International Variability of Japanese Chum Salmon Abundance in the Summer Bering Sea during a Long Monitoring Survey in 2007–2019

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Asian chum salmon (*Oncorhynchus keta*), including Japanese stocks, are mainly distributed in the Bering Sea during summer to feed on abundant prey (Urawa et al. 2018). Since 2007, Japanese salmon research cruises have been annually conducted by R/V *Hokko maru* in the summer Bering Sea in order to monitor the abundance, growth and feeding of chum salmon, and their habitat (e.g., Honda et al. 2021). In this study, we estimated stock-specific abundance of chum salmon using a genetic stock identification (GSI) method. Our monitoring research has been carried out at 17 stations in the central Bering Sea (52°30'N–58°33'N, 174°49'E–174°49'W) using a surface trawl net. The average number of chum salmon caught was 2,885 fish (range: 2,653–3,308 fish) between 2007–2013 except for 2010 (no survey), while it was 2,068 fish (range: 1,532–3,058 fish) between 2014–2019. A total of 21,779 adipose fin samples were collected and DNA was extracted from these samples in the laboratory. Stock compositions (Japan, Russia, and North America) of immature chum salmon were estimated using a conditional likelihood using an SNP baseline dataset from 186 populations in the Pacific Rim (Seeb et al. 2011; Sato et al. 2014).

The estimated GSI compositions were 26.1 ± 1.0 – $38.7 \pm 1.3\%$ (mean $\pm$ standard deviation) Japanese, 58.6 ± 1.5 – $69.4 \pm 1.2\%$ Russian, and 2.6 ± 0.7 – $4.0 \pm 0.9\%$ North American stocks during the 2007–2013 seasons. On the other hand, the stock compositions were 15.8 ± 1.1 – $25.9 \pm 1.4\%$ Japanese, 65.3 ± 1.6 – $73.1 \pm 1.6\%$ Russian, and 7.0 ± 1.1 – $14.7 \pm 1.3\%$ North American during 2014–2019. Stock-specific CPUE (catch per unit effort) of chum salmon in the summer Bering Sea suggests that the abundances of Japanese and Russian stocks in 2007–2013 were higher than that in the 2014–2019 seasons. Particularly, the abundance of Japanese stocks decreased dramatically in 2014 and continued at a low level during the following years (2015–2019). Why has Japanese chum salmon abundance decreased in the summer Bering Sea since 2014? 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 (Urawa et al. 2018; Urawa and Bugaev 2021). Relationships between the abundance of juvenile Japanese chum salmon in the autumn Okhotsk Sea and ocean age (OA)-1 fish in the Bering Sea in the following summer showed significant positive correlations (unpublished data). This result indicates that recruitment of Japanese stocks in the summer Bering Sea may already be decided in the autumn Okhotsk Sea of the previous year. Furthermore, the estimated abundance of Japanese hatchery juvenile fish in the Okhotsk Sea in the fall has decreased since 2013 (Urawa et al. 2018; Urawa and Bugaev 2021). Low numbers of juvenile chum salmon migrating from Japan to the Okhotsk Sea since 2013 may have affected (decreased) the abundance of Japanese chum salmon in the summer Bering Sea since 2014.

To contribute to a stock assessment of Japanese chum salmon, a correlation between the abundance of Japanese stocks in the summer Bering Sea and their adult return was evaluated. For the same brood year fish, relationships between mean CPUE of OA-2 Japanese stocks in the summer Bering Sea and total numbers of adult fish (OA1–4) returning to Japan showed significant positive correlations. This result shows that the CPUE of OA-2 Japanese stocks in the summer Bering Sea may reflect a total abundance of Japanese stocks of the same brood year. In addition, there was a significant positive correlation between the mean CPUE of OA-2 Japanese stocks in the Bering Sea and the numbers of OA-3 fish returning to Japan in the following year. This result indicates a possibility that the number of OA-3 fish returning to Japan can be estimated using the OA-2 CPUE of Japanese stocks in the summer Bering Sea of the previous year. Our results suggest that long monitoring survey data in the summer Bering Sea may be useful for stock assessment of Japanese chum salmon.

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