BEST-BSIERP
Bering Sea PROJECT
UNDERSTANDING ECOSYSTEM PROCESSES IN THE BERING SEA 2007–2013

Climate, Population Dynamics and Predator-Prey Overlap

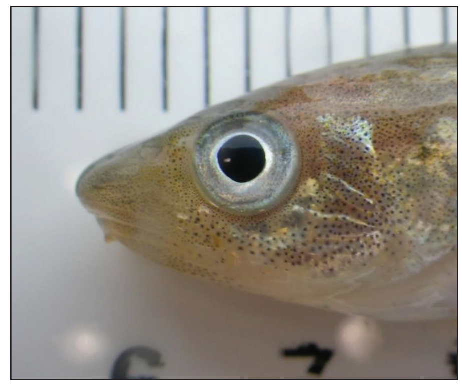
ARROWTOOTH FLOUNDER VS. JUVENILE POLLOCK

Climate- and human-induced changes in marine ecosystems have detectable impacts on the spatial distributions of fishes. However, less is known about how shifts in distributions might alter predator-prey overlap and the dynamics of prey populations. Our study revealed that population size and ocean temperatures have a synergistic effect on the strength of overlap between arrowtooth flounder (predator) and juvenile pollock (prey) in the eastern Bering Sea. Predicted changes in overlap strength occurred largely as a consequence of flounder movement. This result was expected because the abundance of flounder has increased eight-fold over the past three decades, prompting expansion of their habitat. In addition, flounder and pollock distributions are influenced by water temperatures and the location of the cold pool of subsurface water that forms across the continental shelf with the formation and melting of winter sea-ice (Figure 1). Our findings contribute to the growing evidence that continued increases in flounder abundance combined with warming ocean temperatures could translate into higher predation mortality on juvenile pollock in the eastern Bering Sea.

How We Did It

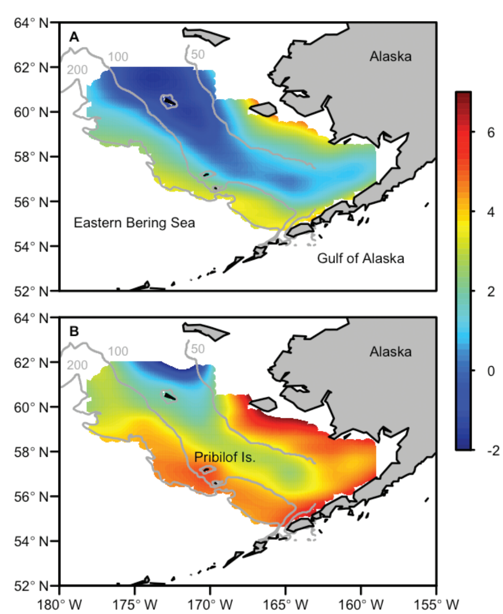
The Bering Sea is an ideal system to examine the ecological consequences of changes in species

continued on page 2


Olav Ormseth

Juvenile pollock.

Fig. 1



Study Region and Cold Pool. *Summer survey bottom temperatures (ºC) in the eastern Bering Sea during a cold year (A; 2007) and warm year (B; 2003). The 50 m, 100 m and 200 m depth contours are shown.*

The Big Picture

The potential for changes in species distributions and interactions is pronounced in the Bering Sea ecosystem and subarctic systems in general. Not only is climate-induced habitat variability especially strong in these regions, but some of the largest commercial fisheries in the northern hemisphere are found in these waters. Using existing assessment survey data, we examined species abundance, distribution, and interactions to gain insights into predator-prey overlap. Our methodology provides the ability to characterize the dynamics of species interactions and quantify the impact of predators on prey under different scenarios. This methodology is particularly valuable for understanding ecological processes in the Bering Sea, as it improves our ability to anticipate shifts in predator-prey relationships involving key species such as arrowtooth flounder and pollock.

A component of the BEST-BSIERP Bering Sea Project, funded by the National Science Foundation and the North Pacific Research Board with in-kind support from participants.

distribution. Like other heavily harvested systems, the Bering Sea is the focus of intense assessment surveys aimed at estimating species abundance, distribution and predator-prey interactions. The survey data are therefore valuable for improving our understanding of species spatial dynamics and ecological interactions in subarctic ecosystems. Using this data, we first characterized pollock and flounder distribution and then predicted their overlap in relation to further increase of flounder biomass and ocean temperature. We found that the predicted changes in overlap at higher temperatures were greater in years of high flounder biomass (Figure 2a) compared to years of low flounder biomass (Figure 2b).

Why We Did It

Better knowledge of the mechanisms that influence the strength of species overlap can improve our ability to anticipate shifts in predator-prey relationships and forecast ecosystem-level effects of changing environmental conditions. For harvested species, understanding the magnitude and variability of natural mortality can be important for setting realistic harvest goals. Further, the potential impact of the growing flounder population on pollock population dynamics has become a real concern. Alaska pollock provide sustenance for many species of commercial and conservation value, and support the world's second largest single-species commercial fishery. Increased predation by flounder on juvenile stages combined with other top-down and bottom-up pressures on the survival of pollock early life stages could have important ecological and economic consequences.

Mary Hunsicker, College of Earth, Ocean, and Atmospheric Sciences (CEOAS), Oregon State University (OSU)

Lorenzo Ciannelli, CEOAS, OSU

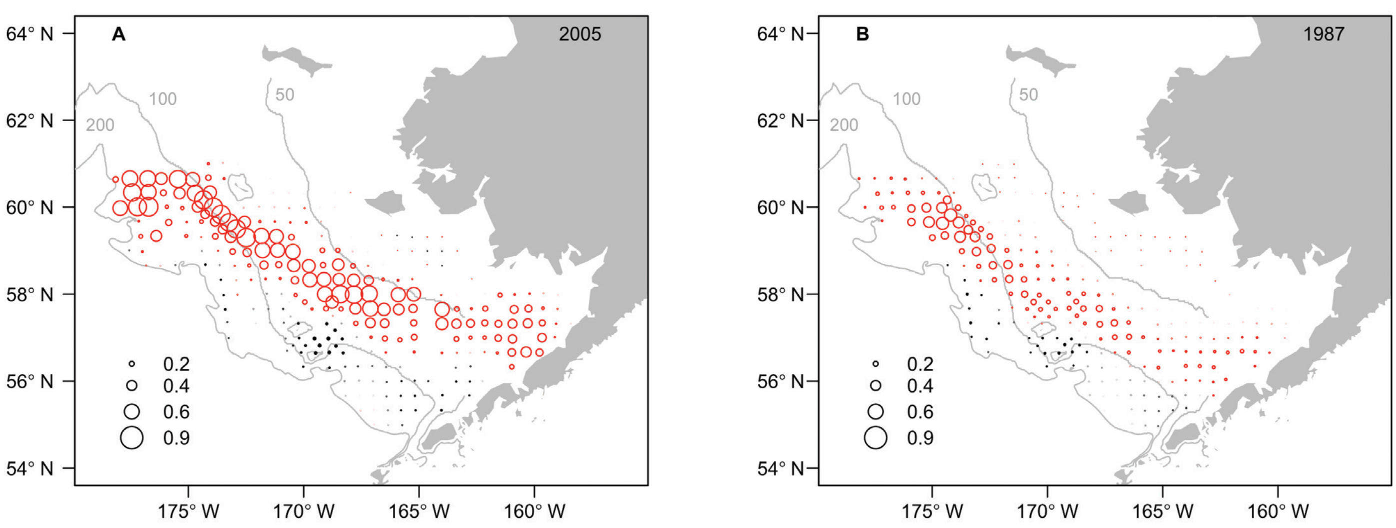
Kevin Bailey, Alaska Fisheries Science Center (AFSC), National Marine Fisheries Service (NMFS)

Stephani Zador, AFSC, NMFS

Leif Christian Stige, Centre for Ecological and Evolutionary Synthesis, University of Oslo

The Bering Sea Project is a partnership between the North Pacific Research Board's Bering Sea Integrated Ecosystem Research Program and the National Science Foundation's Bering Ecosystem Study. **www.nprb.org/beringseaproject**

Fig. 2



Predicted changes in species overlap with increasing temperatures*. Using a a standardized unit increase in spatially-explicit bottom temperatures, red circles indicate locations where the probability of species overlap is predicted to increase, and black circles indicate decrease . The effect of temperature on the magnitude of species overlap was amplified by high flounder biomass. For example, in years when the flounder stock size and temperatures were high (A: 2005), there were large increases in overlap in the northwest shelf and throughout most of the middle and southeast shelf regions. However, when flounder biomass was low (B: 1987), the change in overlap with an increase in temperatures was mostly to the 100 m isobath in the north shelf region. The 50 m, 100 m and 200 m depth contours are shown.*