Science, Service, Stewardship

Climate Change and Arctic Fisheries

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NOAA FISHERIES SERVICE

Presentation at 4th Symposium on the Impacts of an Ice-Diminishing Arctic on Naval & Maritime Operations, Washington DC, 22 June 2011

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Outline: Zoogeography and Arctic Fisheries

- Economic importance
- Oceanography and zoogeography
- Ecosystem changes
- Surveys
- NOAA policies on Arctic fishing

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Economic Importance

Bering Sea Fisheries

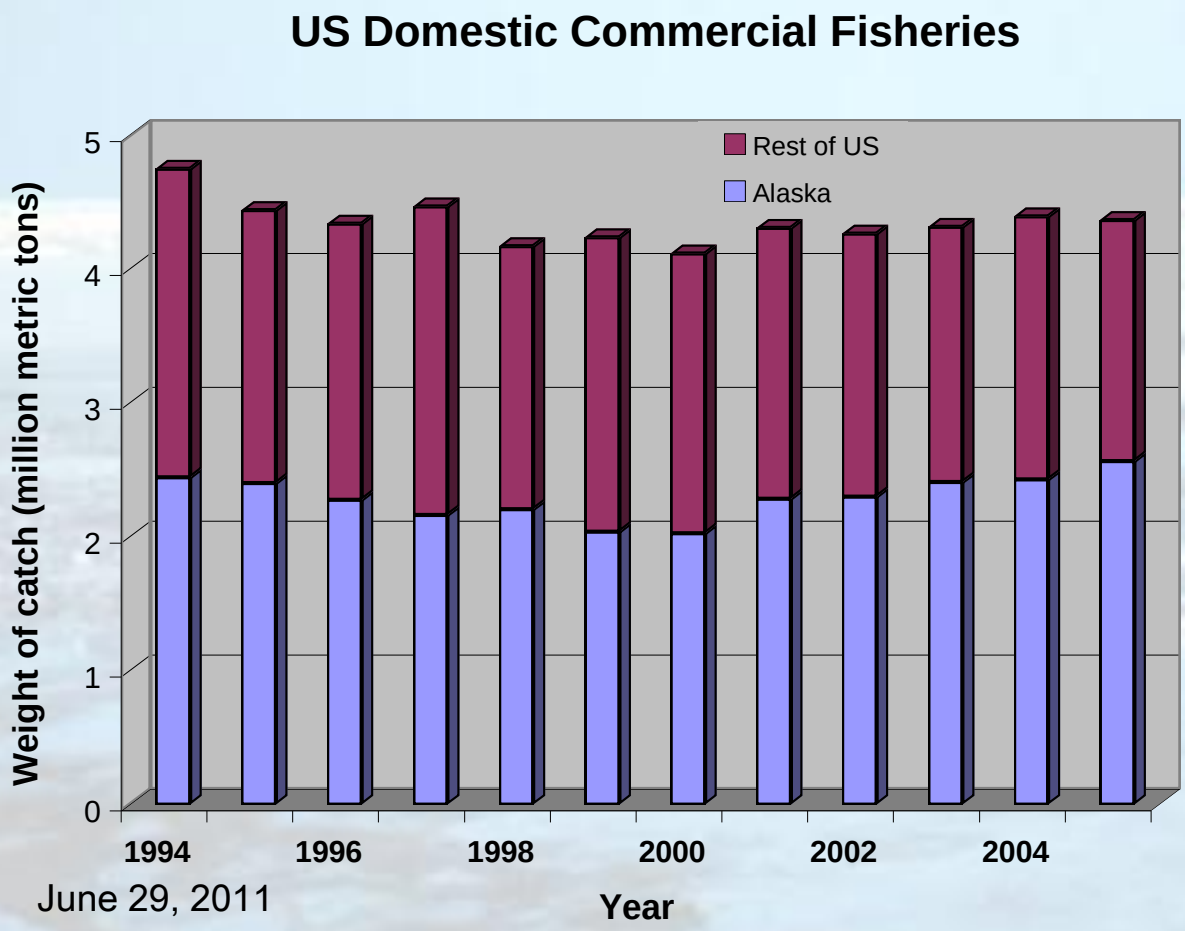
- 2 million metric tons annually

M. Jones, NMFS

M. Sigler, NMFS

Alaska Feeds the Nation

Largest private sector employer in Alaska



U.S. Arctic Fisheries

- Commercial
  - None in EEZ waters
  - Possibly some personal use fishery sales in nearshore waters: red king crab, chum salmon, whitefishes
- Subsistence
  - Dolly Varden
  - Whitefishes
  - Arctic cod
  - Saffron cod
  - Sculpins

Several hundred tons annually
(Arctic Ocean totals 12,800 t)

Zeller D, Booth S, Pakhomov E, Swartz W, Pauly D. 2011. Arctic fisheries catches in Russia, USA, and Canada: baselines for neglected ecosystems. Polar Biology DOI 10.1007/s00300-010-952-3.

Subsistence Harvests Critical for Many Coastal Communities

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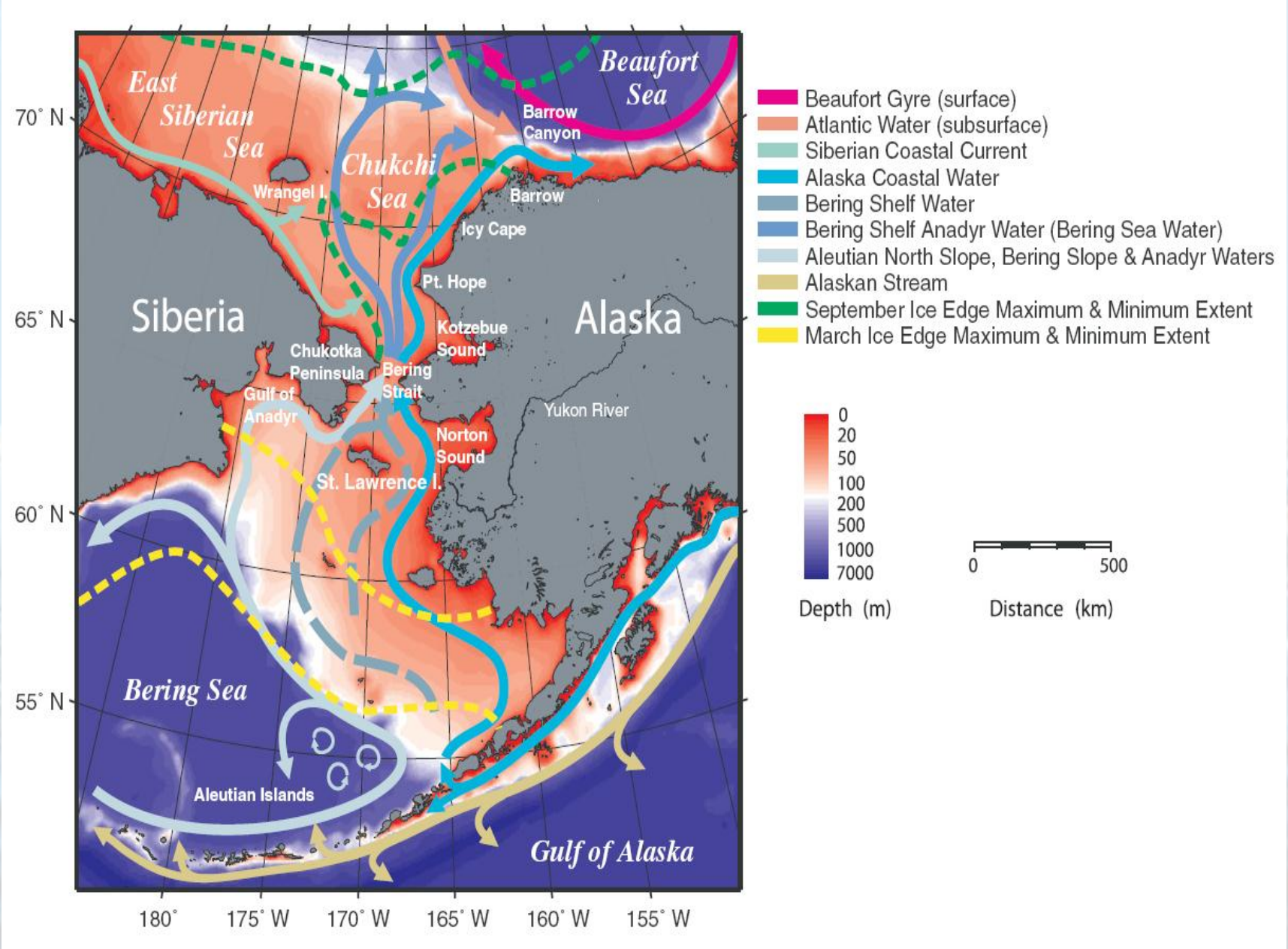
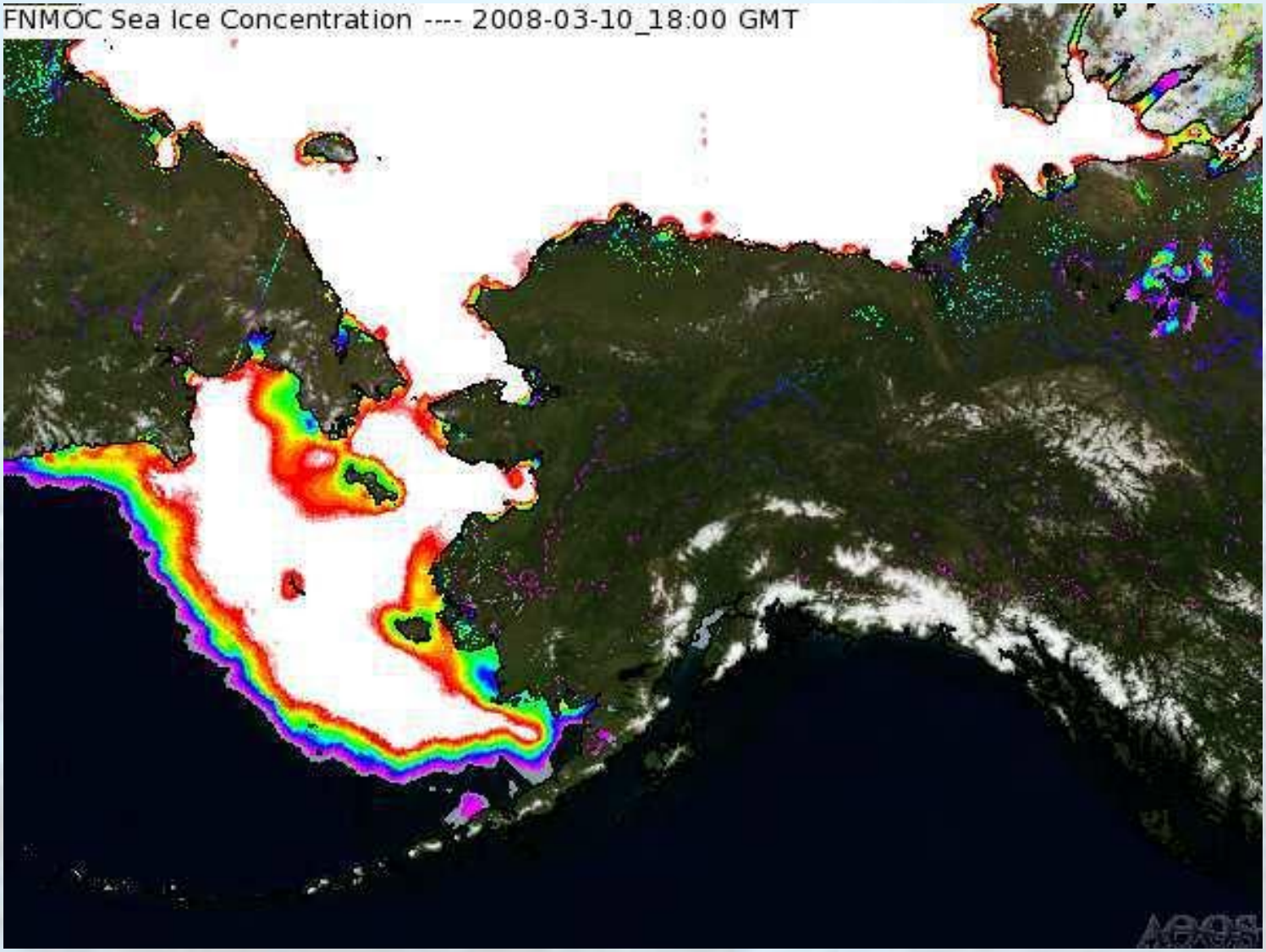
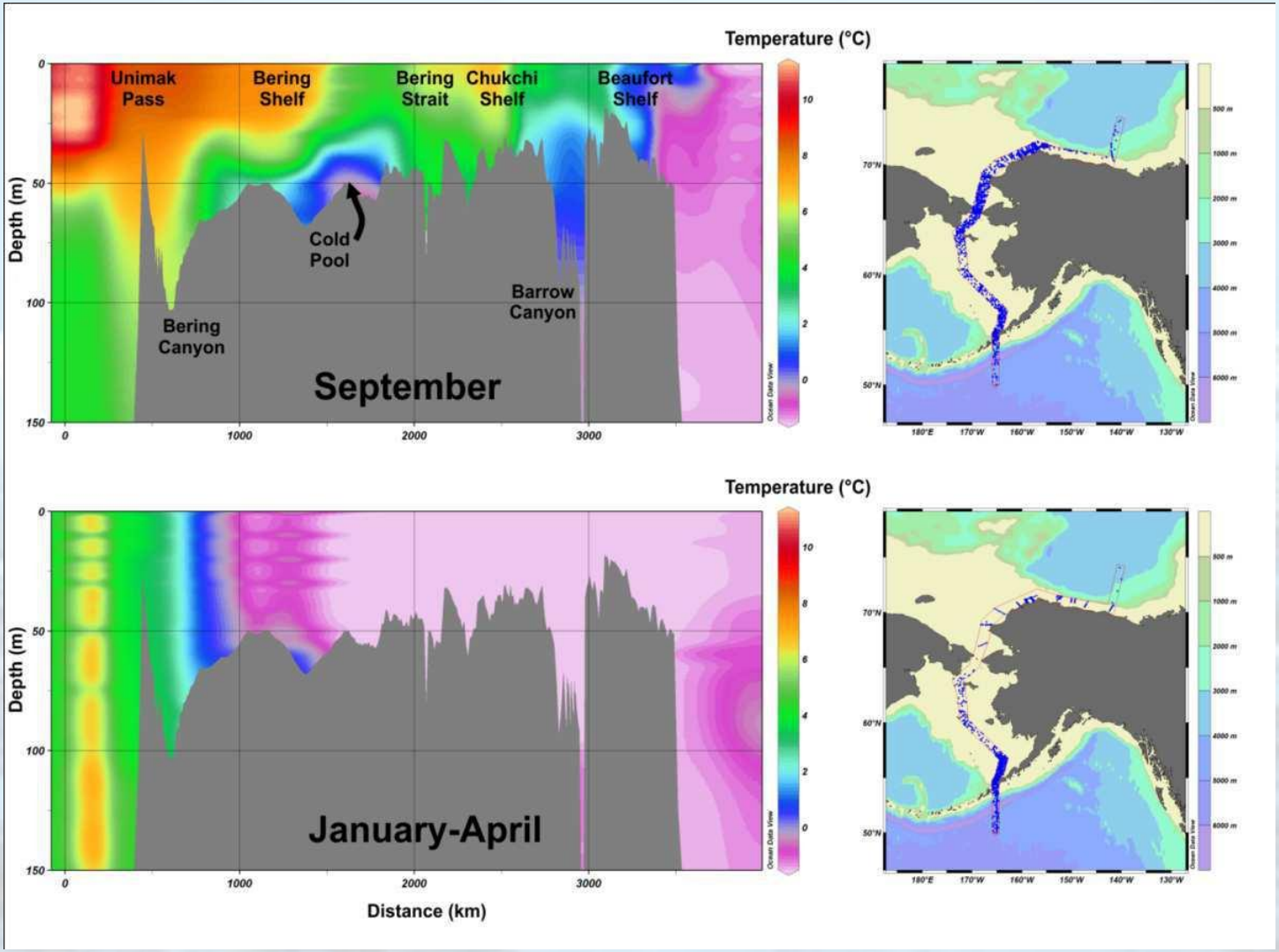
Oceanography and Zoogeography


East Siberian Sea
Beaufort Sea
Barrow Canyon
Chukchi Sea
Wrangel I.
Barrow
Icy Cape
Pt. Hope
Siberia
Alaska
Kotzebue Sound
Chukotka Peninsula
Bering Strait
Gulf of Anadyr
Yukon River
Norton Sound
St. Lawrence I.
Bering Sea
Aleutian Islands
Gulf of Alaska
70° N
65° N
60° N
55° N
180°
175° W
170° W
165° W
160° W
155° W
Beaufort Gyre (surface)
Atlantic Water (subsurface)
Siberian Coastal Current
Alaska Coastal Water
Bering Shelf Water
Bering Shelf Anadyr Water (Bering Sea Water)
Aleutian North Slope, Bering Slope & Anadyr Waters
Alaskan Stream
September Ice Edge Maximum & Minimum Extent
March Ice Edge Maximum & Minimum Extent
0
20
50
100
200
500
1000
7000
Depth (m)
0
500
Distance (km)

Winter ice extent

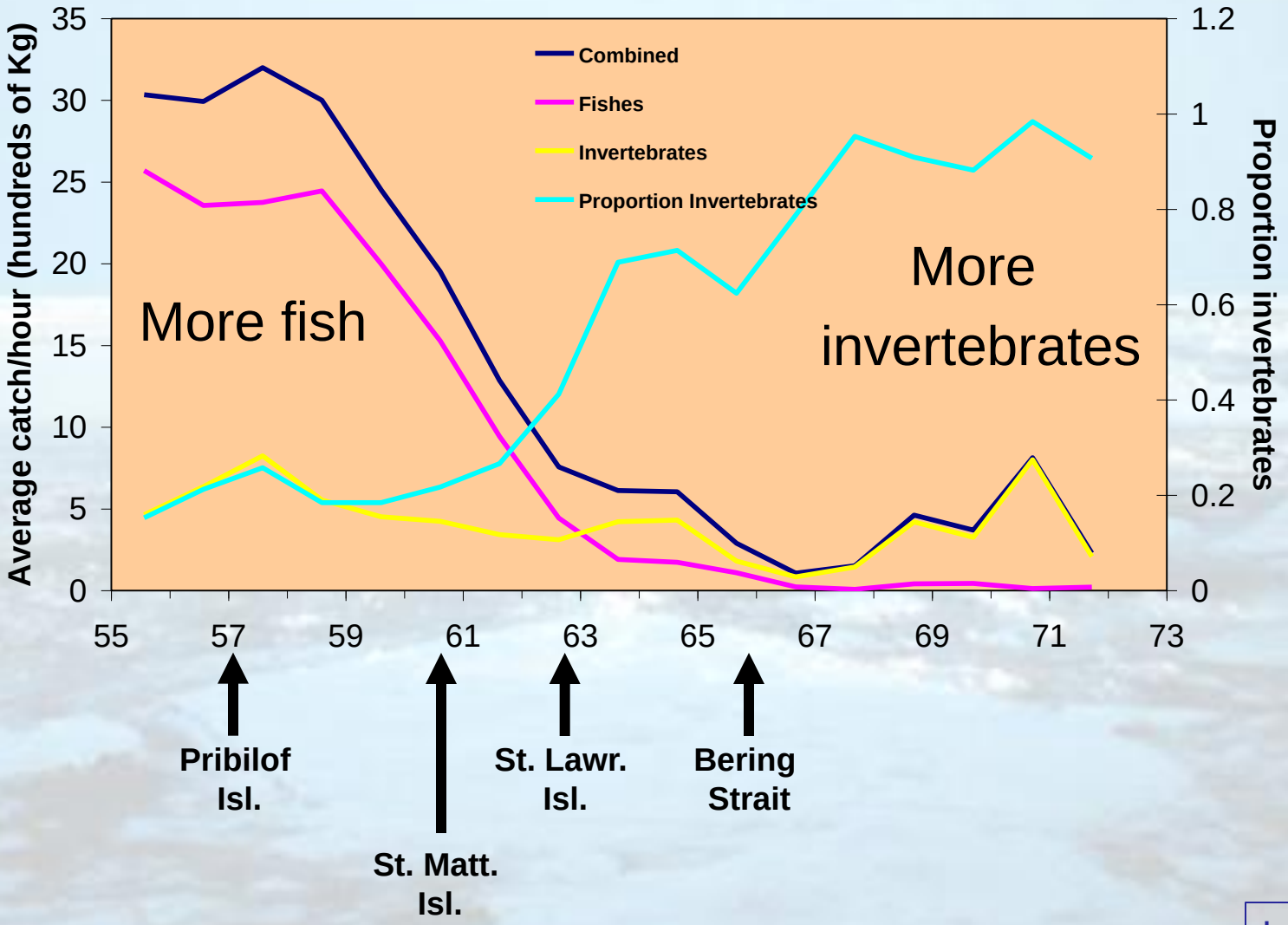


Cross-section of temperatures North Pacific to the Beaufort Sea



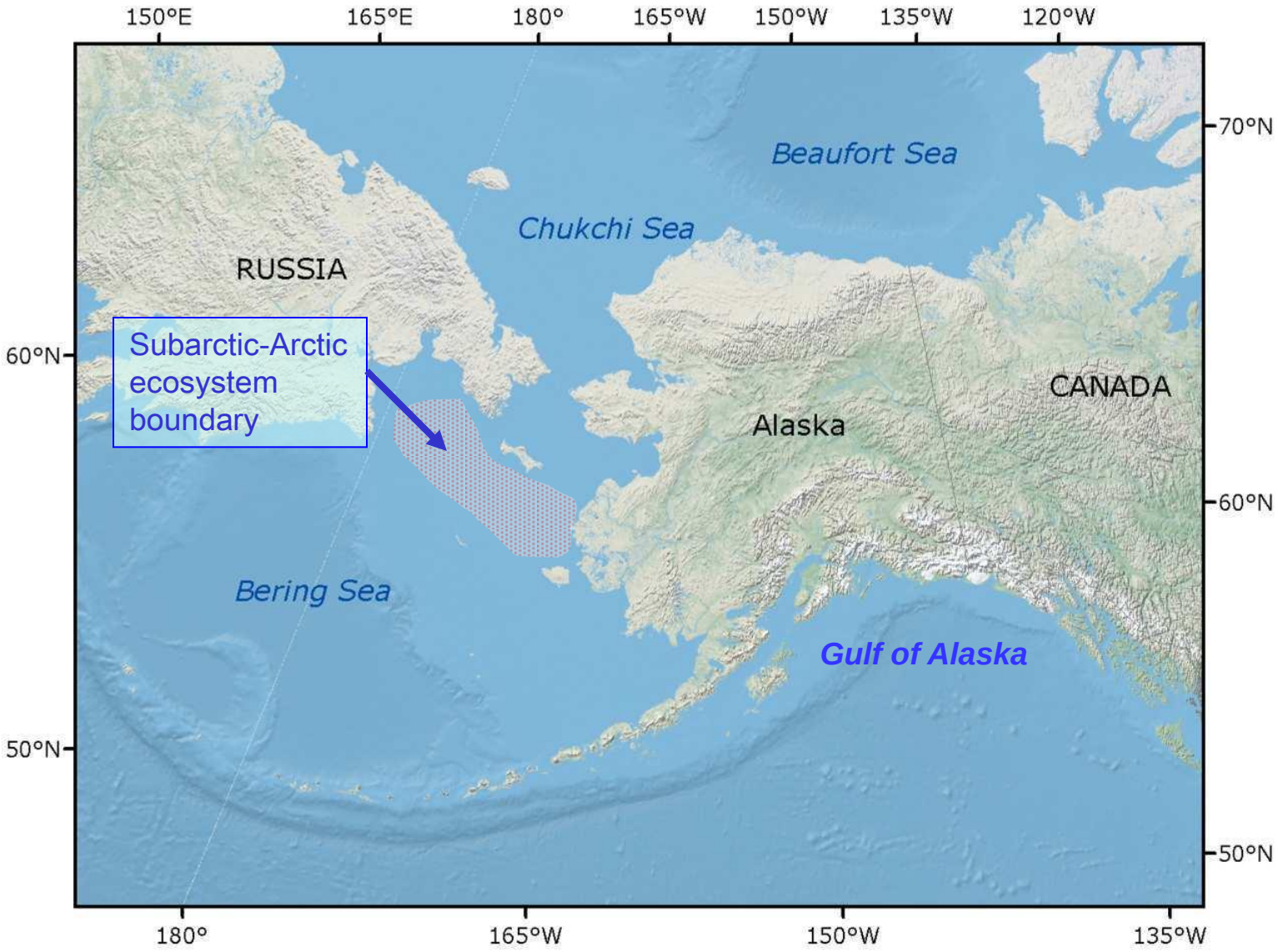
Data are from the World Ocean Database 2009 (Boyer et al., 2009)

Bottom trawl surveys in the eastern Bering and Chukchi Seas



Lauth

U.S. Arctic and Subarctic



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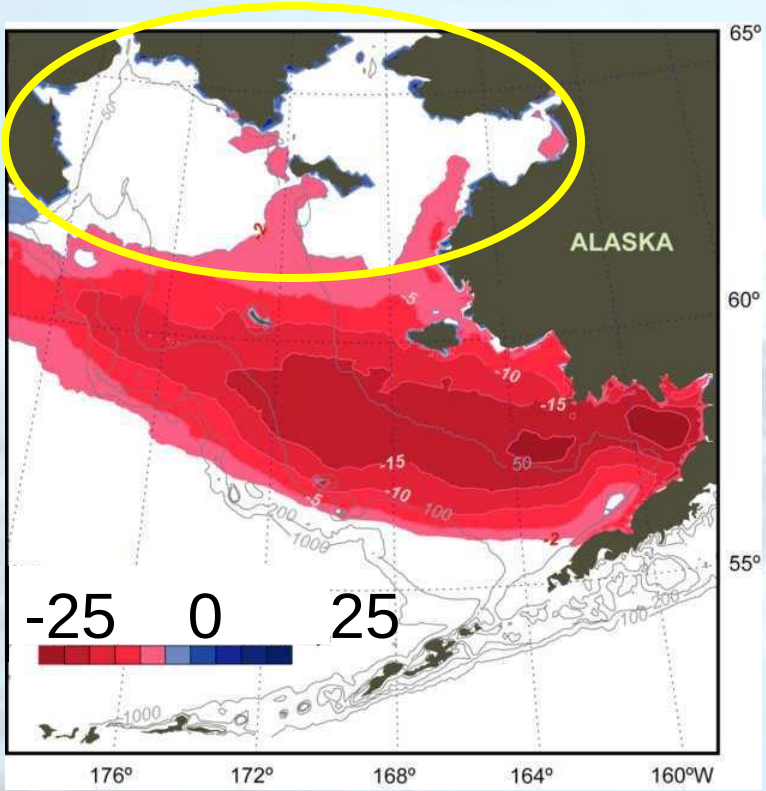
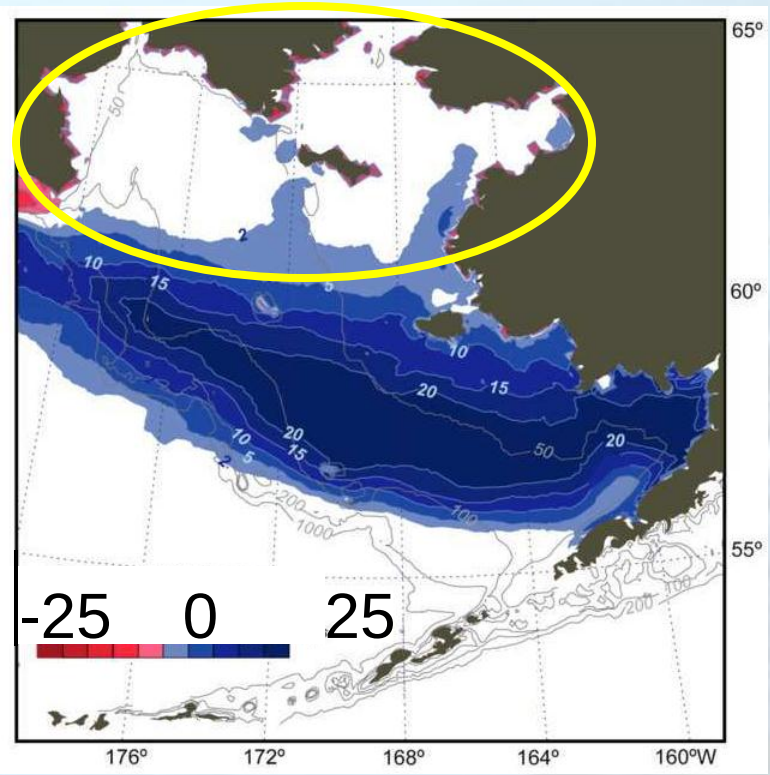
Ecosystem Changes

Northern Bering Sea remains cold

Warm years

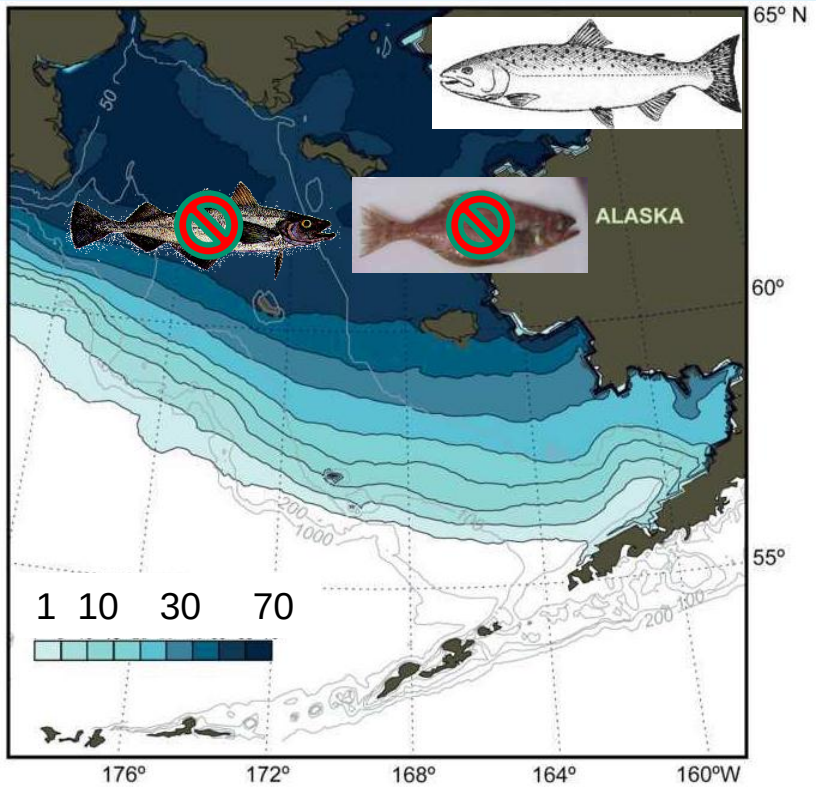


Cold years



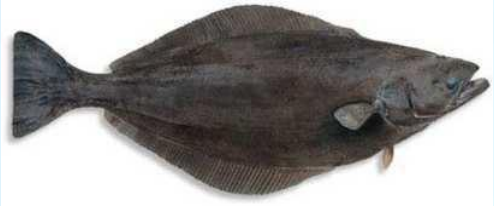
The anomalies of sea-ice coverage during March and April during warm years (2001-2005, left) and cold years (2007-2010, right) (Stabeno, Farley, Kachel, Moore, Mordy, Napp, Overland, Pinchuk, Sigler)

The cold pool will remain and determine habitat suitability



The average number of days in which sea-ice was present in March and April during 2001-2010. Stabeno, Farley, Kachel, Moore, Mordy, Napp, Overland, Pinchuk, Sigler

Significant Northward Displacement within the southeastern Bering Sea



Greenland halibut 98 km

Snow crab 89 km

Bering flounder 76 km

Arrowtooth flounder 46 km

Eulachon 34 km

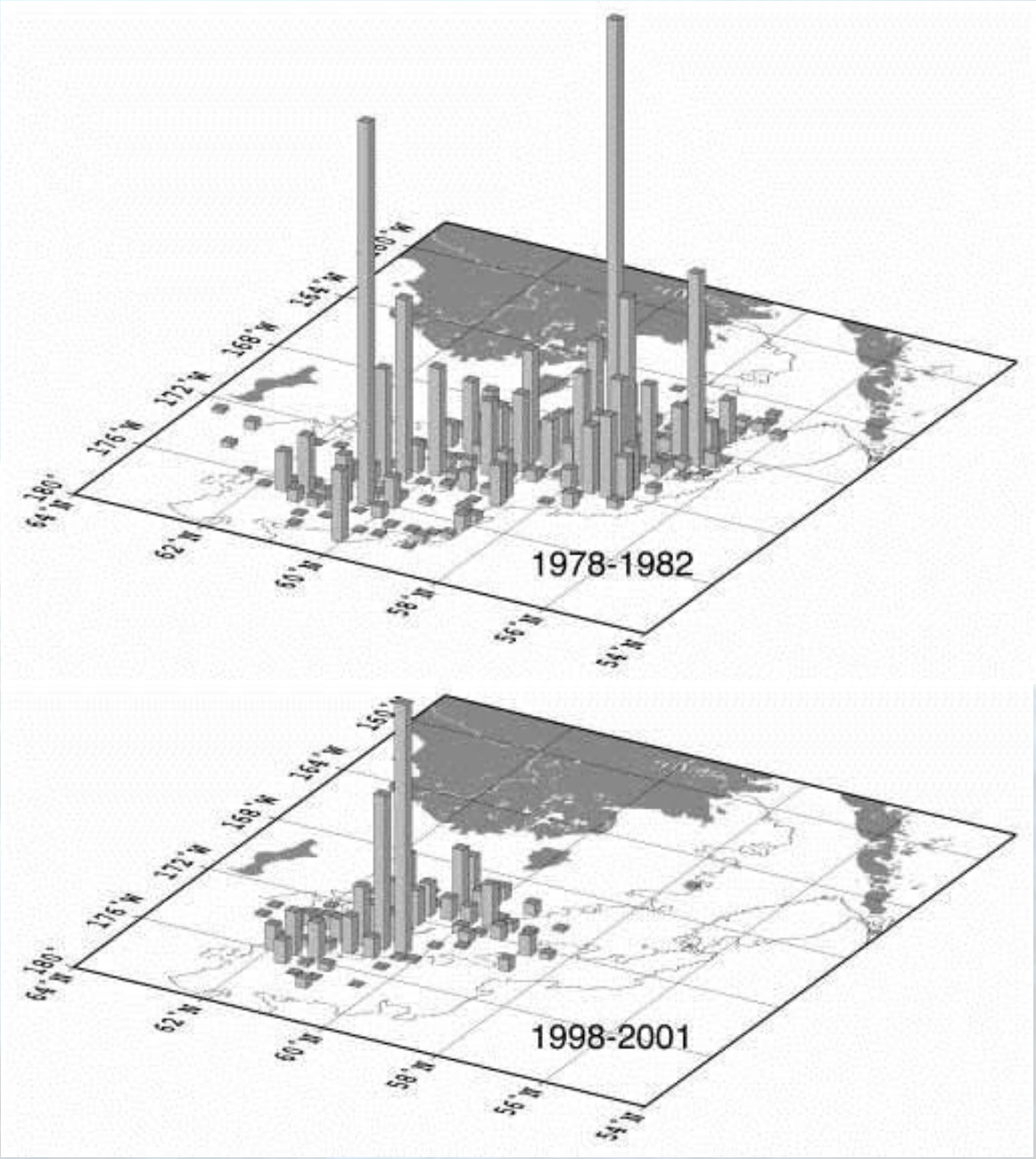
Flathead sole 57 km

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.
Also see: Spencer, P.D. 2008. Density-independent and density-dependent factors affecting temporal changes in spatial distributions of eastern Bering Sea flatfish. Fish. Oceanogr.17: 396-410.

Snow Crab Population Has Diminished and Contracted North



Orensanz, J. L., B. Ernst, D. Armstrong, P. Stabeno, and P. Livingston. 2004. Contraction of the geographic range of distribution of snow crab (*Chionoecetes opilio*) in the eastern Bering Sea: An environmental ratchet? CalCOFI Rep. 45: 65-79.

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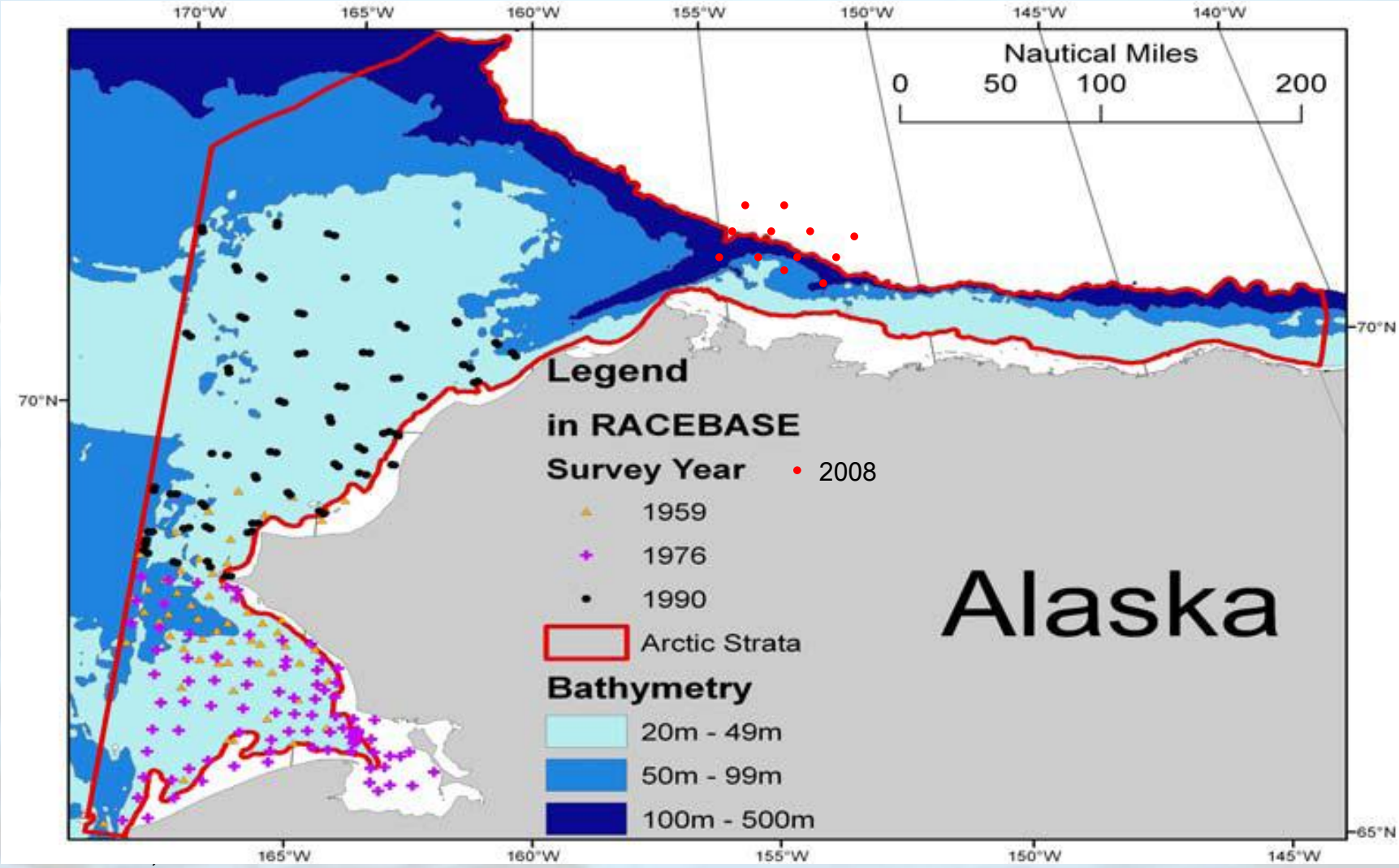
Surveys

Insufficient information to make adequate assessments (Arctic FMP)



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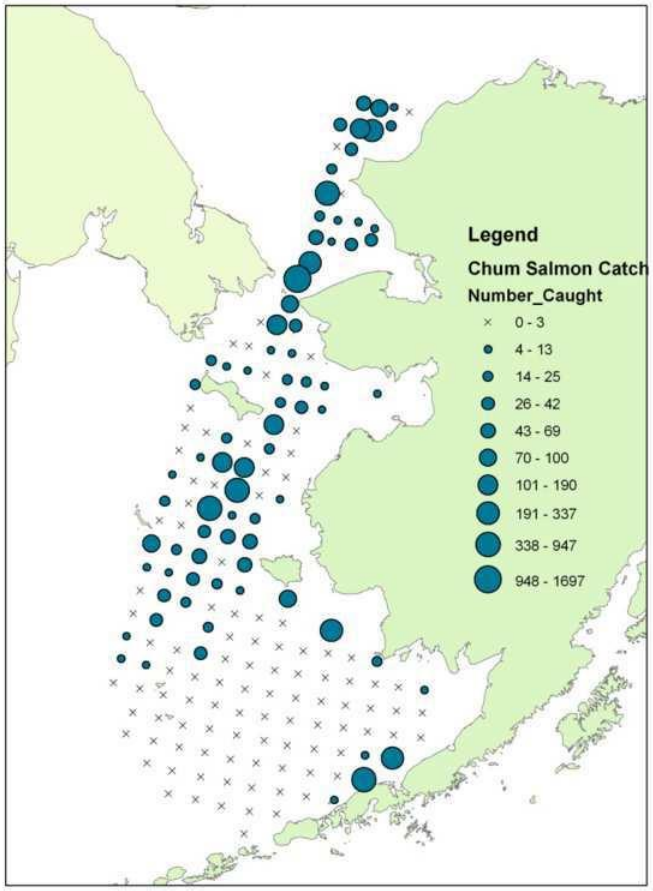
Chukchi Sea Surface Trawl Survey

All five species of salmon were observed in the Chukchi Sea during 2007.



http://www.afsc.noaa.gov/ABL/MESA/mesa_basis.php

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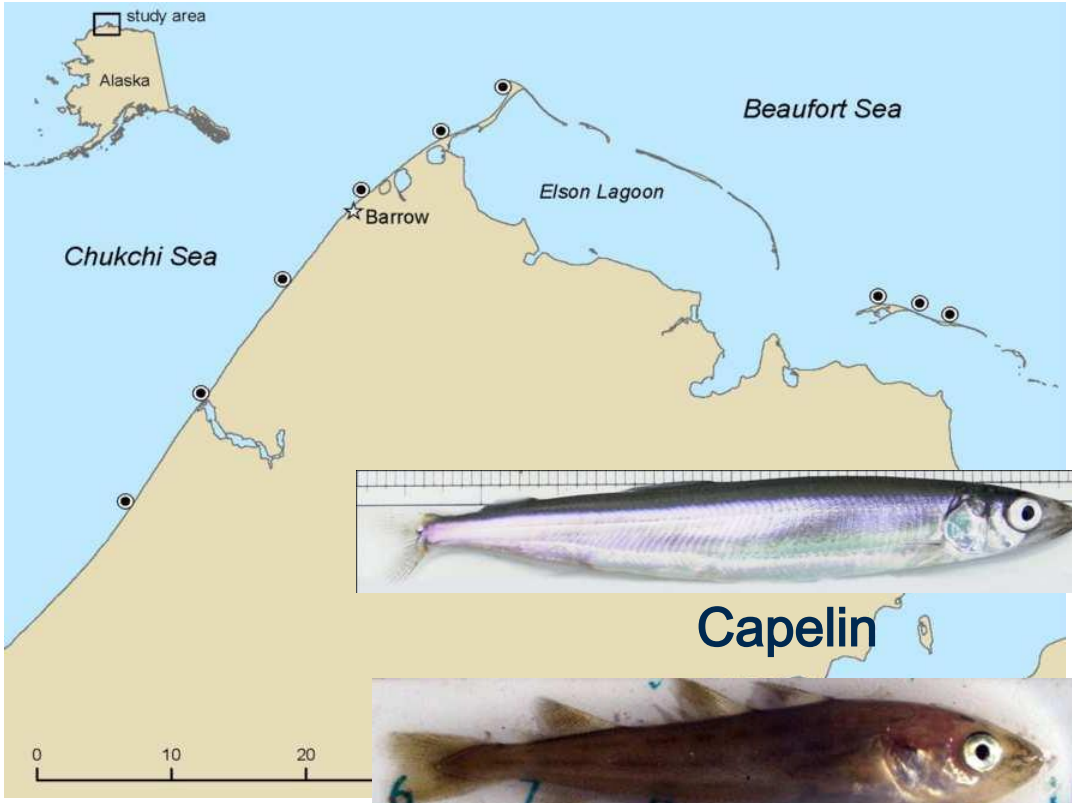
Nearshore Arctic Fish Surveys

- **Established baseline in 2007-2009.**
- **Capelin and Arctic cod accounted for 80% of beach seine and bottom trawl catches.**



Capelin

Arctic cod

http://www.afsc.noaa.gov/ABL/Habitat/ablhab_nearshore_atlas.htm

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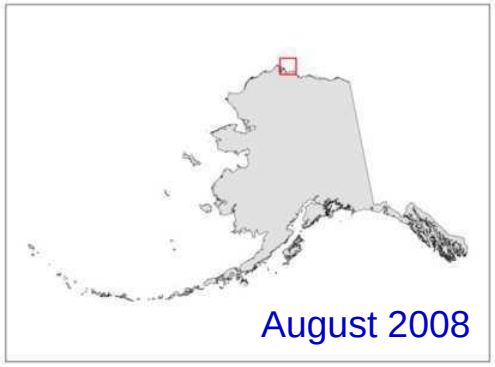
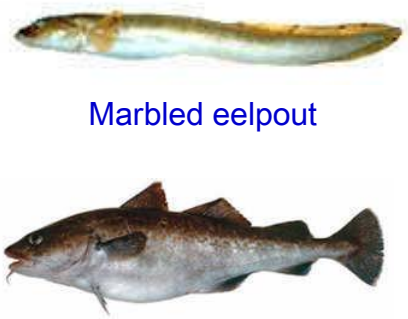
Beaufort Sea Survey



Six Species Have Extended Range from the Bering or Chukchi Seas to the Beaufort Sea



Marbled eelpout

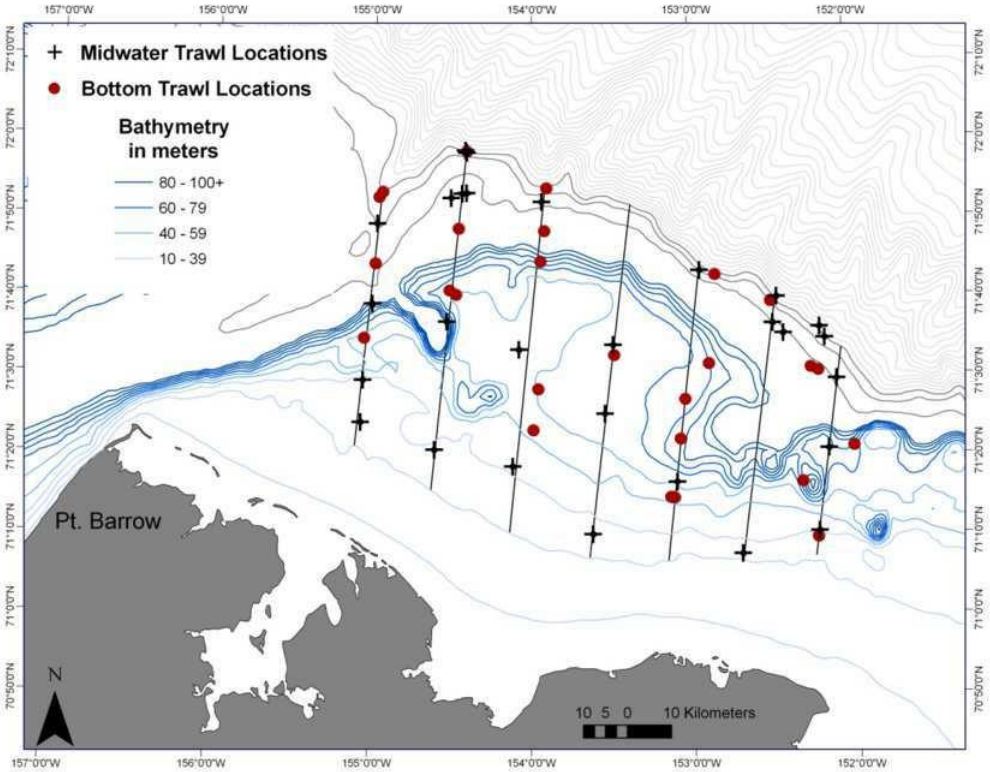
Bering flounder

Pacific cod

Walleye pollock

Bigeye sculpin

Salmon snailfish



Rand, K.M., Logerwell, E.A. 2010. The first demersal trawl survey of benthic fish and invertebrates in the Beaufort Sea since the late 1970s. Polar Biology DOI 10.1007/s00300-010-0900-2

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Brittle stars and Arctic cod were dominant

In general, 3 species are abundant in the Chukchi and Beaufort Seas: snow crab, Arctic cod and saffron cod (Arctic FMP)

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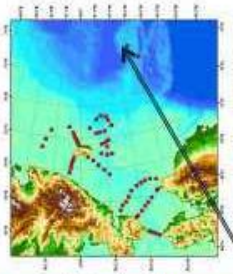
RUSALCA

Related physical and biological sampling

Impacts: Probable Migration of Fish Northward

Surveys west to the East Siberian Sea and North to 77°30



Principal Investigators

Natalia Chernova, Daria Petrova, Catherine Mecklenburg, Brenda Holladay, Christine Gleason, Morgan Busby, Brenda Norcross

25 stations.
The most northerly trawl ever taken in the Pacific Arctic region.
22 species were collected; many species are rare to science.

14 additional Species were collected during RUSALCA 2009

Photos courtesy of Dan Torres

http://www.unols.org/meetings/2010/201004aic/201004aic_ap6.pdf

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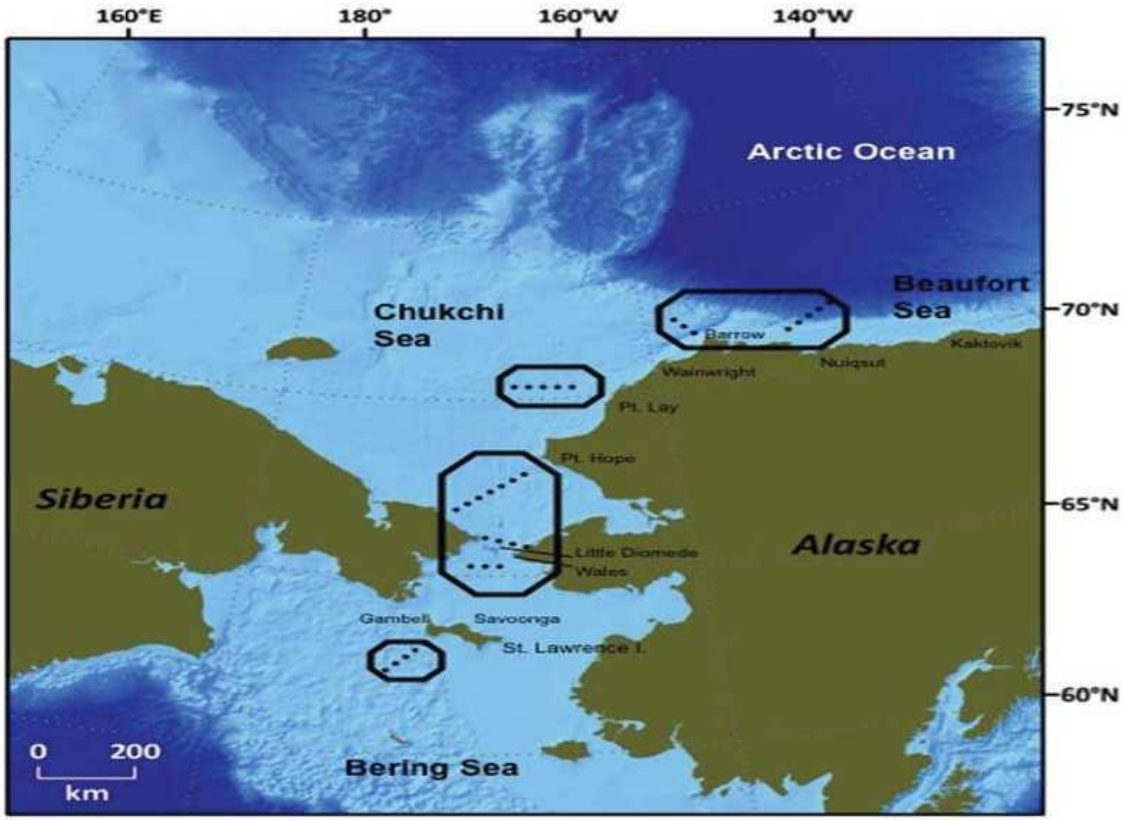
Distributed Biological Observatory

Related physical and biological sampling



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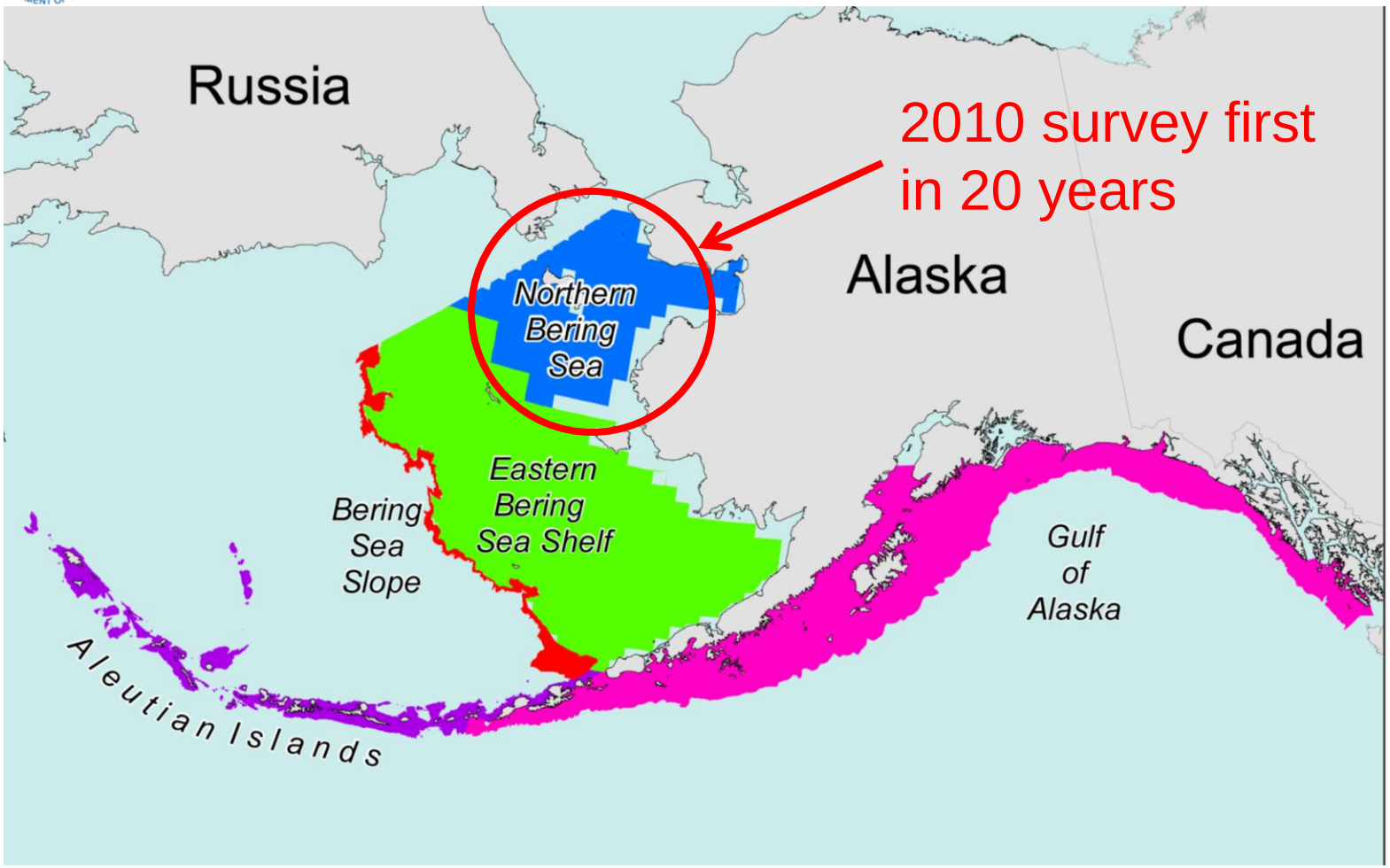
Loss of Sea Ice Program: Standard NOAA surveys



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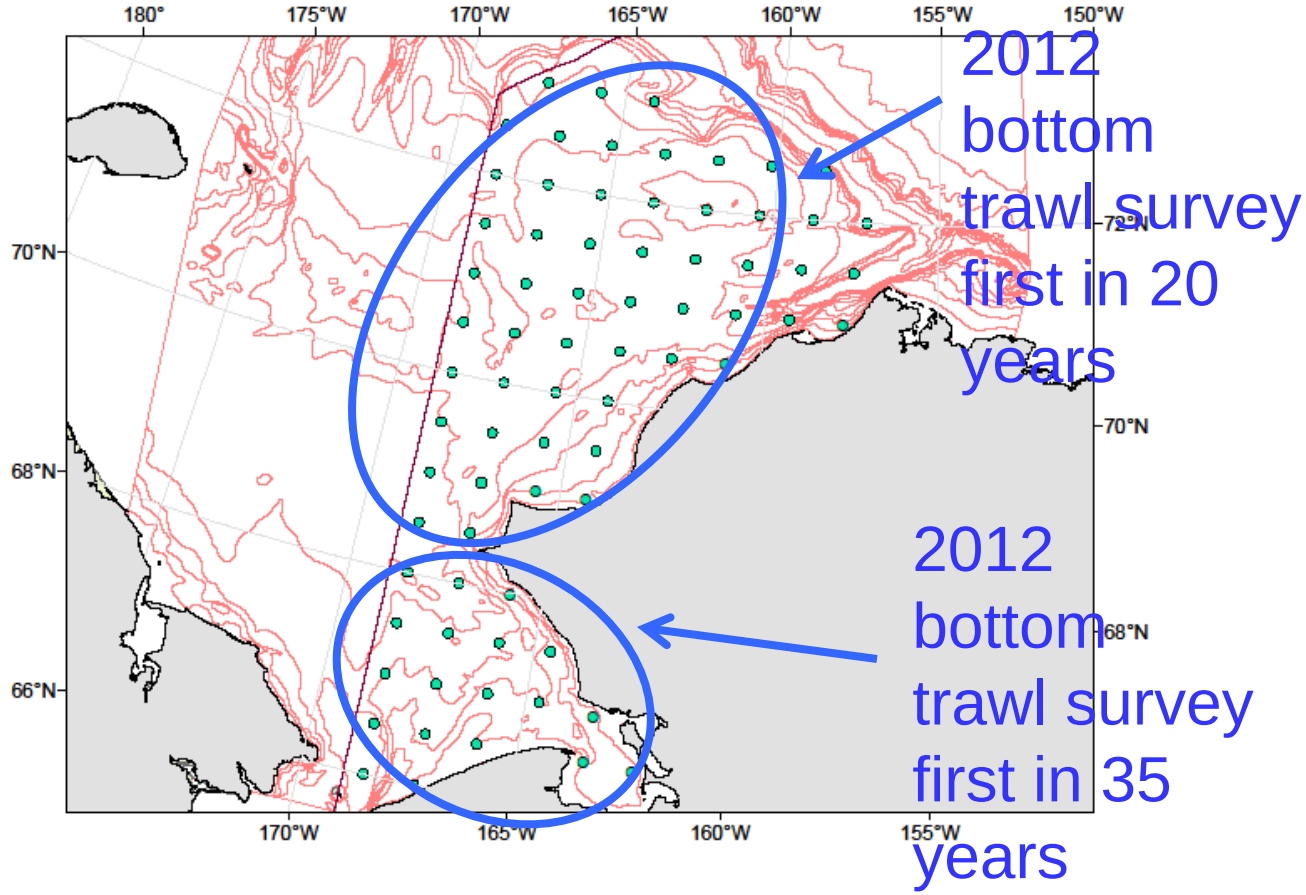
Loss of Sea Ice Program
Standard NOAA surveys

- Planned 2012
- Bottom trawl
- Acoustics
- Surface trawl
- Physical and biological oceanography



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NOAA Policies on Arctic Fishing

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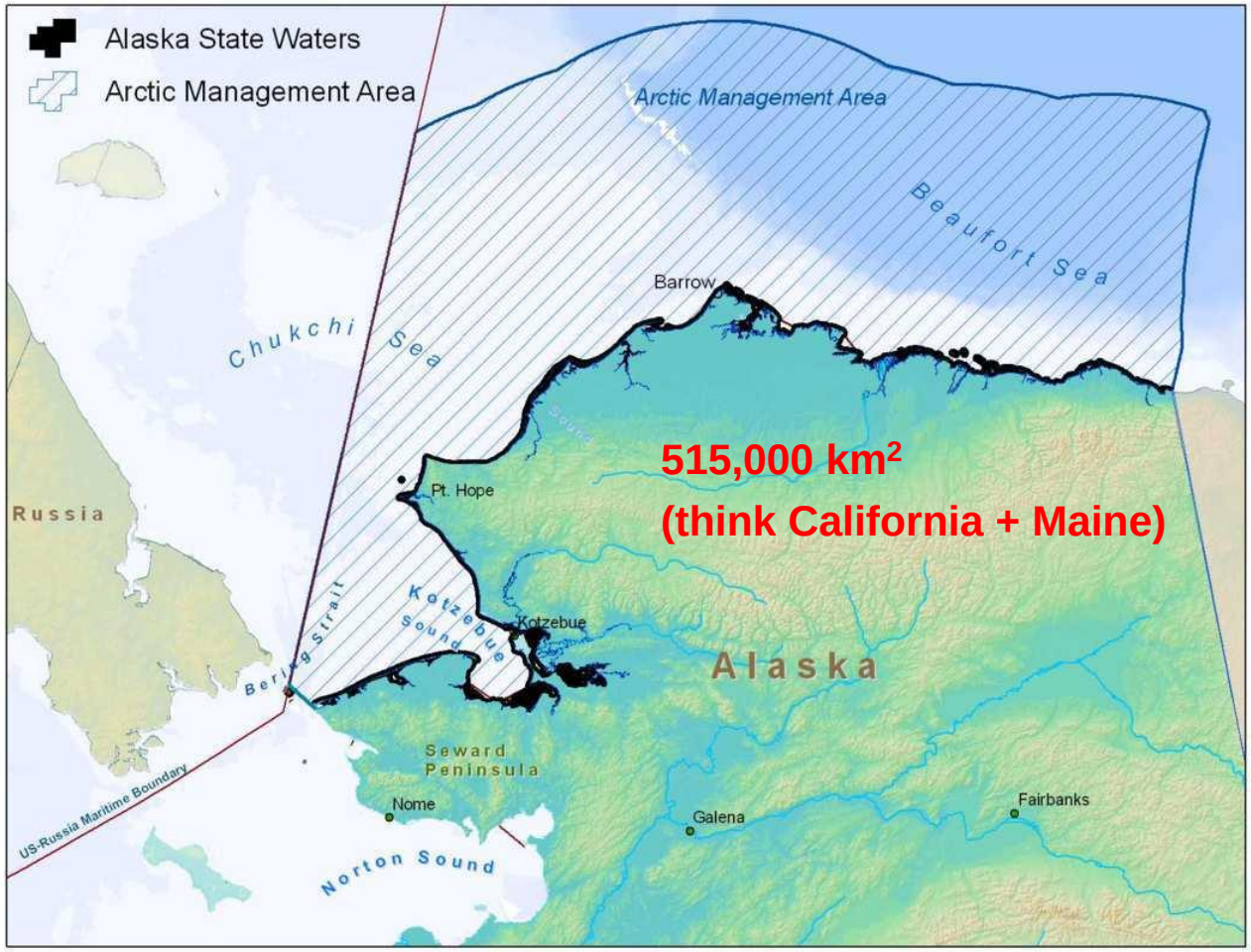
Arctic Fishery Management Plan

- Closes Arctic Management Area to commercial fishing
- Public comment period and Secretarial review



Per NPFMC final action in February 2009

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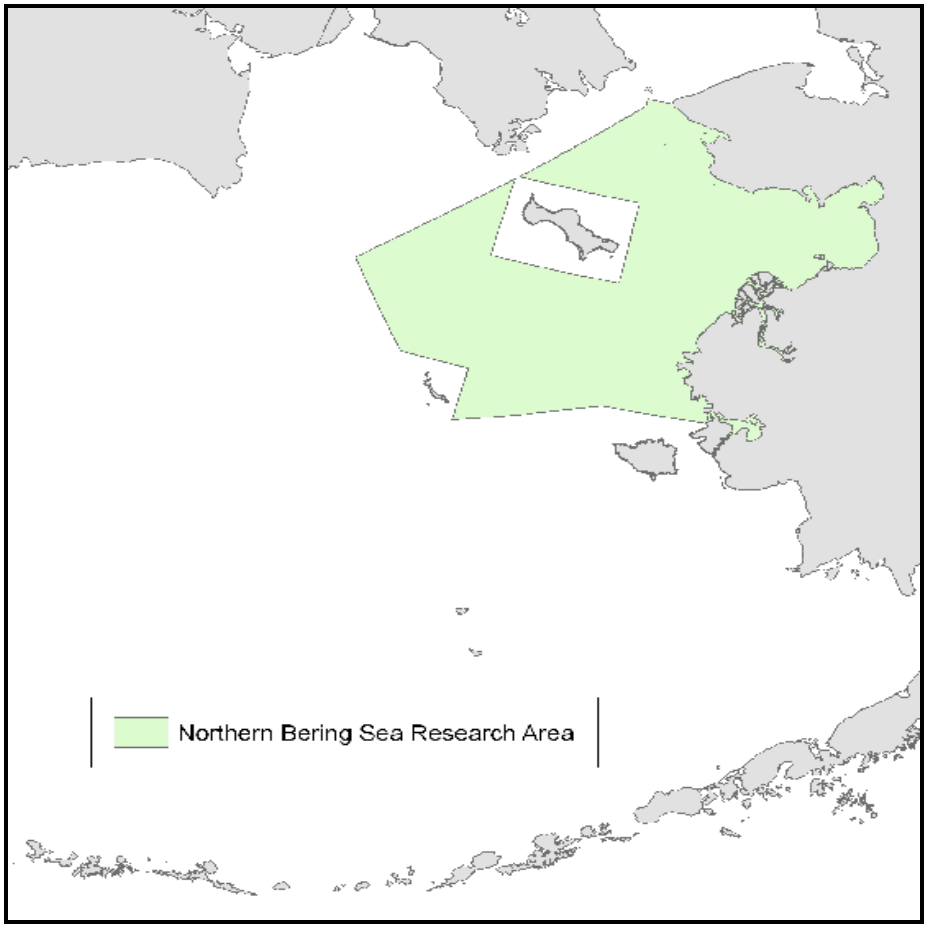
Northern Bering Sea Research Area

Closed to bottom trawling until research conducted and a plan developed to manage fishing in the area, including appropriate protection measures



Per NPFMC final action in June 2007
Effective August 25, 2008 (73 FR 43362)

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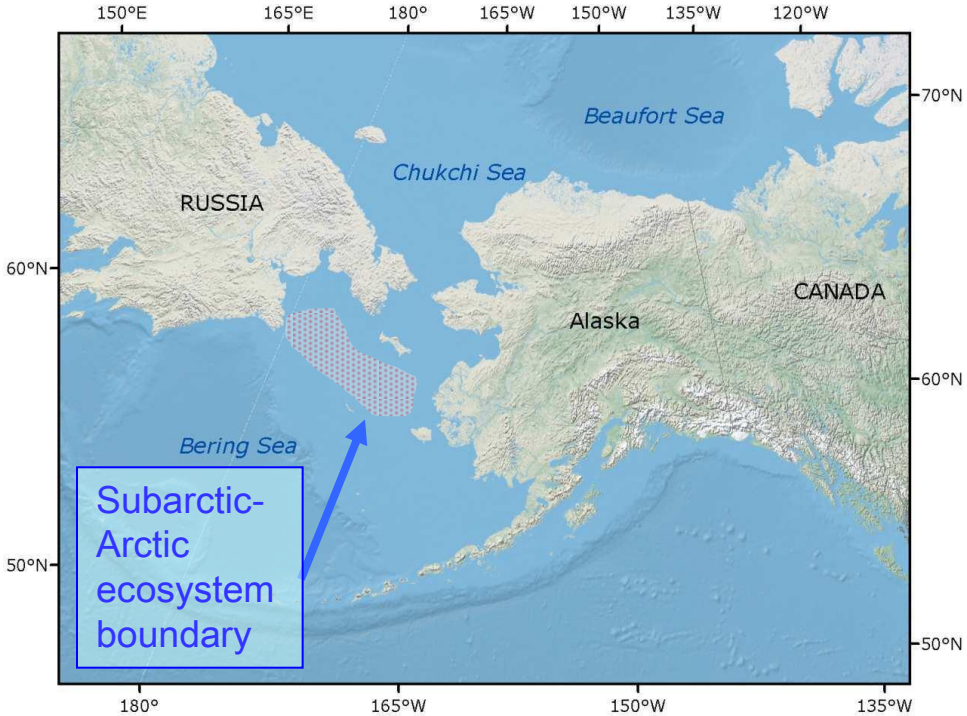
Summary



- The Bering Sea cold pool likely will remain as a barrier for northward shift of abundant southeastern Bering Sea bottom fish populations
- Periodic standard surveys of the northern Bering, Chukchi and Beaufort Seas are necessary for monitoring Arctic change