Survival of Japanese Chum Salmon during Early Ocean Life in 2011–2017

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Keywords: juvenile chum salmon, early ocean life, survival, Okhotsk Sea, otolith mark

Adult returns of Japanese chum salmon have shown a decreasing trend since a peak (76 million fish) in 2004, while falling to 19–31 million fish in recent years (2016–2020). For sustainable management, it is an urgent issue to understand where and why the survival of Japanese chum salmon is decreasing.

The Okhotsk Sea is the most important feeding area for juvenile chum salmon originating from Japan and the Russian Far East, except for the coastal area of the Bering Sea (Urawa et al. 2018). Juvenile chum salmon released from Japanese hatcheries migrate along the coastal shelf of northern Japan, heading for the Okhotsk Sea. Genetic and otolith mark studies have indicated that juvenile chum salmon of all regional populations in Japan are distributed in the Okhotsk Sea during their first summer and fall (Urawa et al. 1998, 2001, 2004, 2006, 2007; Chistyakova and Bugaev 2013, 2016).

A long-term trawl survey has been conducted by Russian research vessels to estimate the abundance of juvenile chum and pink salmon in the Okhotsk Sea during the fall season (mainly October). The occurrence of otolith-marked juvenile chum salmon caught in the Okhotsk Sea during the fall of 2011–2017 was reported by Bugaev et al. (2019). The abundance of juvenile chum salmon in the Okhotsk Sea was variable: 164–553 million fish in 2011–2017. A total of 9,870 juvenile chum salmon were examined for otolith marks, and 347 otolith-marked fish released from hatcheries in Japan were detected by using the NPAFC otolith mark release database (<http://npafc.taglab.org>). In the present study, the abundance of Japanese hatchery-released juvenile chum salmon in the Okhotsk Sea was estimated by using the NPAFC otolith mark release database and the recovery data reported by Bugaev et al. (2019).

Fig. 1. Survival rates and adult returns of chum salmon released from Japanese hatcheries. The survival rates of juvenile fish were estimated from their abundance in the Okhotsk Sea.

Fig. 2. Relationship between estimated abundance of Japanese hatchery chum salmon juveniles in the Okhotsk Sea and adult returns by brood year (BY) stock.

The estimated abundance of Japanese hatchery-released juvenile chum salmon was 122 million fish in 2011 (early survival rate of brood year 2010 fish from release sites to the Okhotsk Sea: 6.8%) and 247 million fish in 2012 (early survival rate of brood year 2011 fish: 15.0%), while it decreased to 21–66 million fish in 2013–2017 (early survival rate of brood year 2012–2016: 1.2–4.4%) (Fig. 1). There was a significant positive correlation ($R^2 = 0.850$; $p < 0.01$) between abundance of Japanese hatchery-released chum salmon juveniles in the Okhotsk Sea and adult returns (Fig. 2). This indicates the brood year strength of Japanese chum salmon is determined in the early life stage during the coastal and offshore migrations to the Okhotsk Sea.

A recent decrease in early ocean survival of juvenile chum salmon might be caused by size-dependent mortalities (Honda et al. 2021). To move from the Pacific coast to the Okhotsk Sea, juvenile chum salmon are forced to migrate against the ocean current with a strong swimming performance (Azumaya et al. 2021), which depends on body length (Iino et al. 2021). However, the growth of juvenile chum salmon is disturbed by a reduced period of favorable habitat (SST: 8–13°C) and nutrient-rich prey abundance in the Pacific coastal water due to climate warming and/or weakened cold currents (Nagasaka and Shimizu 2021; Saito 2021; Sato et al. 2021; Yamada et al. 2021). Further studies are required to clarify the survival mechanisms of juvenile chum salmon during their early ocean life for better management of Japanese populations.

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