Abundance Estimates of Eastern Bering Sea Juvenile Salmon

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The U.S. Bering-Aleutian Salmon International Survey (BASIS) was initiated in 2001 as a coordinated effort by North Pacific Anadromous Fish Commission member nations to define the role of salmon in the Bering Sea ecosystem. Abundance estimates of juvenile salmon support U.S. BASIS survey objectives by improving our understanding of marine survival in western Alaska salmon stocks and helping to define the role of these stocks in the pelagic ecosystem of the eastern Bering Sea shelf. In this report, we compare two different approaches used to estimate juvenile salmon abundance.

During 2002 and 2003, a total of 303 stations were sampled as part of the U.S. BASIS juvenile salmon surveys. Surface rope trawls (Cantrawl models 400/580 and 300/460) were fished by the F/V *Sea Storm* (Farley et al. 2003, 2004). The Cantrawl 400/580 had a typical mouth opening of 14 m H 52 m (vertical H horizontal) and the Cantrawl 300/460 had a typical mouth opening of 11 m H 56 m. The duration for all trawl hauls was 30 minutes and the average towing speed was 4.4 knots. Fishing effort was defined as the area swept by the trawl, and relative abundance (abundance relative to the fishing power of the trawl/vessel combination) of juvenile salmon was defined as the catch per unit of effort, or the number of individuals captured per square kilometer swept by the trawl.

A variety of methods have been developed to estimate abundance from research trawl surveys. Criteria used to select between different methods and to define the appropriateness of the methods are generally centered on the assumptions used to expand sample data to obtain population level statistics. These assumptions are addressed by the variability introduced through the selection of sample locations in design-based methods, and the variability introduced in the catching process in model-based estimators (Smith 1990).

Population abundance estimates of juvenile salmon were similar when the design-based bootstrap estimator (Efron and Tibshirani 1993) and the model-based kriging estimator (Cressie 1991) were used (Fig. 1). Similarity in abundance estimates by both approaches greatly increases our confidence in the estimates of abundance. Similarity in the estimates indicates that results will not be dependent on criteria used to select the estimator. Similarity in the estimates also indicates that there is not a significant design-based or model-based bias in the estimates.

Although our abundance estimates represent an unknown fraction of the true abundance, if this fraction is assumed to be constant over time and species we can compare abundance levels between years and species. Both estimators identify sockeye salmon as the most abundant juvenile salmon species, followed closely by chum salmon in 2002, and by both pink and chum salmon in 2003. Relative biomass estimates of juvenile salmon differed from the pattern observed in abundance due to differences in average weight (Fig. 2). The numbers of pink and chum

Fig. 1. Relative abundance estimates of juvenile salmon on the eastern Bering Sea shelf during the 2002 and 2003 U.S. BASIS surveys.

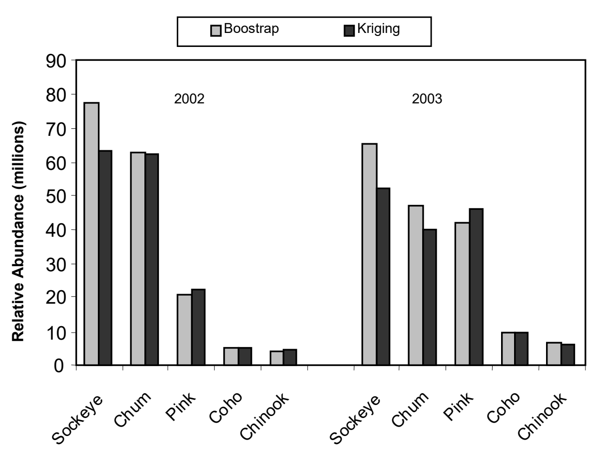
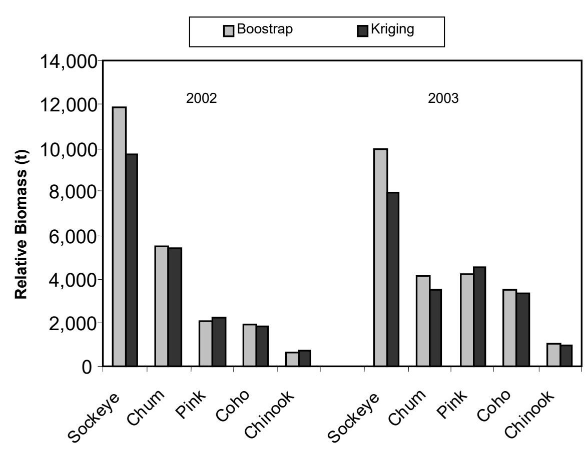


Fig. 2. Relative biomass estimates (metric tons) of juvenile salmon on the eastern Bering Sea shelf during the 2002 and 2003 U.S. BASIS surveys.



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salmon were surprisingly high considering the low numbers of pink and chum salmon returning to western Alaska. The likely contribution of pink and chum salmon from Russian stocks could explain the large numbers of juvenile pink and chum salmon in our survey area. However, even accounting for the presence of Russian-origin chum salmon stocks through genetic stock identification (Russian chum salmon contributions were estimated to be less than 10% in 2002), the abundance levels of juvenile chum salmon are still large relative to their historic return levels to western Alaska river systems. Comparable returns of chum and sockeye salmon to western Alaska is highly unlikely (historic returns differ by an order of magnitude); therefore, the abundance levels of juvenile chum and sockeye most likely reflect a higher subsequent marine mortality in chum salmon. Future work on juvenile salmon abundance will include selection of an optimal estimator of abundance, refining abundance estimates by freshwater age and stock structure, and comparisons with adult returns.

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