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Linkage between Early Ocean Life and Adult Returns of Chum Salmon in the Strait of Nemuro, Japan

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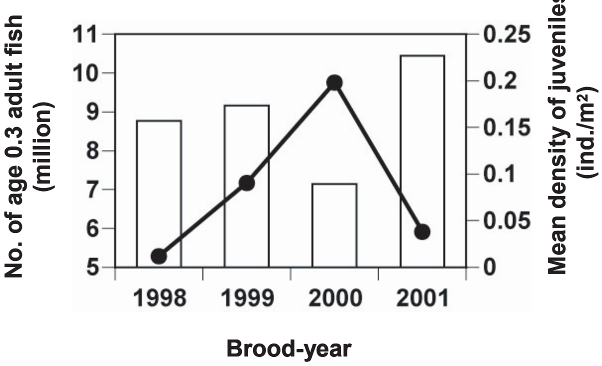
A fundamental premise of population dynamics is that the mortality at an early life stage greatly affects brood-year strengths (e.g. Wootton 1998). This premise is probably true for some chum salmon populations in Japan because fluctuations in marine survival for chum salmon within a brood-year frequently show regional similarities. The fluctuations are thought to be related to coastal ocean conditions at the time of their sea entry (Saito 2002). In a previous study, however, since only SST data were analyzed as a variable indicating ocean conditions, it was unclear how coastal ocean conditions affected the survival of chum salmon. A juvenile survey has been carried out in Nemuro Strait, Japan, from late May to mid July in 1999–2002 (i.e., 1998–2001 brood-year stocks) to improve the understanding of the mechanisms regulating the abundance of juvenile chum salmon in coastal waters. Nemuro Strait is a narrow passage of water connecting the Sea of Okhotsk and the Pacific Ocean.

Six transect lines were set perpendicular along the coast of Shiretoko Peninsula from Shibetsu to Rausu. Each transect had a maximum of eight survey points with the distance from shore being 0.05, 0.25, 0.5, 1, 2, 4, 6, and 8 km, respectively. At each survey point, juvenile salmon were collected using one of two types of purse seine nets; one was 150 m long and 10 m depth and the other was 40 m long and 4 m depth. The latter, smaller net was mainly used at the survey points located in the shallow, near shore areas (< 0.5 km from shore). A NORPAC net was towed from 10 m depth to the surface at the survey points along two of the six transect lines to assess food conditions for juvenile salmon. Fixed transect lines for zooplankton sampling were established. In this paper, we compared the abundance, growth, condition of juvenile salmon and zooplankton abundance among the four study years and evaluated whether the abundance of the juveniles could be linked to the abundance of adults that returned at age 0.3.

The number of purse sein nets ranged from 46 to 117 operations per year (mean 92.2 operations/year). The year-to-year variation in the number of seines was due to weather or gear trouble. The mean density of juveniles was significantly higher (0.20 fish/m^2) in 2001 compared to 1999 and 2002 (0.01 and 0.04 fish/m^2, respectively). Juvenile chum salmon occurred densely within inshore areas (< 1 km from shore) until early June, migrated offshore in late June and left from the study area up to mid July. This seasonal pattern of distribution was almost identical among the study years. Growth rates during coastal residence, estimated from back-calculated length based on otolith increments, were 10–17% higher for juveniles in 1999 and 2001 than those in 2000 and 2002. Analysis of fish condition was evaluated using the weight-length relationship proposed by Vila-Gispert and Moreno-Amich (2001) and revealed that fish collected in 2001 were in slightly better condition than fish caught in the other years, especially 1999 and 2000. As a consequence, juvenile salmon collected in 2001 (2000 brood-year stock) were considered as the most successful among the four brood years studied. The success of the 2000 brood-year stock was probably the result of the zooplankton abundance in 2001, which was four to five times higher from mid May to late June in 2001, compared with that in the other years. The dominant species of zooplankton were *Pseudocalanus* spp. and *Acartia longiremis*. This dominance was an almost common feature during the study period.

Fig. 1. Relationship between the number of age 0.3 adult chum salmon returning to the Nemuro Strait, Japan (bars) and mean density of juvenile salmon at their coastal residency (line) for 1998-2001 brood-year stocks.



In fall 2005, the 2001 brood-year fish that entered seawaters in 2002 returned to the Nemuro Strait as age 0.3 adult fish. Their returns enabled us to compare the status of 1998–2001 brood-year stocks at the adult stage. Interannual comparisons in age 0.3 adults revealed that the number of the 2000 brood-year stock (7 million; year-to sea in 2001) was the least abundant among the four brood-year

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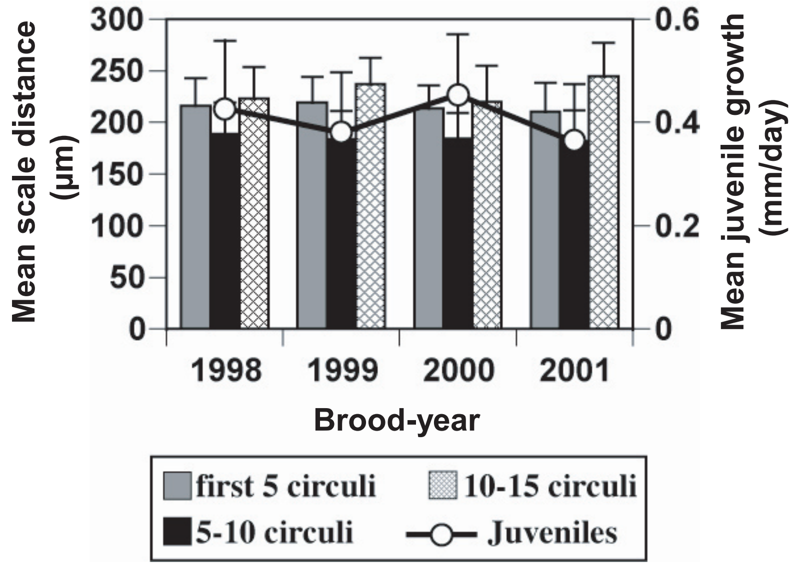
Fig. 2. Relationship between mean scale distance for age 0.3 adult chum salmon returning to the Nemuro Strait (bars) and mean juvenile growth during their coastal residency (line). The scale distance up to the first 5 circuli, that between 5th and 10th circuli, and that between 10th and 15th circuli were averaged for 100 fish per brood-year stock. Juvenile growth was estimated from back-calculated length based on otolith increments. Error bars indicate 1 SD.



stocks (range: 7–10 million). This was completely opposite to the results of our stock assessment at the juvenile stage (Fig. 1). Furthermore, the first year growth of returning adult fish, estimated with scale circuli spacings, showed little evidence that the 2000 brood-year stock had higher growth rates than the other brood-year stocks at the juvenile stage (Fig. 2). Although the reason for the discrepancy between juvenile and adult stages was unknown, we speculated that the spatial and temporal heterogeneity of juvenile distribution might bias our evaluation of juvenile status. Kaeriyama (1986) reported that juvenile chum salmon attaining 80 mm or more in fork length start migrating offshore. However, almost all juvenile salmon collected during our juvenile survey were less than 80 mm in fork length, suggesting that offshore migration had not occurred yet. If one tried to evaluate brood-year strengths at the juvenile stage, such offshore migrating fish also would have to have been monitored. This study suggested that a juvenile survey limited to small coastal areas may be difficult for forecasting the future adult returns using only the results of such juvenile survey.

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