastern Bering Sea ecosystem. This “Bering Sea Project” integrates two research programs, the NSF Bering Ecosystem Study (BEST) and the NPRB Bering Sea Integrated Ecosystem Research Program (BSIERP). Their common goal is to understand how climate change is affecting the Bering Sea ecosystem and the consequences of these changes on lower trophic levels for fish, seabirds, marine mammals, and ultimately people.
- The BEST-BSIERP Bering Sea Project is a 6-year study of the Bering Sea ecosystem, from the benthos and the atmosphere to human communities, and everything in between. Nearly a hundred principal scientists are linked through a vertically integrated process and modeling program. Field research began in 2007 and reached full speed the following year, with at-sea sampling conducted from February through September 2008. The Bering Sea winter ice cover reached a 30-year high in 2008, and Alaska shivered through a cold and wet spring and summer. In this article, we present a few select observations from the first complete field year and highlight some of the new results.

bsierp

- The Bering Sea Integrated Ecosystem Research Program (BSIERP) spring cruise was conducted 7-20 May 2009 aboard the NOAA ship *Oscar Dyson* in the Bering Sea to examine the interactions among climate, weather, and recruitment of fishes in the eastern Bering Sea.

  Ichthyoplankton and zooplankton sampling was conducted in the waters along the eastern Aleutian Islands chain, the Alaska Peninsula, and the Pribilof Islands (Fig. 10 above) in order to examine horizontal and vertical distribution of larval walleye pollock, Pacific cod, and arrowtooth flounder as well as the abundance and distribution of their plankton prey, and to perform genetic discrimination of *Atheresthes* spp. larvae at sea using molecular techniques (see previous article by Mike Canino).

  The cruise represents collaboration between NPRB/BSIERP and NOAA's North Pacific Climate Regimes and Ecosystem Productivity program. Eighty-one stations were sampled for ichthyo- and zooplankton abundance using a bongo net array and a neuston net (505 µm mesh). The contents of one of each of the bongo nets and the neuston net were immediately preserved in sodium borate-buffered formalin to be sorted and identified at a later date. The contents of the remaining 60-cm bongo net were sorted live for fish larvae.

- The Gulf of Alaska (GOA) is one of the world's most productive ocean regions. It sustains large animal populations and provides a way of life for many people.
- The Alaska Current and the Alaska Coastal Current dominate the GOA. These are the strongest and most persistent currents found along either coast of North America. They function as pathways for organisms and the resources they depend on. The large embayment estuaries of the southeast island archipelago, Prince William Sound, Kenai Fjords, Cook Inlet, and Shelikof Strait provide nursery and juvenile habitat for many species.
- The value of an integrated ecosystem research program is that it brings together different disciplines to comprehensively attempt to answer complex ecological questions in the face of uncertainty and ecosystem change.
- Like the BEST-BSIERP Bering Sea Project, the Gulf of of Alaska Project aims to determine and quantify processes that drive upper trophic level populations and to better understand observed and future variability therein as they affect key management issues in the North Pacific.
- **Above:** The geographic scope of the Upper Trophic Level (UTL) component in the Gulf of Alaska. See larger image
- **Overarching question**
- The Gulf of Alaska IERP Implementation Plan is structured around this question:
- How do environmental and anthropogenic processes, including climate change, affect trophic levels and dynamic linkages among trophic levels, with emphasis on fish and fisheries, marine mammals, and seabirds within the Gulf of Alaska?
- **A four-Component program**
- Implementation of the GOA IERP is structured around four separately competed components which will link together to form a fully integrated ecosystem study in the Gulf of Alaska. The four components of this program are:
- **Upper Trophic Level (UTL):** The overall goal of this component focuses on identifying and quantifying the major ecosystem processes that regulate recruitment strength of key groundfish species (arrowtooth flounder, Pacific cod, Pacific ocean perch, sablefish, and walleye pollock) in the GOA. The focus is on a functional group of five predatory fish species that are commercially important and account for most of the predatory fish biomass in the GOA. Taken together they encompass a range of life history strategies and geographic distributions that provide contrast to explore regional ecosystem processes.