

Occurrence of wild chum salmon (*Oncorhynchus keta*) juveniles in the surf zone of a sandy beach, Niigata prefecture, northern Sea of Japan.

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Background

For sustainable management of chum salmon, conservation of naturally spawning populations is critical. However, information on the ecology of wild chum salmon is limited in Japan. This study examined the residence pattern of wild chum salmon juveniles in the surf zone of an extensive sandy beach in the northern part of the Sea of Japan.

Methods

Chum salmon juveniles sampling

Field surveys were made at Fujitsuka Beach, an open coast shallow sandy beach located in the northern part of the Sea of Japan (Fig. 1). Artificially propagated chum salmon fry (average fork length; 50 mm) were released in the Kaji and Tainai River flow into adjacent areas of the Fujitsuka Beach in March (Fig. 1).

Sampling was conducted 1-3 times a month from February through June using a small seine net (Fig. 2) for the 2011-2014 year-classes.

On each sampling date, 50 m hauls at approximately 0.4-0.8 m depth were performed two or three times by two persons wading backwards along the beach.

Mean surface water temperature (SST) and salinity were measured by handheld device (Model 30, YSI, Fig. 3).

Discriminating the origin of specimens, Wild ? Hatchery ?

For the 2014 year-class, we examined differences in muscle nitrogen and carbon stable isotope ratios between hatchery (Kaji and Tainai hatchery) fry and collected juveniles.

We assume that the $\delta^{15}\text{N}$ value of hatchery fry fed artificial diets is high compared with that of wild juvenile fed natural diets.

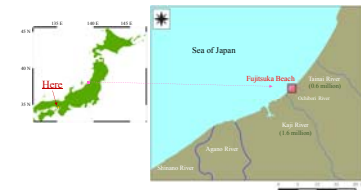


Fig. 1 Maps of the study site where chum salmon juveniles were collected with a small seine net in the surf zone of Fujitsuka Beach. Artificially propagated chum salmon fry are released in the Kaji and Tainai River every year. The number in parentheses is the total number of chum salmon fry released.

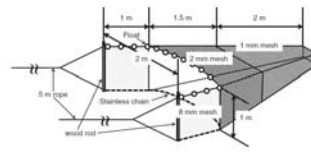


Fig. 2 The small seine net used to collect chum salmon juveniles of the 2011-2014 year-classes. The net was towed by two persons using a pair of ropes.



Picture showing Fujitsuka Beach where chum salmon juveniles were collected (See Fig. 1).



Picture showing the small seine net to collect chum salmon juveniles (See Fig. 2).

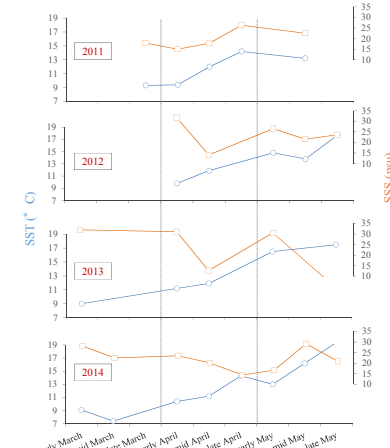


Fig. 3. Changes of SST and salinity in the surf zone of Fujitsuka Beach, Northern sea of Japan, from 2011 to 2014.

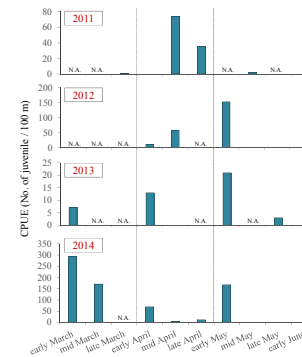


Fig. 4. Changes in CPUE (catch per unit effort, the number of juveniles per 100 m beach seine net) of juvenile chum salmon captured in the surf zone of Fujitsuka Beach from 2011 to 2014.

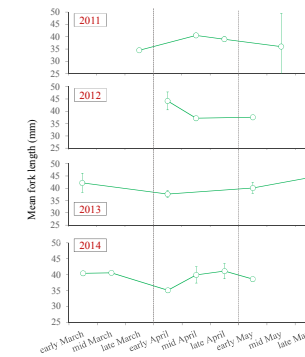


Fig. 5 Changes in mean fork length of juvenile chum salmon captured in the surf zone of Fujitsuka Beach from 2011 to 2014. Bars indicate 95% confidence interval.

Results

Residence pattern of chum salmon juveniles

Chum salmon juveniles were generally present from March through May in 2011-2014 (Fig. 4).

Peak CPUE was mid-April in 2011 (SST and salinity: 12.0 °C, 17.8 psu), early-May in 2012 (14.8 °C, 26.5 psu) and early-May in 2013 (16.5 °C, 30.5 psu), early-March in 2014 (9.1 °C, 28.1 psu) respectively (Fig. 3,4).

Average fork length (\pm SE) was 40.0 \pm 0.3 mm in 2011, 37.7 \pm 0.3 mm in 2012, 40.0 \pm 0.9 mm in 2013, and 39.4 \pm 0.2 mm in 2014 respectively (Fig. 5).

Specimens over 50 mm FL (average release size of the Tainai and Kaji hatchery) were few in all year-classes, 3.2% (N=7, Total 221) in 2011, 1.4% (N=4, Total 295) in 2012, 6.8% (N=3, Total 44) in 2013, 2.1% (N=13, Total 612) in 2014 respectively.

Nitrogen and carbon isotope ratio of hatchery and collected juvenile

The $\delta^{15}\text{N}$ and $\delta^{13}\text{C}$ value of the Kaji and Tainai hatchery fry was 13.2 \pm 0.9 ‰ and -18.9 \pm 0.4 ‰ (mean \pm SD), 12.7 \pm 0.6 ‰ and -18.9 \pm 0.4 ‰ respectively (Fig. 6).

The $\delta^{15}\text{N}$ and $\delta^{13}\text{C}$ value of collected juvenile was 13.0 \pm 0.9 ‰ and -18.8 \pm 0.6 ‰ in early March, 13.3 \pm 1.0 ‰ and -19.5 \pm 1.0 ‰ in early April, 12.6 \pm 1.7 ‰ and -19.3 \pm 1.3 ‰ in early May, respectively (Fig. 6).

Significant difference of the $\delta^{15}\text{N}$ and $\delta^{13}\text{C}$ values between the groups was not detected by Kruskal-Wallis test ($P>0.05$), respectively.

Conclusion

The $\delta^{15}\text{N}$ values of hatchery fry and collected juveniles were almost the same, because the $\delta^{15}\text{N}$ values of artificial diets (8.7-9.6 ‰) was low, and might be almost the same as that of natural diets (9.0 ‰, Ito and Kakegawa 2008, Fig. 6). Therefore, we could not distinguish the specimens between hatchery and wild juvenile clearly depending on those values.

However, the average size of specimens was small (Fig. 5) compared with that of the Kaji and Tainai hatchery release size (FL 50 mm), we assumed that almost all specimens were derived from natural spawning for the 2011-2014 year-classes.

We concluded that the population of wild chum salmon juvenile is substantial between March and May in the northern part of the Sea of Japan, even when SST is relatively high, namely above 13 °C which had been considered as the upper SST limit for chum salmon juveniles in the coastal waters of Hokkaido.

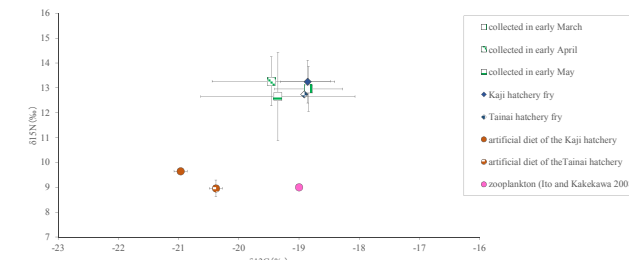


Fig. 6 Mean stable carbon and nitrogen isotope ratios ($\delta^{13}\text{C}$ and $\delta^{15}\text{N}$, \pm SD) of chum salmon collected in the surf zone of Fujitsuka Beach, reared in Kaji and Tainai hatchery, and artificial diets.