Effect of release time and body size of chum salmon fry on adult return rates

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Introduction

In Japan, chum salmon fry are currently released at >1 g in weight when coastal-water temperatures range 5–10˚c. However, even though fry are released under similar conditions, adult return rates have shown significant regional differences and yearly fluctuations. Therefore, it is assumed that the most suitable time and size for release is dependent on regional biotic and abiotic factors. In order to reveal this point, we released otolith-marked chum salmon fry to three rivers in Hokkaido under different conditions and compared how adult return rate changes.

Materials & Methods

Data from the three rivers in Hokkaido – the Shari (Okhotsk Sea region), Shizunai (Pacific region) and Chitose (Japan Sea region) rivers (Fig. 1) – were collated for the 1999–2008 brood years and the relationships between adult return rates, release times and release sizes estimated. Returning adults were captured each year at a weir located near the hatcheries. Approximately 100 adults (~50 males and 50 females) were sampled every 10 days; age was determined from scales. Return rate (φ_t) was calculated for each brood year, t, as follows:

$$\varphi_t = (\sum_i \sum_j p_{Mi,j,t+i} \cdot y_{Mj,t+i} + \sum_i \sum_j p_{Fi,j,t+i} \cdot y_{Fj,t+i}) \cdot x_t^{-1},$$

where $p_{Mi,j,t}$ and $p_{Fi,j,t}$ are the proportion of otolith-marked fish of age i and season j in year t for males and females, respectively; $y_{Mj,t}$ and $y_{Fj,t}$ are the number of male and female fish caught in season j in year t; and x_t is the number of otolith-marked fry released in brood year t (Morita et al. 2015, R. Soc. Open Sc. 2). Coastal water temperatures were measured near the river mouths at a depth 3 m (Fig. 1). Changes in the daily mean water temperatures were shown in Fig. 2. We used the temperature at a date of the fry were released for analysis.

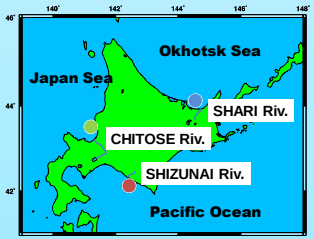

Fig. 1. Map of the surveyed rivers and measuring points of coastal water temperature (colored circles).

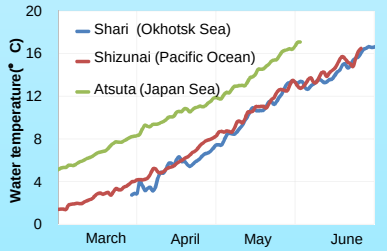

Fig. 2. Changes in the daily mean coastal water temperatures at each river mouths.

SHARI Riv. (Okhotsk Sea)

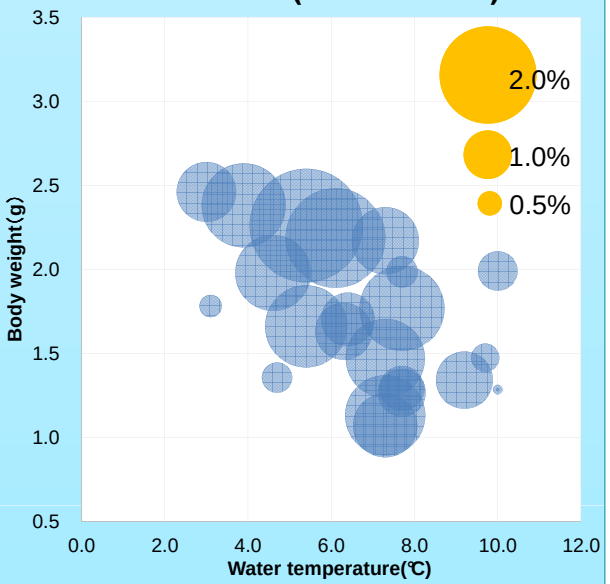

Fig. 3. Relationships between coastal water temperature and body weight at the release time of otolith-marked chum salmon fry and adult return rate on the Shari river. A diameter of circle means adult return rate.

Table 1. A range of suitable body weight, coastal water temperature and release time that takes to achieve more than 1% in Shari river.

Release size in body weight	Coastal water temperature	Release time
1.1 – 2.5g	3 – 10˚ C	Late April – early June

SHIZUNAI Riv. (Pacific Ocean)

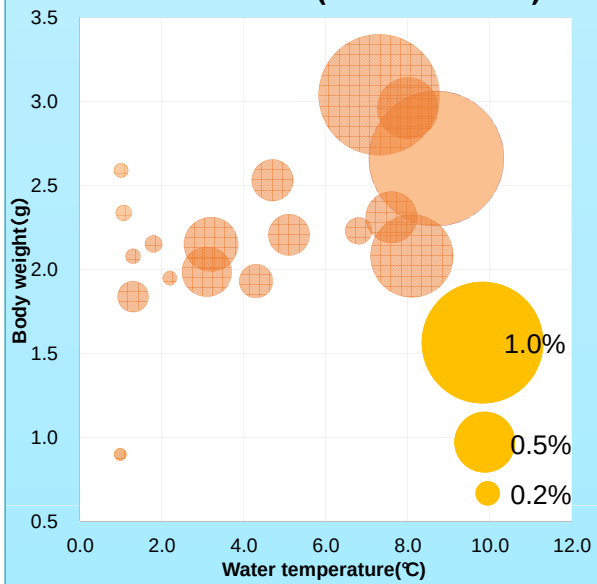

Fig. 4. Relationships between coastal water temperature and body weight at the release time of otolith-marked chum salmon fry and adult return rate on the Shizunai river. A diameter of circle means adult return rate.

Table 2. A range of suitable body weight, coastal water temperature and release time that takes to achieve more than 1% in Shizunai river.

Release size in body weight	Coastal water temperature	Release time
2.5 – 3.0g	7 – 9˚ C	Mid – late May

CHITOSE Riv. (Japan Sea)

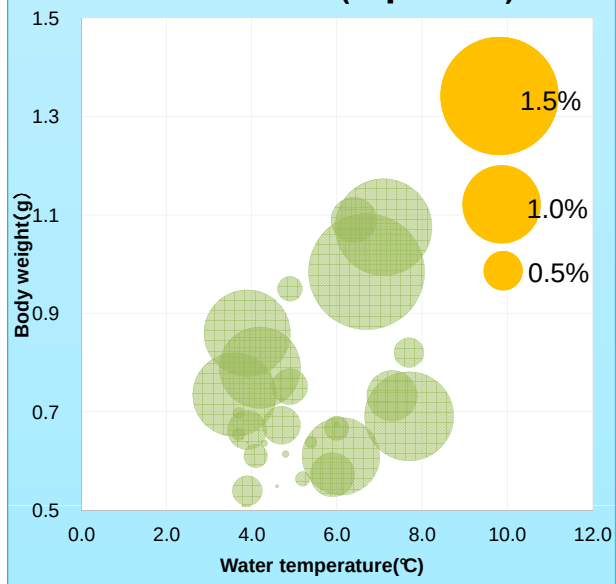

Fig. 5. Relationships between coastal water temperature and body weight at the release time of otolith-marked chum salmon fry and adult return rate on the Chitose river. A diameter of circle means adult return rate.

Table 3. A range of suitable body weight, coastal water temperature and release time that takes to achieve more than 1% in Chitose river.

Release size in body weight	Coastal water temperature	Release time
0.7 – 1.1g	4 – 8˚ C	Late March – mid April

Conclusion

The appropriate times and sizes for release of chum salmon fry vary with region. In the Shari river, where fry were released at a wider coastal-water temperature and at a body weight, the adult return rate was 1.03–2.51%. In the Shizunai River, where fry were released within a narrow temperature range and at a body weight, the adult return rate was 1.02–1.14%. In the Chitose River, where fry were released at a temperature range of 4–8˚ C and a body weight of 0.7–1.1 g, the return rate was 1.00–1.42%.

Future works

It is required that further research to establish regional biotic / abiotic characteristics including prey environment and dynamics of coastal current to improve stock enhancement. Furthermore, we need to broaden this kind of research to entire region of northern Japan.