The Potential Impact of Loss of Sea Ice on Alaska's Arctic Marine Ecosystems

NOAA FISHERIES

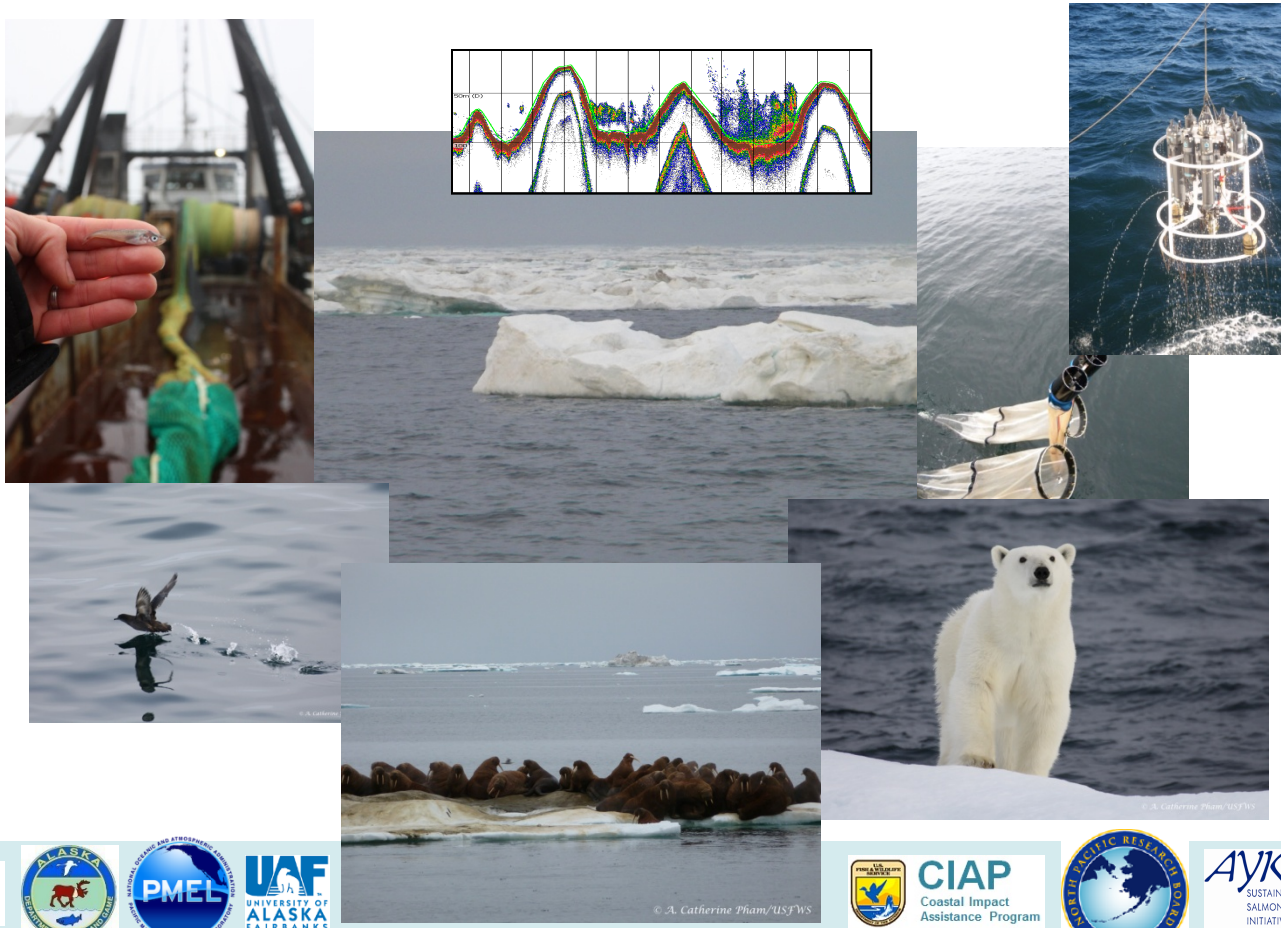
Lisa Eisner

and Ed Farley

Alaska Fisheries Science Center

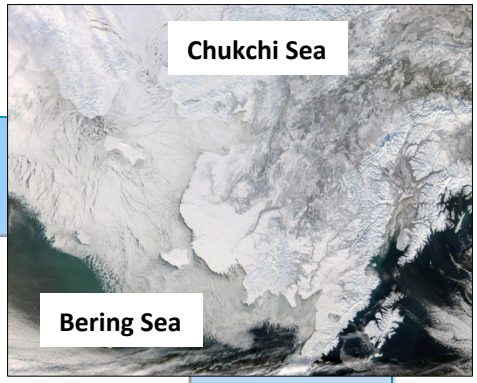
Auke Bay Laboratories

Juneau, Alaska



NOAA FISHERIES BOEM PMEL UAF CIAP Coastal Impact Assistance Program AYK SUSTAINABLE SALMON INITIATIVE

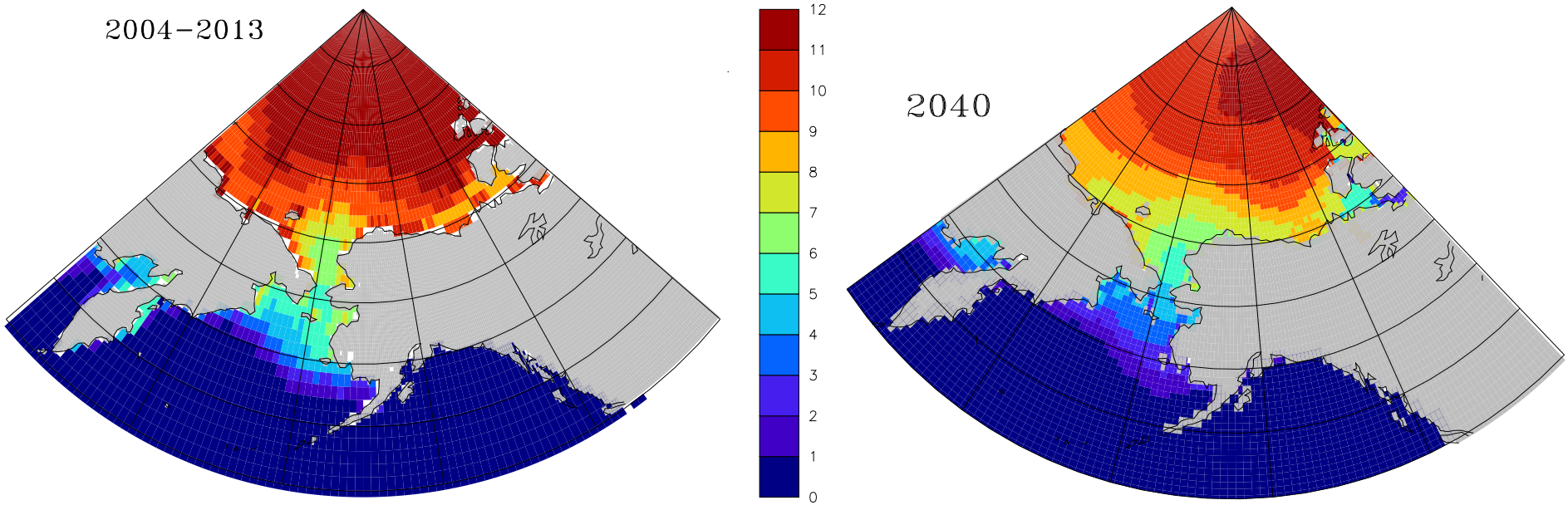
Sea Ice Change



Figures courtesy of National Snow and Ice Data Center

Future Sea Ice Duration in Alaska Arctic

Still have a winter wall of freezing temperatures



# of months sea ice

Observations (72 N)

3 months Open Water Now

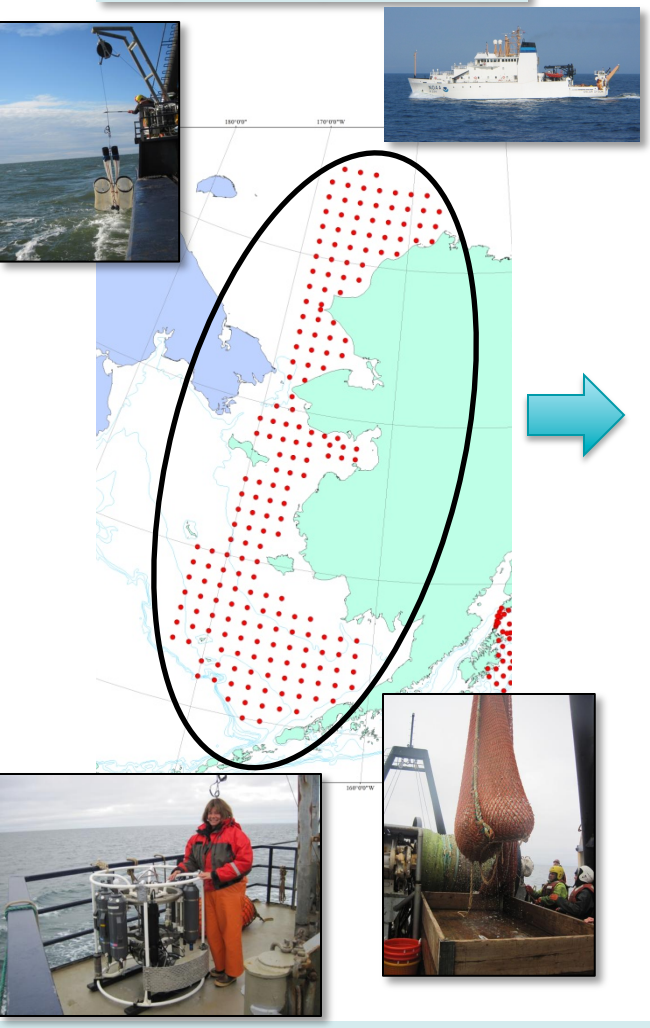
Ensemble mean of 12 CMIP5 models

5 months Open Water by 2040

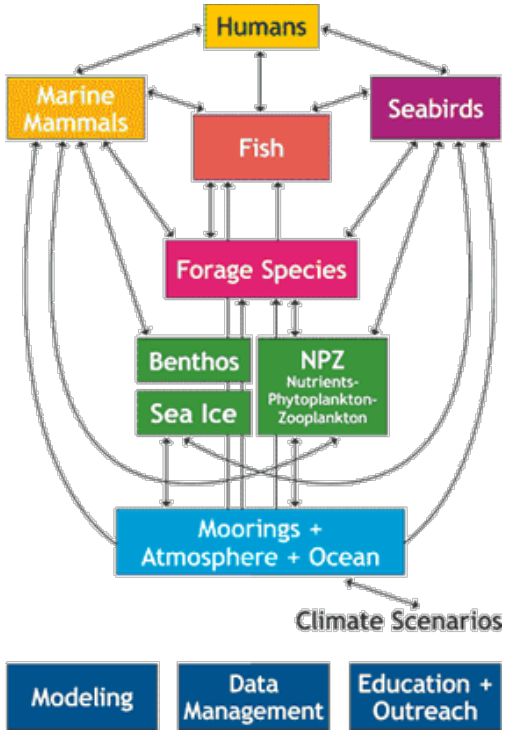
Wang and Overland, 2015

Integrated Ecosystem Research to improve IEA for Integrated Ecosystem Management

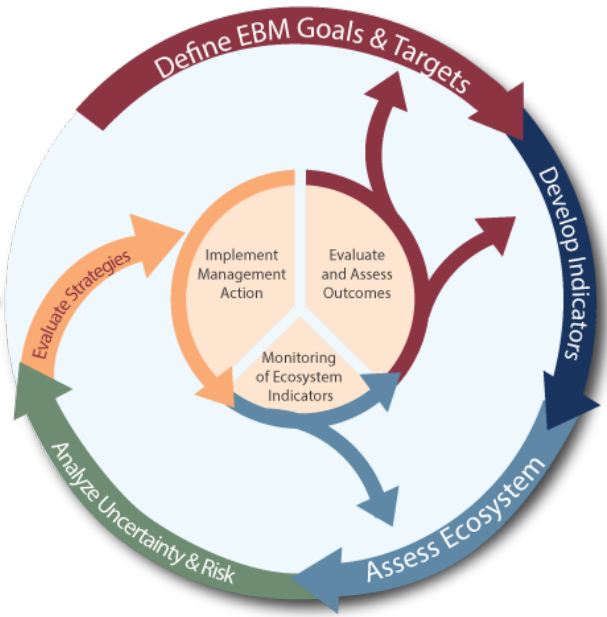
Integrated Ecosystem Surveys



Integrated Ecosystem Models

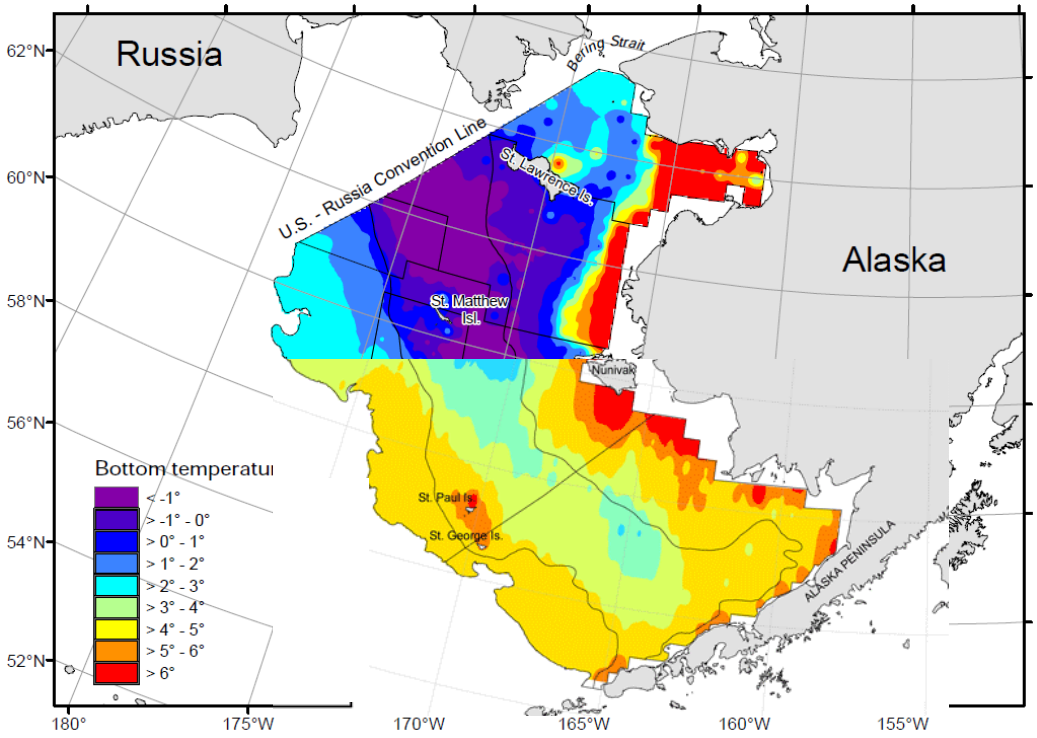


Integrated Ecosystem Assessments

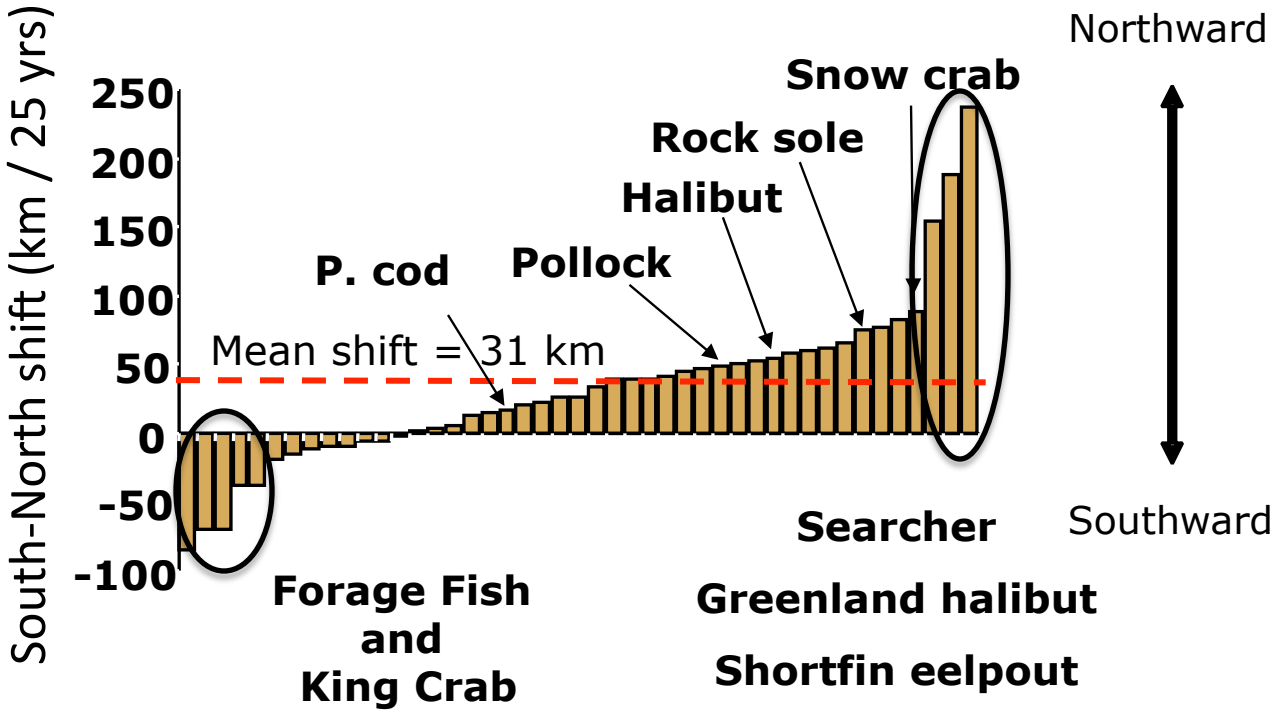


http://www.noaa.gov/iea/next-gen-tool.html

Will fish move north with loss of sea ice?



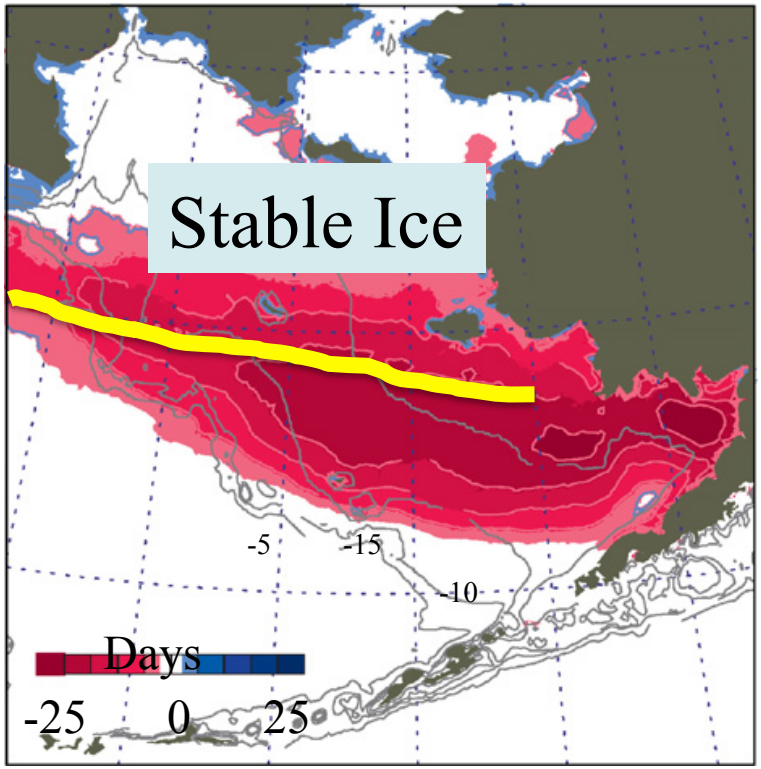
North-South Shifts in Species Distributions (Adult Fish) within the Southeastern Bering Sea from 1982 to 2006



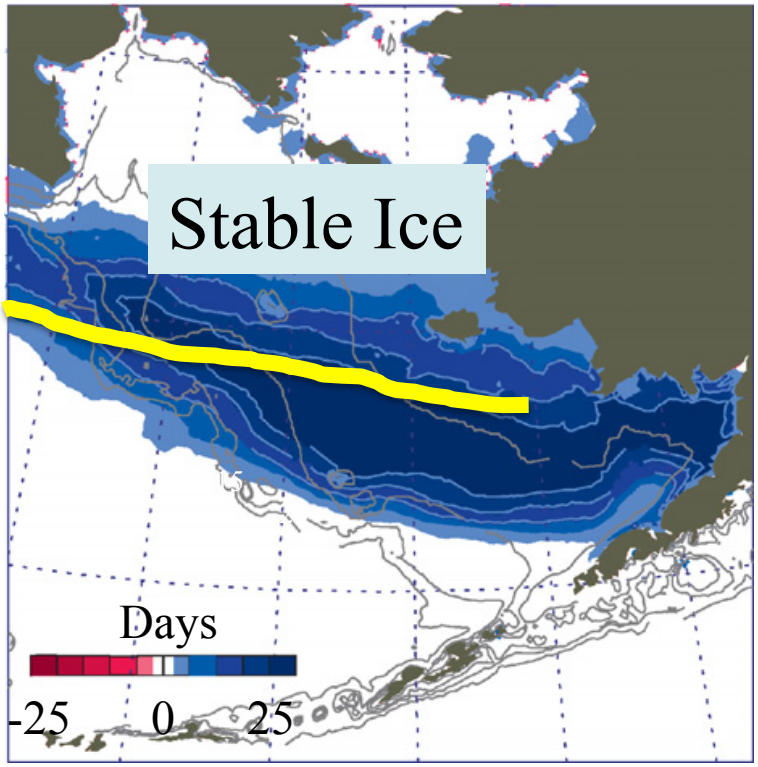
Mueter, F.J., and M.A. Litzow. 2008. Sea ice retreat alters the biogeography of the eastern Bering Sea continental shelf. Ecol. Appl. 18(2).

Future Ocean Conditions: The North Will Remain Cold and Dark

Warm years (2001-2005)



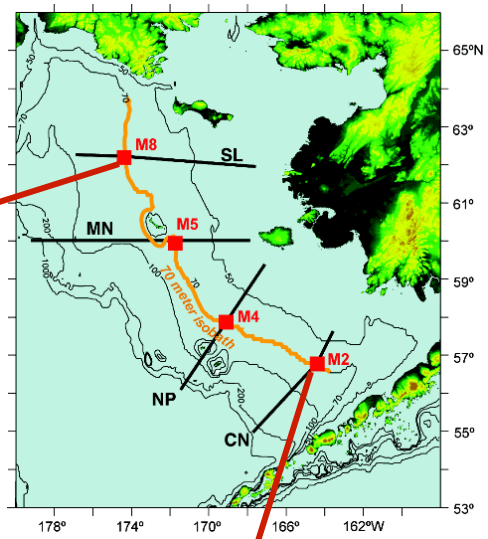
Cold years (2007-2010)



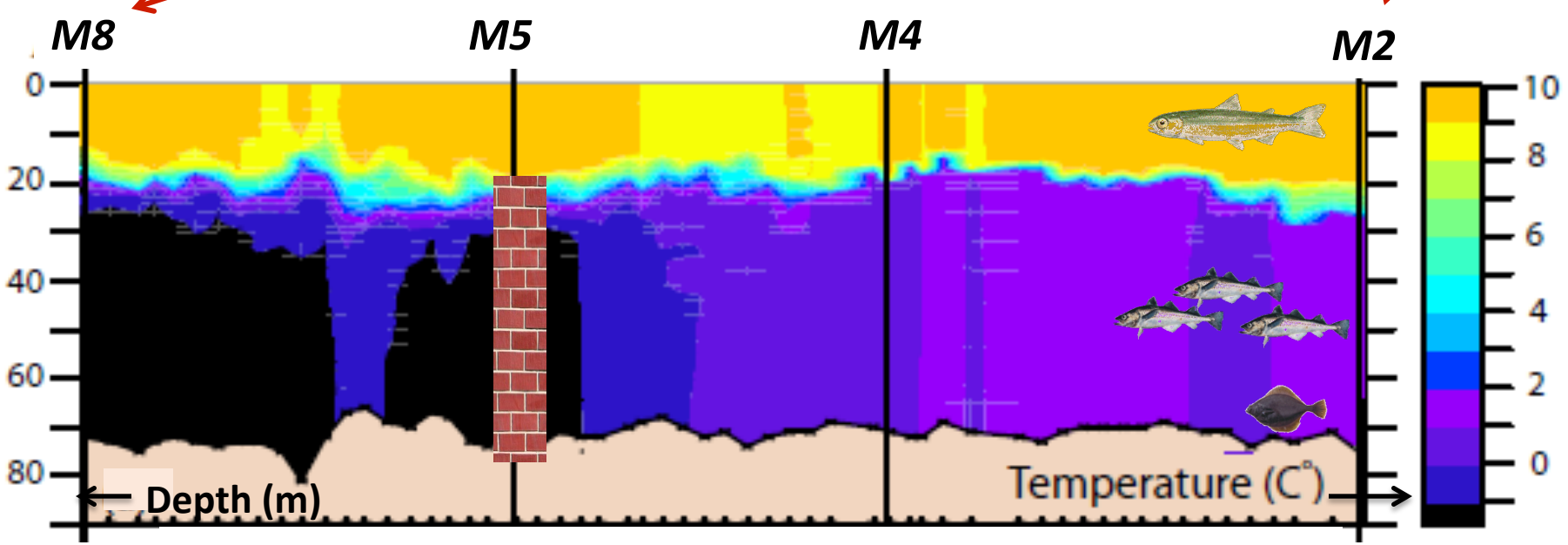
Anomalies of sea-ice coverage during March and April

Stabeno, P.J., E.V. Farley, Jr., N.B. Kachel, S. Moore, C. Mordy, J. Napp, J. Overland, A. Pinchuk, and M. Sigler. 2012. A comparison of the physics of the northern and southern shelves of the eastern Bering Sea and some implications for the ecosystem. Deep Sea Res. II 65-70:14-30.

What is the Potential for Other Fish Species to Move North?

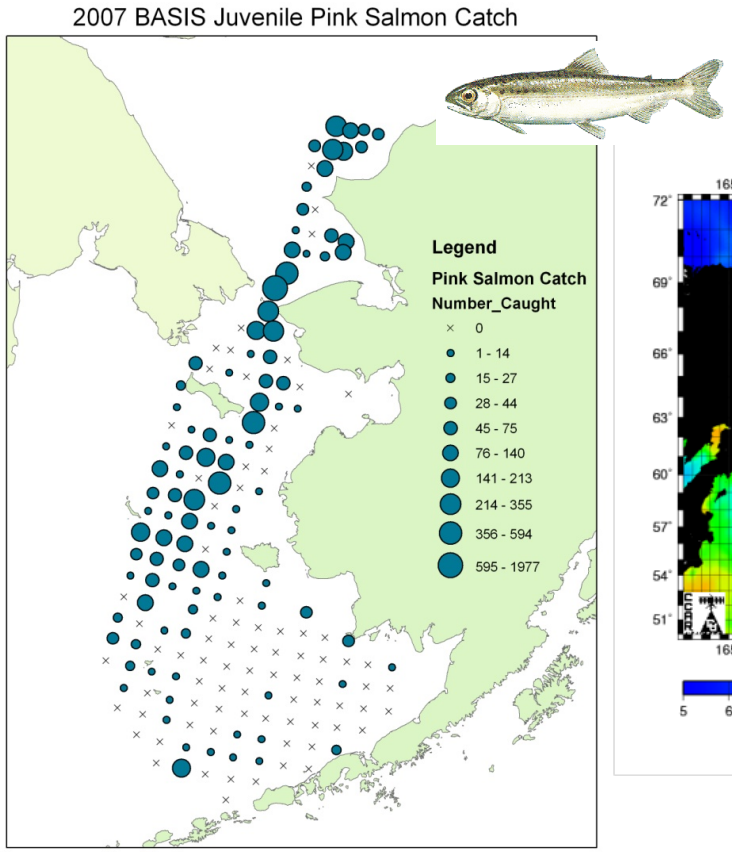


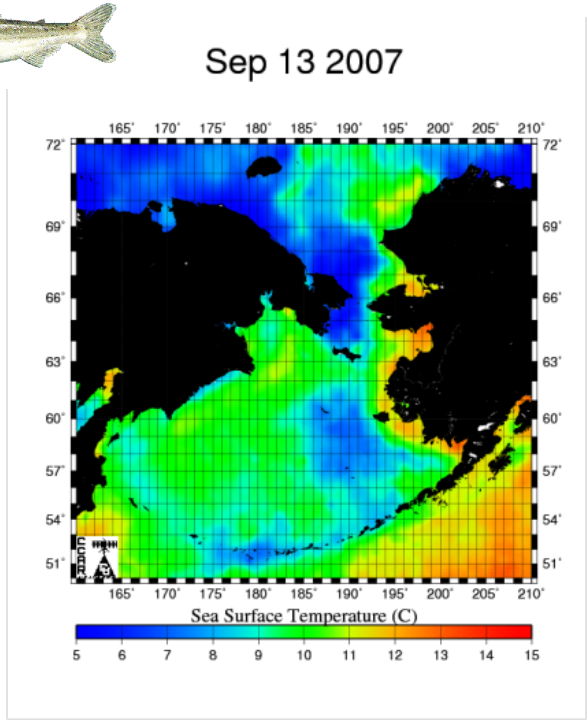
01 – 05 September 2008



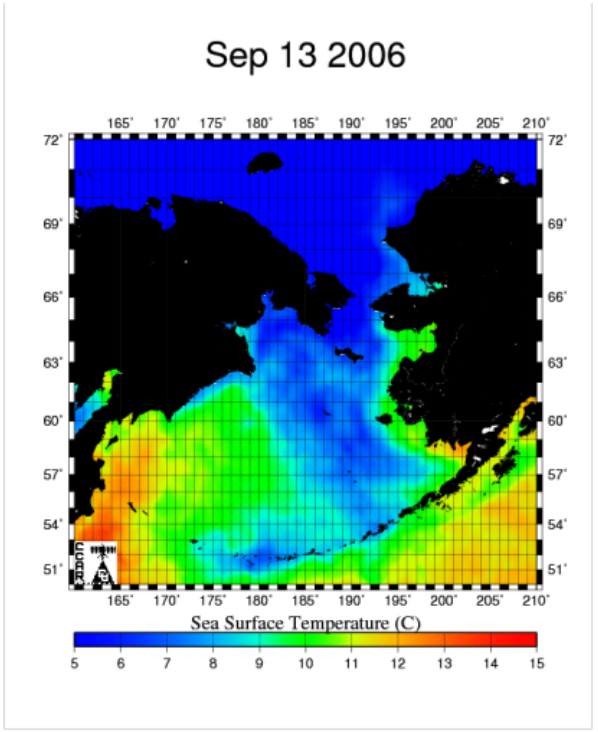
Stabeno, P.J., E.V. Farley, Jr., N.B. Kachel, S. Moore, C. Mordy, J. Napp, J. Overland, A. Pinchuk, and M. Sigler. 2012. A comparison of the physics of the northern and southern shelves of the eastern Bering Sea and some implications for the ecosystem. Deep Sea Res. II 65-70:14-30.

Juvenile Salmon Move North
(Sept. 2007)





Warm Year

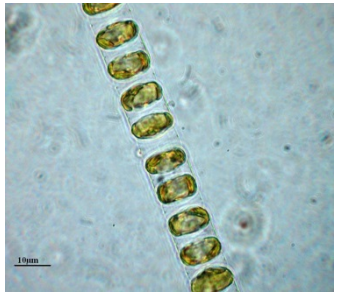


Cold Year

Moore, S.E., L. Logerwell, L. Eisner, E.V. Farley, Jr., L.A. Harwood, K. Kuletz, J. Lovvorn, J.R. Murphy, and L.T. Quakenbush. 2014. Marine fishes, birds, and mammals as sentinels of ecosystem variability and reorganization in the Pacific Arctic Region. Pages 337-392, In. J.M. Grebmeier and W. Maslowski eds. The Pacific Arctic Region, ecosystem status and trends in a rapidly changing environment.

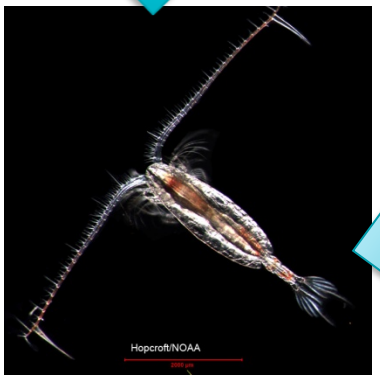
.

In the Arctic (Chukchi), It's Survival of the **Fattest**



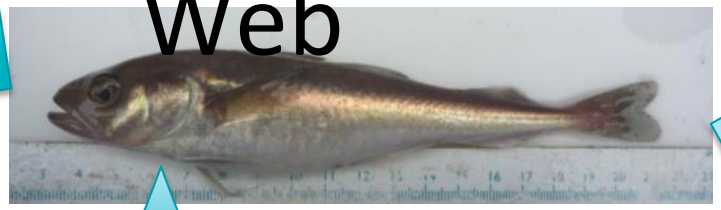
Phytoplankton

Polar Bear



Zooplankton

Food Web

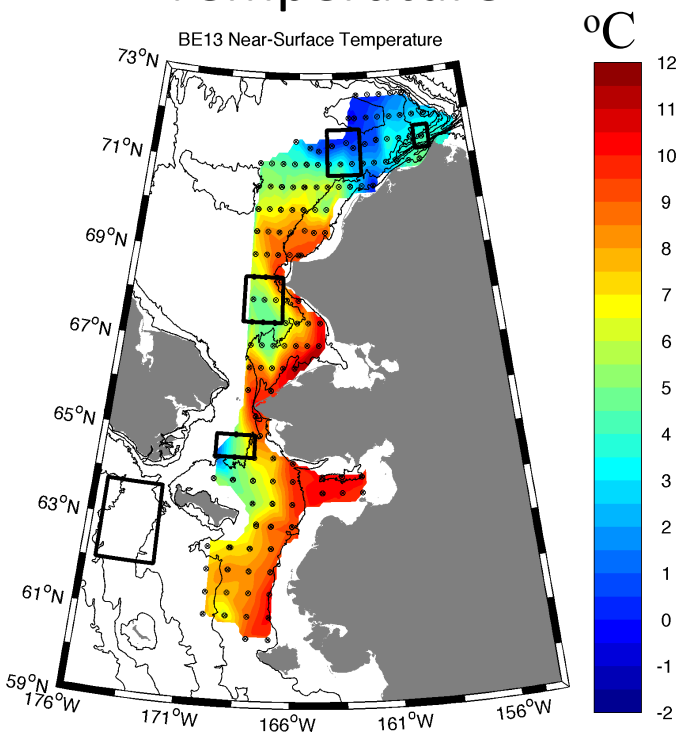


Arctic cod

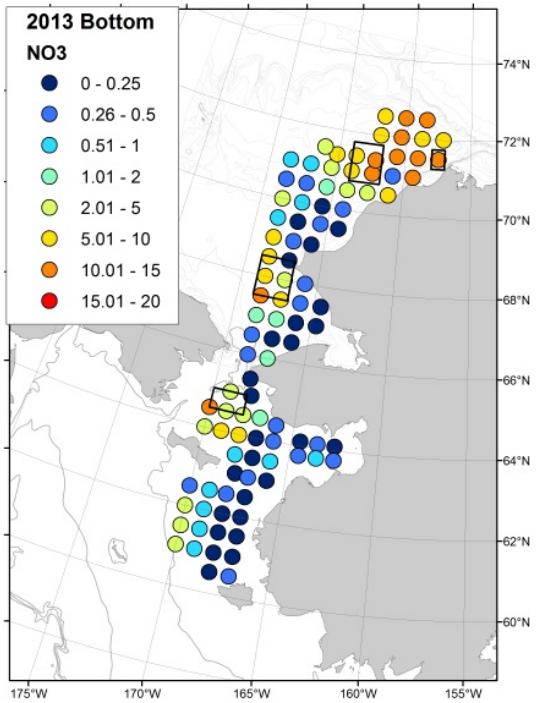
Ice seals

Chukchi Sea Oceanographic Data: Aug-Sept 2013

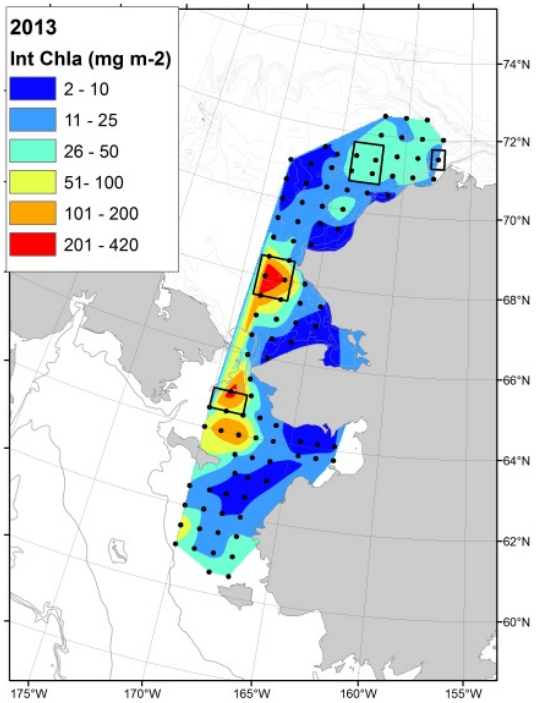
Surface Temperature



Nutrients (Nitrate)



Phytoplankton (Chlorophyll *a*)



Data are from the Arctic Ecosystem Integrated Survey - see https://web.sfos.uaf.edu/wordpress/arcticeis/

Chukchi Sea Zooplankton Data: Aug-Sept 2013

Pacific species will increase, Arctic species will decrease with warming?

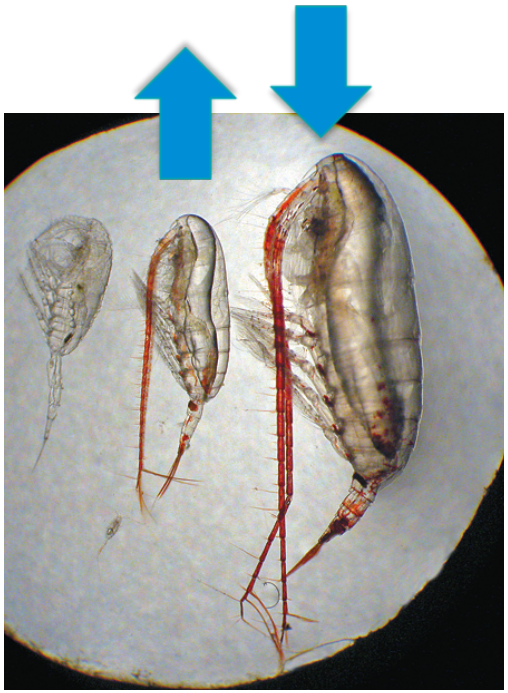
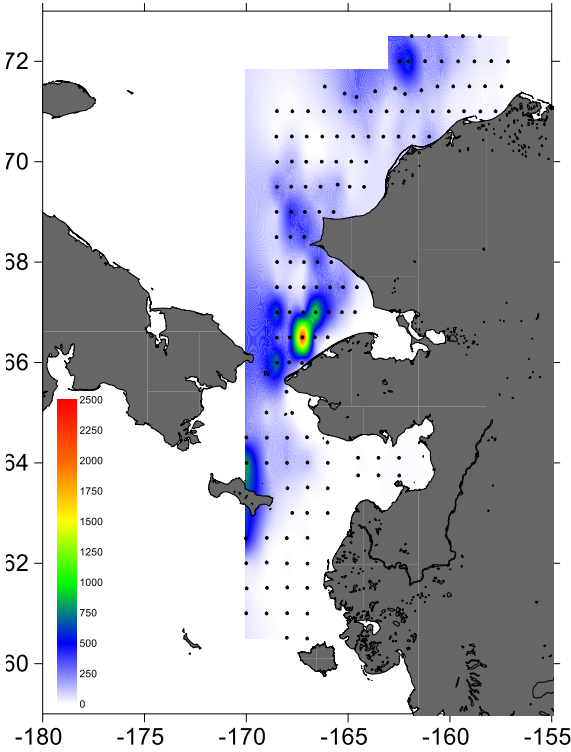
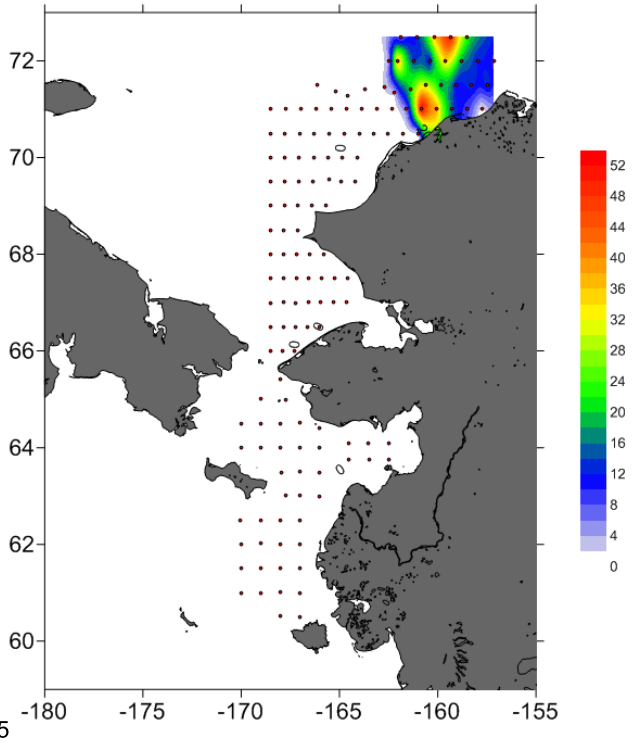


Photo by Carin Ashjian, Woods Hole Oceanographic Institution

Pacific Species
Calanus glacialis



Arctic Species
Calanus hyperboreus

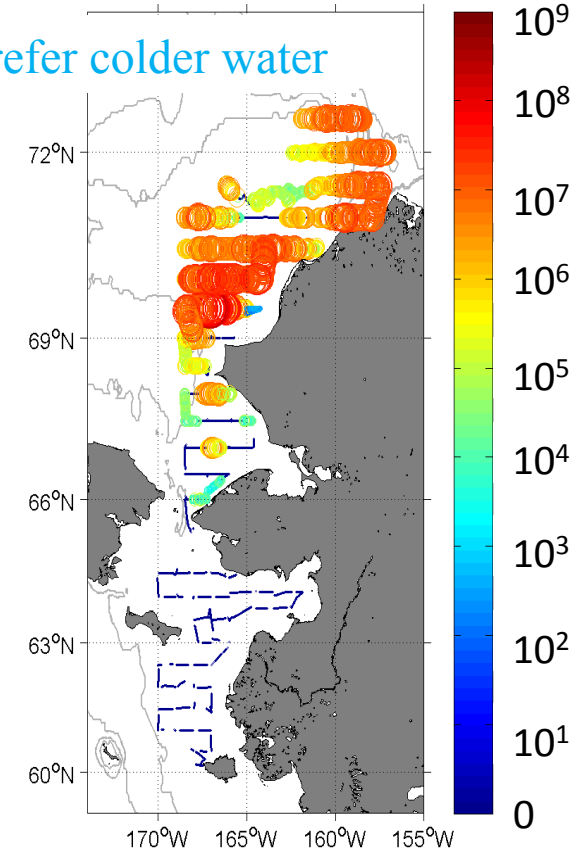


Data are from the Arctic Ecosystem Integrated Survey - see https://web.sfos.uaf.edu/wordpress/arcticeis/

Summer Distribution and Abundance of Young Arctic and Saffron Cod

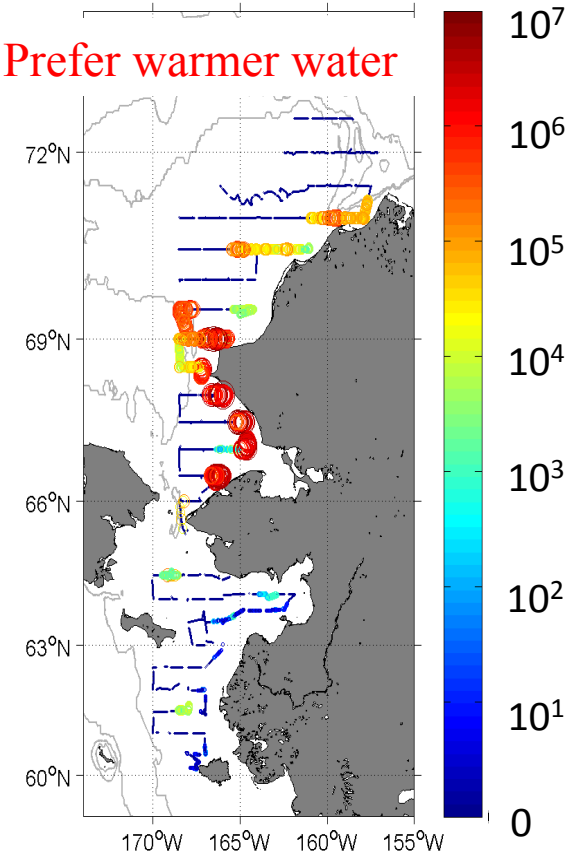
Arctic cod
(total ~ 3 x 10^{11} fish)

Prefer colder water

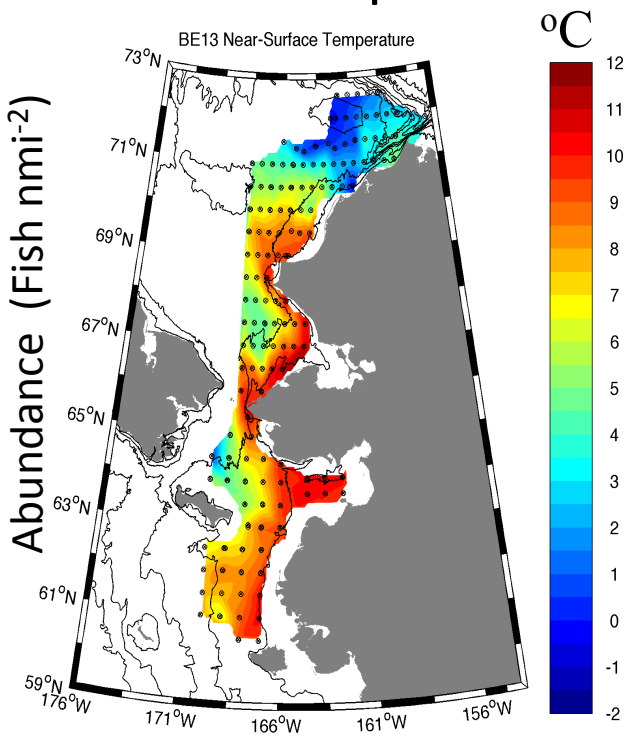


Saffron cod
(total ~ 7 x 10^9 fish)

Prefer warmer water

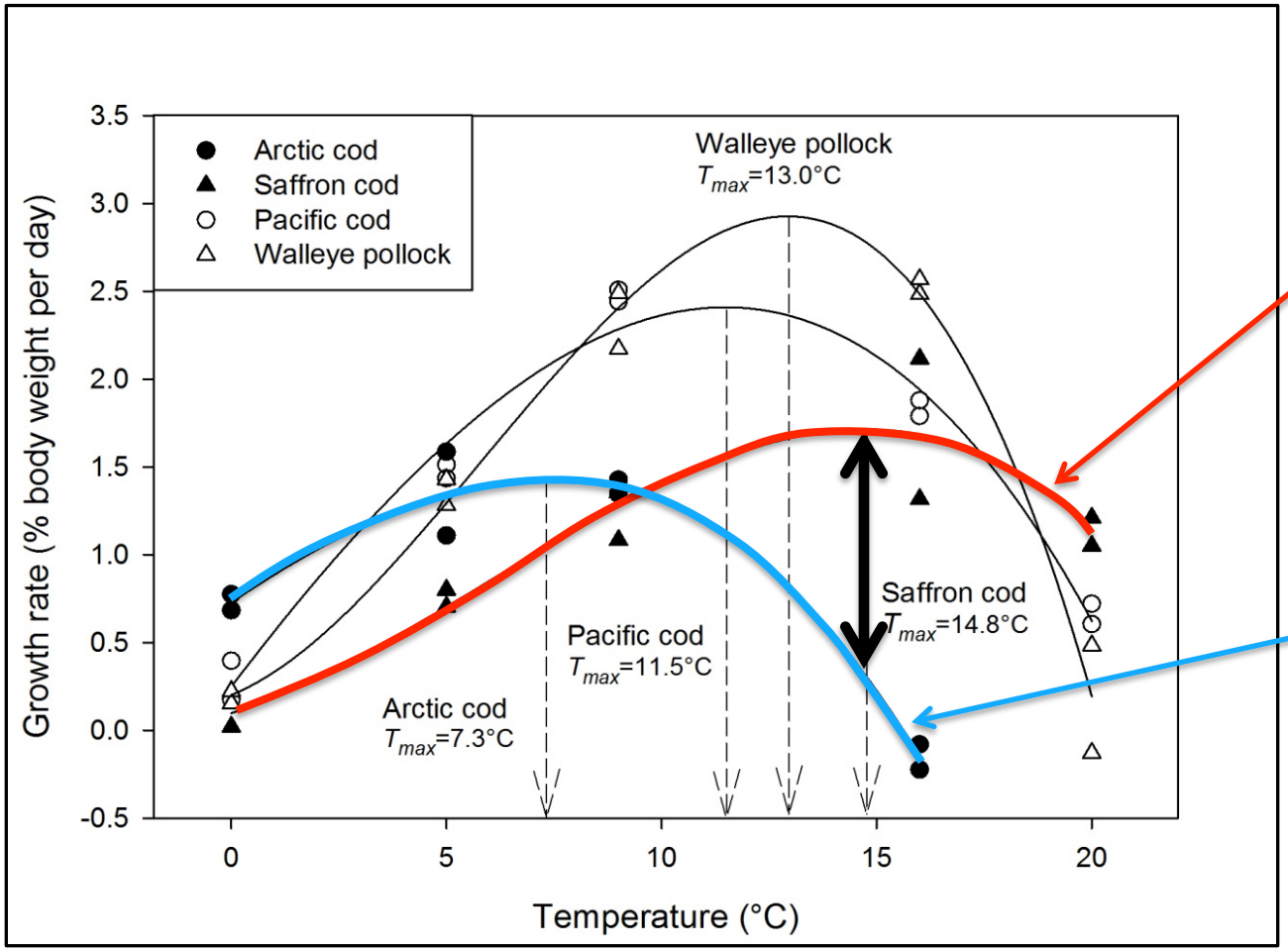


Surface Temperature



Data are from the Arctic Ecosystem Integrated Survey - see https://web.sfos.uaf.edu/wordpress/arcticeis/

Growth Response in Relation to Temperature

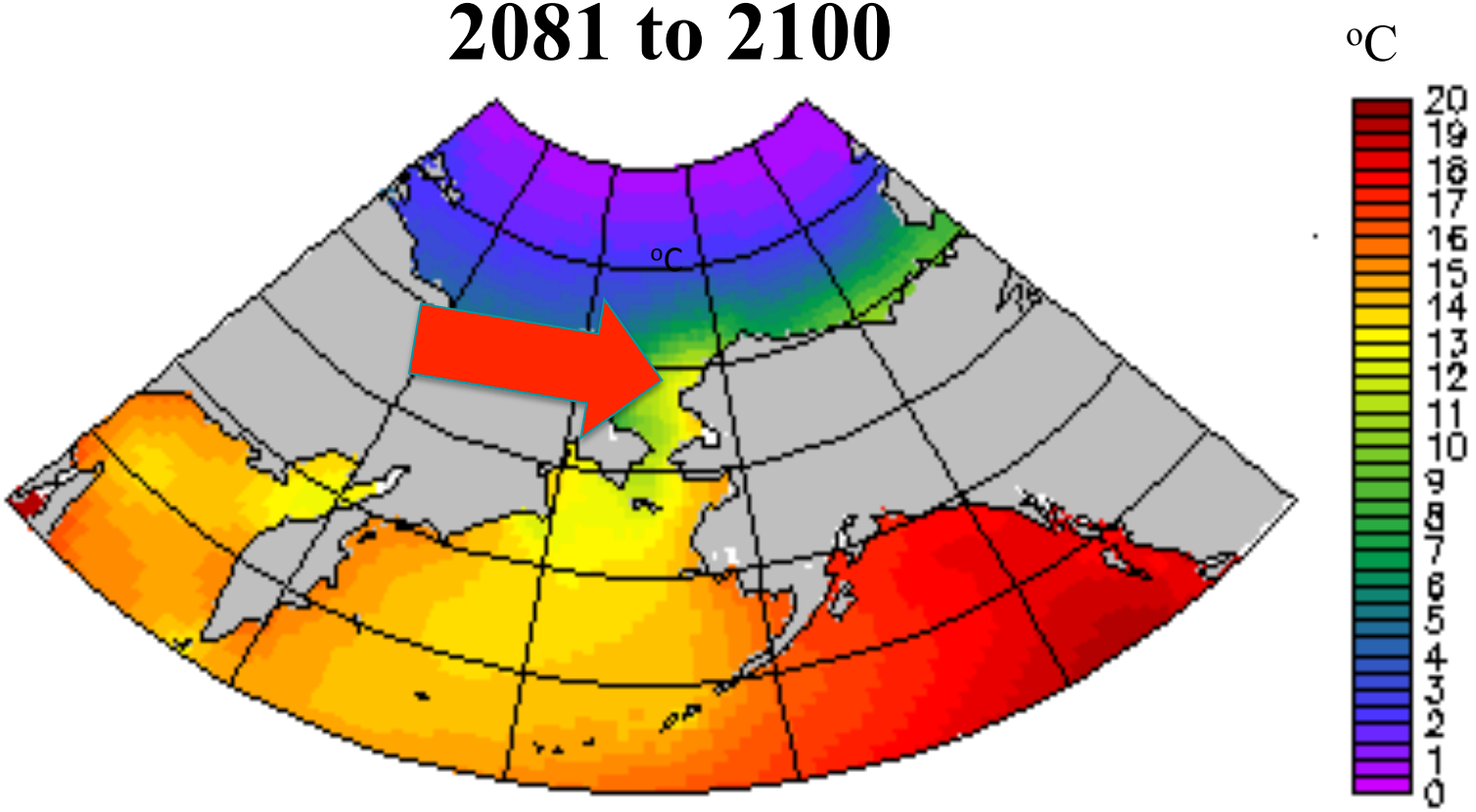


Saffron cod

Arctic cod

Ben Laurel, Accepted

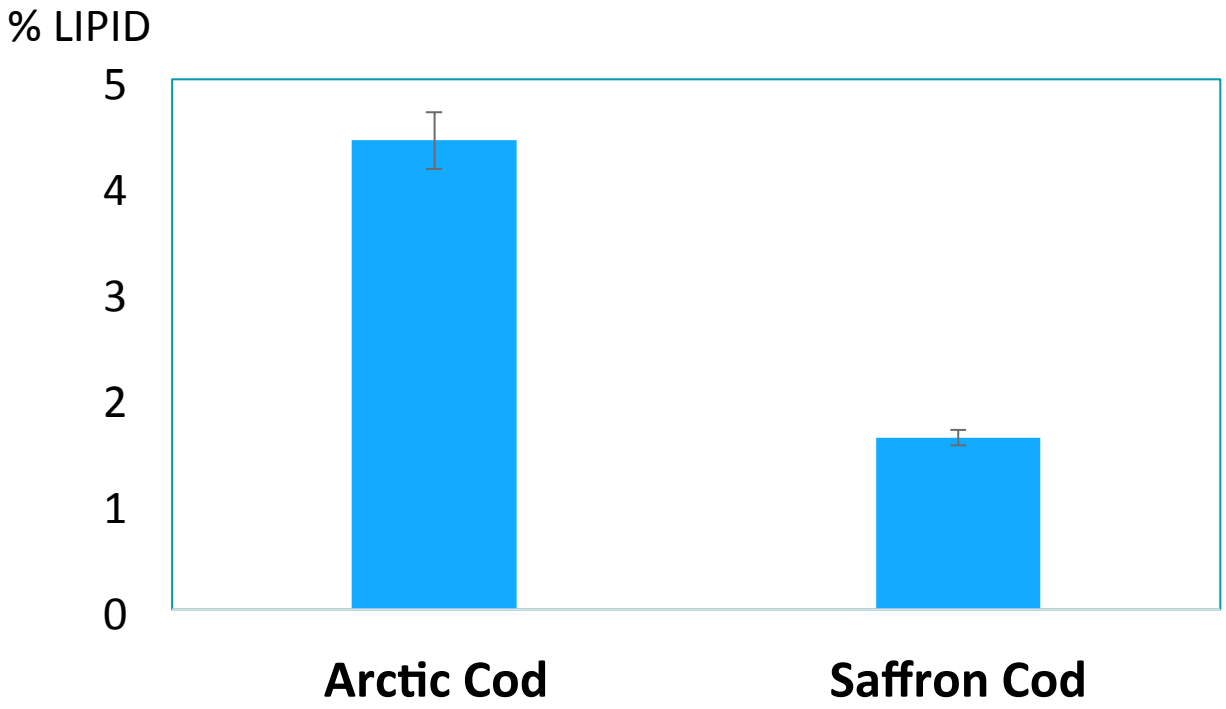
Summer Sea Surface Temperature Model Projections 2081 to 2100



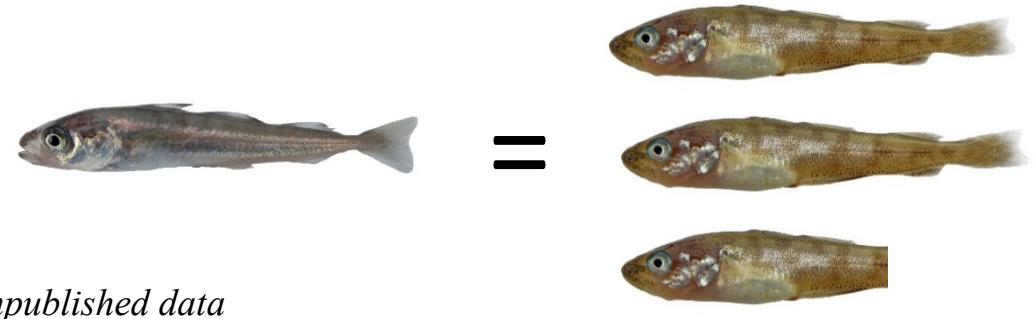
Water will be too warm for Arctic Cod?

Courtesy of Muyin Wang, Pacific Marine Environmental Laboratory, Seattle, WA

Fat Content of Cods



Predators must consume 2.7x the Saffron Cod to get the same lipid as 1 Arctic Cod



Heintz & Vollenweider Unpublished data

Conclusions

Groundfish in the eastern Bering Sea will not move northward; however Pacific salmon abundance will increase in the US Arctic

Reduced sea ice extent and duration in Alaska's Arctic and Subarctic ecosystems will limit the available **HIGH FAT** prey that Fish and Mammals require for good health and survival.

This has the potential of affecting some of the most important commercial fisheries in Alaska and could impact marine mammal populations in the Arctic that Alaskans depend on for food.