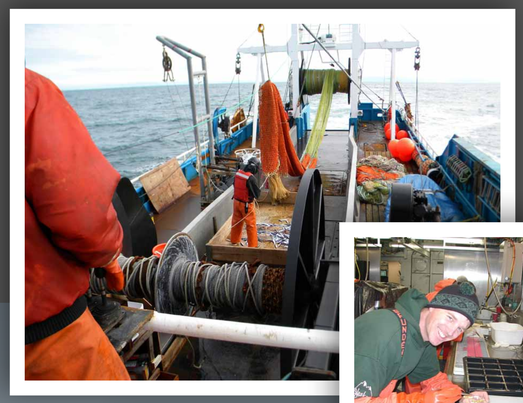
The ups and downs of capelin (*Mallotus villosus*) and Pacific herring (*Clupea pallasii*) in the eastern Bering Sea.

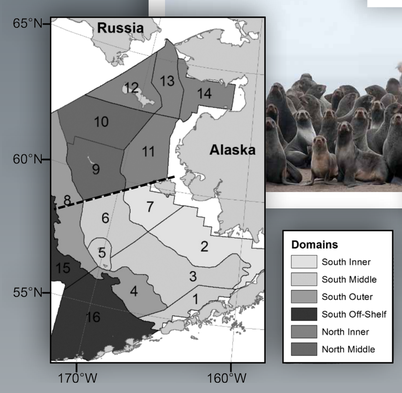
Alexander G. Andrews III[1*], Wesley W. Strasburger[1], Edward V. Farley Jr.[1], James M. Murphy[1], and Kenneth O. Coyle[2]

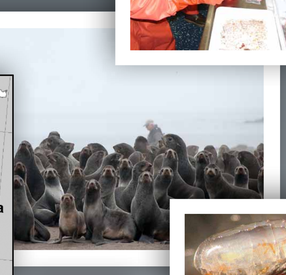
[1] Auke Bay Laboratories, Alaska Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, 17109 Point Lena Loop Road, Juneau, AK 99801, USA
[2] School of Fisheries and Ocean Sciences, University of Alaska, Fairbanks, AK 99775-7220, USA

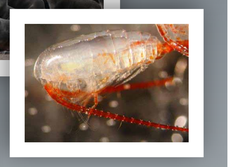
*Corresponding author: tel: +1 907 789-6655; fax: +1 907 789-6408; email: alex.andrews@noaa.gov

NOAA FISHERIES









Introduction

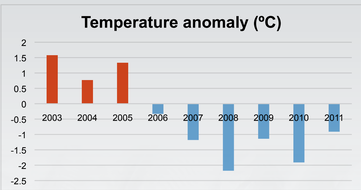
This poster examines how anomalously warm (2003 – 2005) and cold (2006 – 2011) climate conditions have influenced capelin (*Mallotus villosus*) and Pacific herring (*Clupea pallasii*) in the eastern Bering Sea (EBS). Climate warming has impacted the southern extent of sea ice and lead to many changes in ocean conditions and the food web in the region. We explore how these changes have affected two key forage fish species in order to gain insights into the effects of climate change on this commercially important ecosystem. Data on catch per unit effort (CPUE), size, and diet of capelin and Pacific herring were collected from a fisheries oceanographic survey conducted in the (EBS) from mid-August to early October 2003 through 2011.

Methods

Survey/Gear Type: These data were collected during the Bering-Aleutian Salmon International Survey (BASIS) using catches from 30 minute surface tows.

Diets: At each station the contents of 10 stomachs from randomly sampled fish were combined together. Contents were identified to lowest taxon.

Lengths: A random subsample of 25-100 fork lengths (nearest 1.0 mm) were measured at each station when possible.



Key Findings

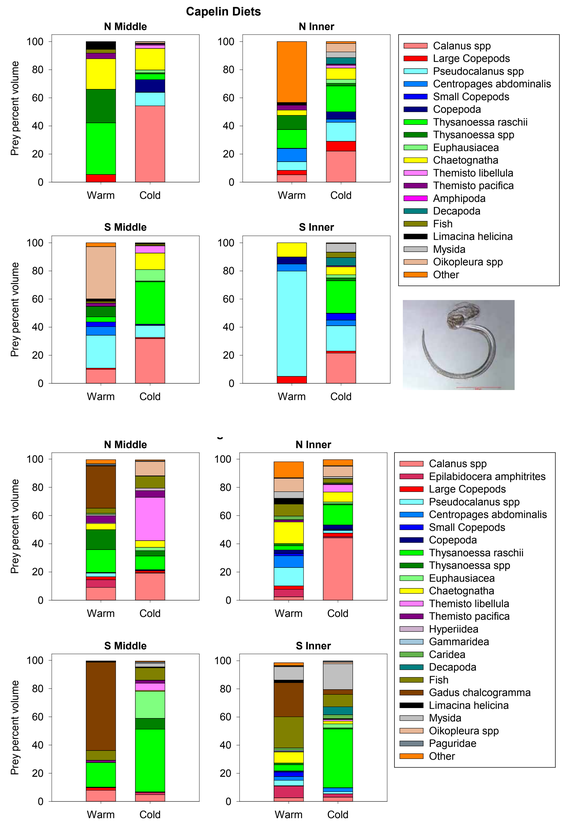


Figure 1. Percent stomach content index (SCI) for prey categories in the diet of capelin (top four bar plots) and herring (bottom four bar plots) within each domain, and during both warm (2003-2005) and cold (2006-2011) climate periods.

Overall, an increase in consumption of large, lipid-rich crustacean prey during Cold years

Capelin diets:

- *Calanus spp.* increased in every domain from Warm to Cold periods, and euphausiids increased in both domains in the South.
- *Pseudocalanus spp.* in higher proportions in the South in Warm years
- *Oikopleura spp.* in higher proportions in the South Middle in Warm years

Herring diets:

- *Calanus* spp. increased in the North from Warm to Cold periods, while euphausiids increased in the South
- Walleye pollock (*Gadus chalcogramma)* in higher proportions in the South in Warm years
- *Themisto libellula* in higher proportions in the North Middle in Cold years

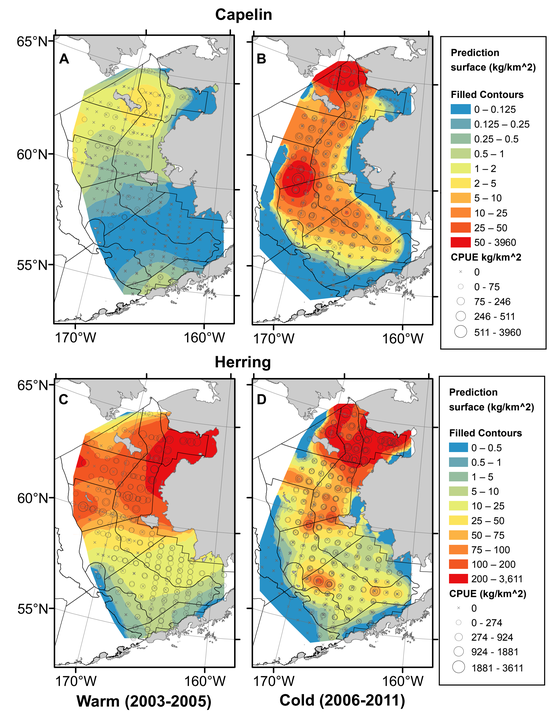


Figure 2. Distribution plots of capelin and herring catch per unit effort (CPUE; kg/km²) during Warm (2003-2005) and Cold (2006-2011) climate periods. Local polynomial interpolation was used to generate shaded contours for visualization. Circles represent magnitude of CPUE at each station that were trawled.

Capelin distribution shifts significantly between climate periods

Highest catches of capelin and herring in the North during, irrespective of climate conditions

Capelin distributions:

- Increased biomass and expanded into the South during Cold years
- Capelin are distributed more equally between Inner and Middle domains except during Cold years where catches were higher in the North Middle domain

Herring distributions:

- Maintained broad distribution and catches remained more stable between climate periods

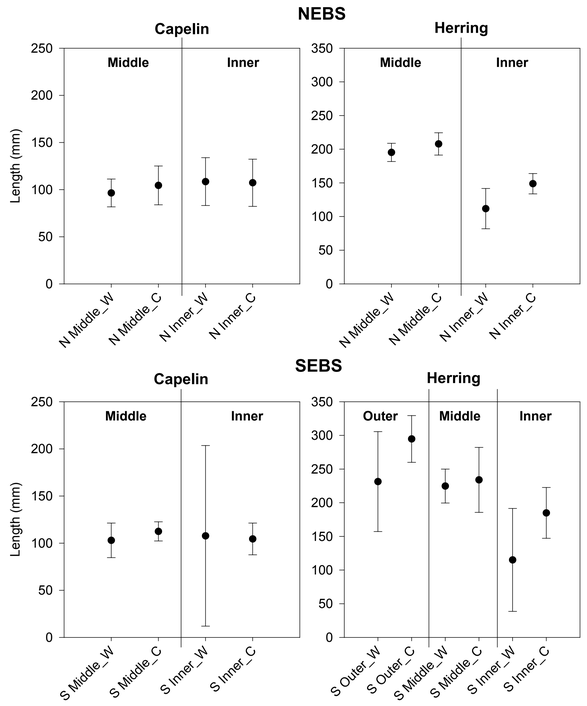


Figure 3. Catch weighted mean lengths for capelin and herring by climate period and domain in the northeastern Bering Sea (NEBS) and the southeastern Bering Sea (SEBS). Warm (2003-2005) and cold (2006-2011) climate periods are differentiated for each domain with W for warm, and C for Cold. Error bars represent 95% confidence intervals.

Herring lengths displayed a pattern of increasing size with distance from shore, while capelin did not

Capelin Lengths:

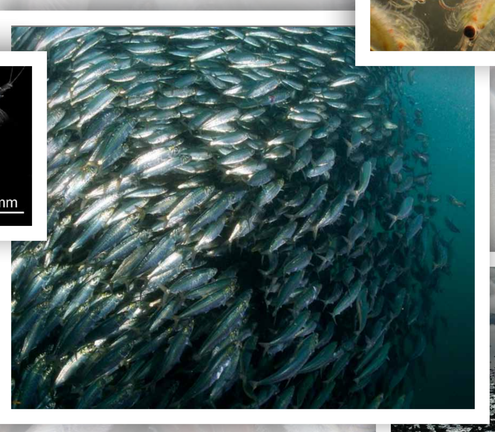
- No difference in size between climate periods
- No difference in size among domains

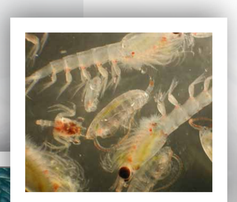
Herring Lengths

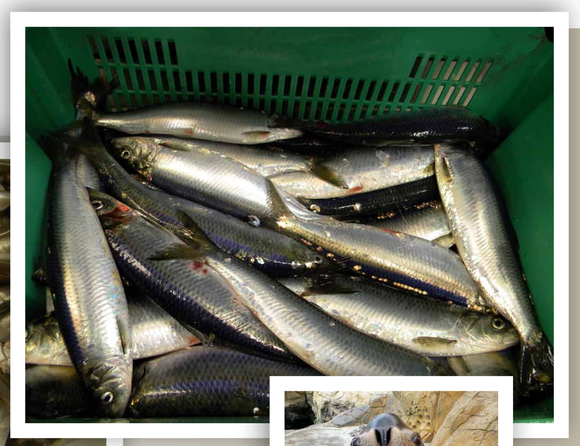
- No difference in size between climate periods
- Conversely to capelin, larger sizes from Inner to Outer domains

Conclusions

- Diets results consistent with other studies in the Bering Sea and reductions of large, lipid rich prey may have negative impacts on over winter survival and recruitment
- Large shifts in the distribution of capelin, a key forage fish in the region, may have implications for upper level predators including sea birds, seals, sea lions, and whales
- Capelin may be the "canary" for climate change in the eastern Bering Sea
- Smaller herring and higher catches in the North Inner domain may indicate an important nursery area for the eastern Bering Sea







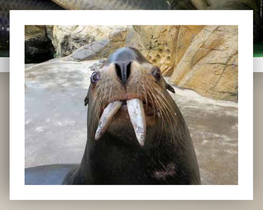


Photo Credits: *Keith Cox (NOAA), Doris Elkhorn (NOAA), Russ Hopcroft (UAF), Brenda Rone (NOAA), Matt Wilson (NOAA), and Dave Withrow (NOAA)*

Acknowledgements

We thank the officers and crew of the NOAA ship *Oscar Dyson* as well as the captains and crews of the following fishing vessels: F/V *Sea Storm*, F/V *Northwest Explorer*, F/V *Epic Explorer*, and F/V *Bristol Explorer*. We also thank the many scientists that assisted with processing and sampling the catch. This project would not have been possible without the expertise of Natalia Kuznetsova (TINRO) and Mary Auburn-Cook for performing on board diet analyses. We greatly appreciate Peter Hulson (AFSC), Dr. Franz Mueter (UAF) and Kathy Mier (AFSC) for their guidance and assistance with some of the statistical analyses. A big thanks also to Rebecca White (AFSC – Communications) for assistance with this poster.

The recommendations and general content presented in this poster do not necessarily represent the views or position of the Department of Commerce, the National Oceanic and Atmospheric Administration, or the National Marine Fisheries Service.

References

Eisner, L.B., Napp, J.M., Mier, K.L., Pinchuk, A.I., Andrews, A.G.III., 2014. Climate-mediated changes in zooplankton community structure for the eastern Bering Sea. Deep-Sea Research II 109, 157-171.

Heintz, R.A., Siddon, E.C., Farley Jr., E.V., Napp, J.M., 2013. Correlation between recruitment and fall condition of age-0 pollock (*Theragra chalcogramma*) from the eastern Bering Sea under varying climate conditions. Deep Sea Research II 94, 150-156.

Rose, G.A., 2005. Capelin (*Mallotus villosus*) distribution and climate: a sea "canary" for marine ecosystem change. Ices Journal of Marine Science 62, 1524-1530.