Estimation of Pacific Hake Larval Abundance Using Adaptive Sampling

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Adaptive sampling is a sampling design in which the procedure for selecting sample sites and allocating sampling effort depends on data collected during the survey because the spatial distribution is not known *a priori*. In the case of biological sampling in the ocean, modification of the survey can be based upon observed abundance of the animals or on observed environmental variability, which can serve as a proxy for abundance. A stratified adaptive sampling was used to survey Pacific hake larvae during March 9-27, 1995. For Pacific hake larvae, variance among tows is positively correlated with larvae abundance. Adaptive sampling allocates greater sample sizes to strata where larvae are common and thus reduces variance.

The survey was conducted between California Cooperative Oceanic Fisheries Investigation (CalCOFI) lines 66.7 and 90.0. The survey area was divided into 18 strata and each stratum was 40 x 80 nm^2. Various estimates for Pacific hake larval density under adaptive sampling were computed for comparison. A stratified cluster adaptive sample mean corrected for its intersection probability is a modified Horvitz-Thompson (HT) estimator for probability sampling. The intersection probability of a patch is a function of the patch area divided by the stratum area. A stratified two-stage cluster HT was used to estimate mean catch per tow by which we basically subsampled the clusters encountered and the area of a network (a subset of a cluster) was estimated. The variance of the HT estimate included the variance due to subsampling within a cluster. Retrospectively, various estimates for Pacific hake larval density under the adaptive sampling, simple random sampling, and conventional stratified sampling scheme were obtained and their relative efficiencies of estimates were compared. Our results indicated that HT has the lowest variance among all the estimates. Simulation studies are necessary to confirm the variance of these estimators under this survey design. The logistics of survey planning is also a consideration.

Interannual Variability of Mesoscale Eddies and Patchiness of Young Walleye Pollock as Inferred from a Spatially Explicit, Individual-Based Model

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A coupled biophysical model has been used to hindcast the early life history of a population of walleye pollock (Theragra chalcogramma) in the western Gulf of Alaska to assess possible physical causes of interannual variability in recruitment, including the effects of mesoscale eddies. Our modeling approach combines a wind- and runoff-driven, eddy-resolving, primitive equation hydrodynamic model with a probabilistic, individual-based biological model of growth, development, and mortality. Individuals are tracked through space using daily velocity fields generated from the hydrodynamic model, along with self-directed vertical migrations appropriate to each life stage in the biological model. Lacking sufficient data or a lower trophic level model, the prey of larvae and juveniles were assumed in this initial model to be uniformly distributed throughout the model domain. A preliminary spatially explicit model of larval food has also been coupled to this individual based model. Both physical and biological models have been validated with available circulation and larval data. Seasonal trends in Lloyd's patchiness index calculated from model output exhibit similarities to observed patchiness from larval data. Model hindcasts span a wide range of meteorological conditions and recruitment success. Output reveals large interannual differences in the character and extent of larval patchiness, in response to the mesoscale energy of the velocity field. Eddies appear capable of both enhancing patchiness of early larvae (through entrapment), and dissipating patchiness of juveniles (through mesoscale mixing).

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CHANGING OCEANS AND CHANGING FISHERIES: ENVIRONMENTAL DATA FOR FISHERIES RESEARCH AND MANAGEMENT A WORKSHOP

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