Early Marine Growth as an Indicator for Chum Salmon Production

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Faster early marine growth rates have been linked to higher marine survival rates in salmon (Mortensen et al. 2000). Ecological interactions with pink salmon that influence chum salmon growth may influence the production of chum salmon. For example, density-dependent reductions in the growth of juvenile pink salmon, due to higher adult pink salmon abundances, were shown to reduce the marine survival of pink salmon (Blackbourn and Tsaka 1990; Beamish 2012). Adult and juvenile pink salmon also consume similar prey items as juvenile chum salmon, such as euphausiids, pteropods, amphipods, and other zooplankton. Therefore, the relationship between early marine growth and returns of chum salmon may differ during years of higher and lower pink salmon abundances. The possible mechanism is the density-dependent effects of adult and juvenile pink salmon on the feeding and growth of juvenile chum salmon. The main goal of this project was to develop a time series for forecasting chum salmon returns. The specific objectives were to (1) evaluate the early marine growth of juvenile chum as an indicator for the returns of chum salmon three years later and (2) evaluate the influence of juvenile and adult pink abundances on the early marine growth and returns of chum salmon.

Scales were collected from chum salmon carcasses at Fish Creek near Hyder, Southeast Alaska. Samples were collected by the National Marine Fisheries Service and the Alaska Department of Fish and Game during the peak of the chum salmon run in mid-August, 1980–1996. Early marine growth was measured on the scales of age-0.3 male chum salmon. The acetate impressions of the scales were projected and measured using an Eberbach scale projector at a magnification of 80x. Early marine growth (1977–1993) was estimated as the distance from the 1st to the 9th circulus in the juvenile growth zone (Fig. 1). Juvenile salmon form approximately one circulus every seven to ten days (Clutter and Whitesel 1956). The early marine growth period for this study estimates growth during the first two to three months at sea.

Fig. 1. Scale image from an age-0.3 male chum salmon showing the early marine growth measurement area.
Peak counts of live adult chum salmon in the river were determined by the Alaska Department of Fish and Game (Piston and Heinl 2011) and used as an index of chum salmon returns (1980–1996). Juvenile and adult pink salmon abundances (1977–1993) were back-calculated using mortality schedules (Parker 1968) and the harvest information for pink salmon from the southern Southeast Alaska management region.

Time plots were used to show the relationship between juvenile growth ($t-3$) and the adult chum salmon return index ($t$). A linear regression model was used to describe the peak counts of chum salmon as a function of the early marine growth of chum salmon, and the estimated abundances of juvenile and adult pink salmon during the year of growth. The Pearson product-moment correlation coefficient was used to assess the relationship between early marine growth and pink salmon abundances. Analyses were conducted in SigmaPlot (Systat software Inc., version 12.0).

Results indicated that time trends of early marine growth and chum salmon returns show synchronous patterns from 1980 to 1996 (return year; Fig. 2). In the linear regression model, early marine growth was a positive predictor of chum salmon returns to Fish Creek three years later ($R^2 = 0.675; p < 0.001$; Fig. 3). However, estimated abundance of juvenile and adult pink salmon was not significant in the model. In addition, there were no significant correlations between the early marine growth of chum salmon and the estimated abundances of juvenile and adult pink salmon from southeast Alaska.
In conclusion, the early marine growth of chum salmon was a good indicator for strong returns of chum salmon three years later. This relationship needs to be assessed using early marine growth patterns on scales collected from juvenile chum salmon captured at sea. This would provide a preseason indicator for year-class strength of chum salmon three years prior to returning to the fishery and the natal stream.

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REFERENCES


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