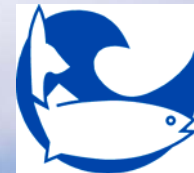




# Distribution, transport, and condition of early life stages of walleye pollock, Pacific cod and arrowtooth flounder in the eastern Bering Sea under the auspices of changing climatic conditions



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## ABSTRACT

The North Pacific Research Board (NPRB) and the National Science Foundation (NSF) have joined together to initiate a comprehensive, 6-year research effort aimed at understanding ecosystem processes in the eastern Bering Sea (EBS). Seventy United States university, state, and federal research scientists are involved in a project to address issues including climate forcing, oceanography, lower trophic ecology, and fish, seabird, and mammal ecology, to try to better understand and predict how the Bering Sea ecosystem may respond to climate change.

Our project component focuses on the transport, dispersal, and energetic content of early life history (ELH) stages of three important groundfish taxa in the EBS, namely walleye pollock (*Theragra chalcogramma*), Pacific cod (*Gadus macrocephalus*), and arrowtooth flounder (*Atheresthes stomias*). Over three field years, 2008-2010, we will assess horizontal and vertical distribution and abundance of eggs, larvae, and age-0 juveniles by season (spring, early summer, late summer/early fall), examine transport pathways between spring spawning areas and juvenile summer/fall distributions, and determine ontogenetic and seasonal patterns in energetic content and proximate composition of the three target taxa.

Our data will be integrated into several, competing models to provide the basis to predict the effect of future climate change on the EBS ecosystem. Data collected as part of this project provide the means to ground truth these models and to compare modeled results with observed field data. We expect that this project will enhance our understanding of the distribution of ELH stages of three ecologically and economically important Bering Sea fish species, provide information on the transport pathways between larval and juvenile nursery grounds, explore seasonal patterns in energy content, examine the mechanisms involved in the transport, and evaluate the effects of climate change on larval dispersal in the eastern Bering Sea.

## OBJECTIVES

1. Examine seasonal and interannual patterns of horizontal and vertical distribution and abundance of early life stages of walleye pollock, Pacific cod and arrowtooth flounder.
2. Examine interannual differences in transport pathways of ELH stages and their effects on fish production.
3. Examine the seasonal and interannual patterns in energy density of ELH stages of three target fish species.

## METHODS

Early life stages of the three target fish taxa will be collected in the spring, early summer, summer, and fall during four research cruises to the eastern Bering Sea in 2008-2010 (Table 1). In spring and early summer, depth-stratified samples of ELH stages will be collected with a 1 m<sup>2</sup> MOCNESS (Multiple Opening Closing Net and Environmental Sensing System) equipped with nine 500 μm mesh nets (Figure 1, 2). After retrieval of the gear, all net bags will be carefully rinsed down, codends detached, and samples preserved in 10% formalin seawater. Samples will be brought to the lab for further processing. The contents of the drogue net of the MOCNESS will be examined on board and all ELH stages of target fish taxa will be removed. Target ELH stages will be counted and frozen at -80 °C for further analysis in the lab.



Figure 1. The MOCNESS fishing at the surface (Picture J. Worsam)

Table 1. Summary of annual research cruises planned for 2008-10 to track early life stages of walleye pollock, Pacific cod, and arrowtooth flounder in the eastern Bering Sea.

Cruise	Months	Gear	Targets
NPCREP	May	MOCNESS, Bongo, Neuston sled	Eggs: walleye pollock Larvae: walleye pollock, Pacific cod, ATF
BEST	June/July	MOCNESS, Neuston sled	Post-larvae/juveniles: Walleye pollock, Pacific cod, (ATF)
MACE	July	Midwater trawl, acoustics	Age-1 Juveniles: Walleye pollock
BASIS	August/ September	Surface trawl, midwater trawl, acoustics	Age-0 & age-1 juveniles: Walleye pollock, Pacific cod



Figure 2. Depth-stratified samples (a) and late larval walleye pollock (b) collected with MOCNESS during early summer BEST cruise in the eastern Bering Sea.

## RESULTS

The year 2008 represents the first in a series of three years of field sampling. To date, two cruises (spring and early summer) have been completed and collected samples are currently being processed in the lab. The year 2008 has been characterized as an

During the NPCREP cruise, ELH stages of walleye pollock, Pacific cod, and arrowtooth flounder were targeted. Highest rough counts for Pacific cod were observed in Unimak Pass and north of Unimak Island, while a patch of walleye pollock was located north of the outer tip of the Alaska Peninsula (Figure 3). Abundances of *T. chalcogramma* were higher than those of *G. macrocephalus*, but were lower than in previous years.

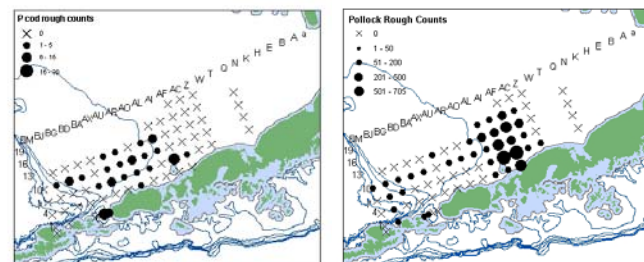


Figure 3. Rough counts of larval Pacific cod (*G. macrocephalus*) and walleye pollock (*T. chalcogramma*) collected during the NPCREP survey in May 2008.

During leg 1 of the BEST cruise, a total of 45 stations on 7 transects were sampled. The examination of the drogue net of the MOCNESS resulted in the collection of early life stages of all three target taxa. Overall, a total of 440 *T. chalcogramma*, 24 *G. macrocephalus*, and 9 *Atheresthes* spp. were frozen for analysis of energy density. Highest abundances of *T. chalcogramma* were observed in the vicinity of St. Paul Island; at all other stations, numbers of *T. chalcogramma* were substantially lower (Figure 4). ELH stages of *G. macrocephalus* were sparse and collected primarily along the Alaska peninsula and in Unimak Pass.

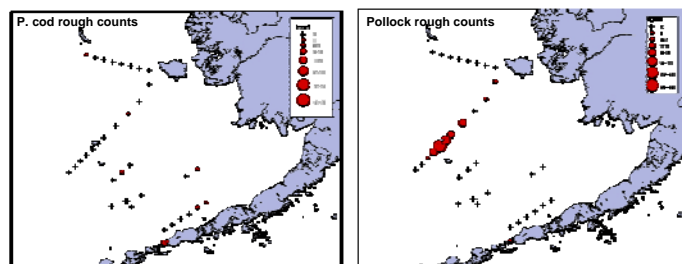


Figure 4. Rough counts of larval Pacific cod (*G. macrocephalus*) and walleye pollock (*T. chalcogramma*) collected during the BEST survey in July 2008.

## ACKNOWLEDGEMENTS

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