

Recent Patterns in Return Rate of Chum Salmon to Different Regions of Hokkaido

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Japanese chum salmon *Oncorhynchus keta* has contributed substantially to the recent high abundance of chum salmon in the North Pacific, representing more than 54-72 % of total commercial chum salmon catches during 2000-2009 (NPAFC, www.npafc.org/new/index.html). Hokkaido is the principal area of salmon production in Japan. Hokkaido chum hatchery production is intensive; currently an annual total of ~one billion hatchery-reared chum salmon juveniles are stocked in 140 rivers and 80 net-pen sites. The number of chum salmon returning to Hokkaido has been at historical high levels since the 1990s. Recent high returns have been attributed to favorable ocean conditions in the North Pacific (Kaeriyama et al. 2009) and to innovations in hatchery technology that improved release timing and fish quality by feeding fry at the hatchery (Kobayashi 1980; Kaeriyama 1999). Fry are reared for more than one month in hatcheries, making it possible to release them when the river and coastal environmental conditions are favorable.

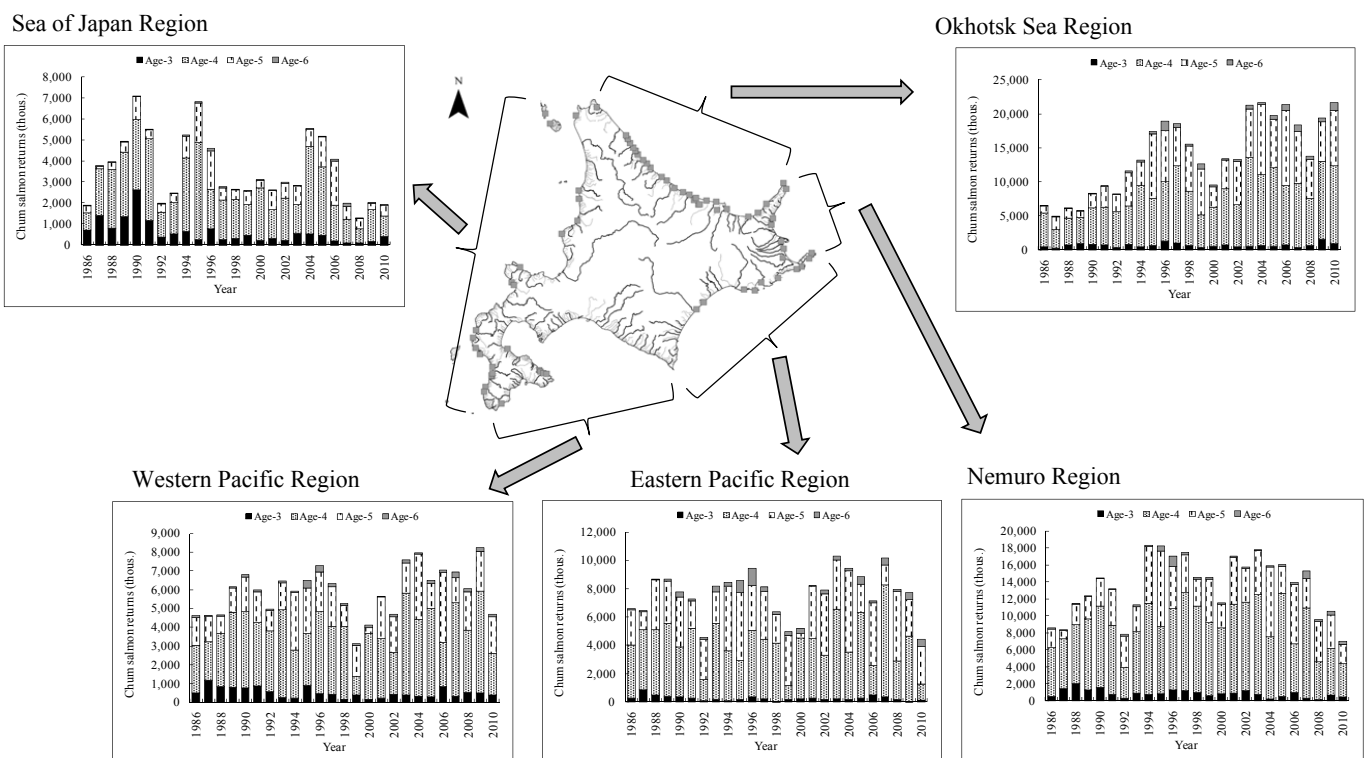


Fig. 1. Number of adult chum salmon returning to the Okhotsk Sea, Sea of Japan, and Pacific Ocean regions of Hokkaido stratified by age in thousands of fish, 1986-2020.

In its efforts to enhance commercial chum salmon stocks, the Hokkaido chum salmon hatchery program is considered successful. Nevertheless, many research areas require further investigation to continue making improvements to the program. Despite recent high return rates, since the late 2000s inter-annual fluctuations and large differences in return rates have been observed among regions in Hokkaido (Fig. 1). For example, return rates are historically high in the Okhotsk Sea region, relatively low in the Sea of Japan region, and highly variable in the Pacific Ocean region. Return of adults to

the Okhotsk Sea region has provided a substantial portion of total chum salmon return to Hokkaido in the last few years. Since 2000, return rates have varied significantly with distinct year-to-year variations in adult fish returning to the Nemuro Strait and Pacific Ocean regions (Fig. 2). In the last few years, there have been remarkable declines in returns to the Pacific Ocean and Nemuro Strait regions. Research has been conducted to clarify the causes of these fluctuations (e.g. Miyakoshi et al. 2007; Saito and Nagasawa 2009; Saito et al. 2011) and several investigators have focused on environmental factors in coastal waters during the residence of juvenile salmon (Nagata et al. 2007; Saito et al. 2009). It has been recommended that hatchery-reared juveniles should be released when coastal sea water temperatures range from 5° to 10°C (Kobayashi 1980). However, the timing when coastal sea water temperatures are within this range has been gradually changing.

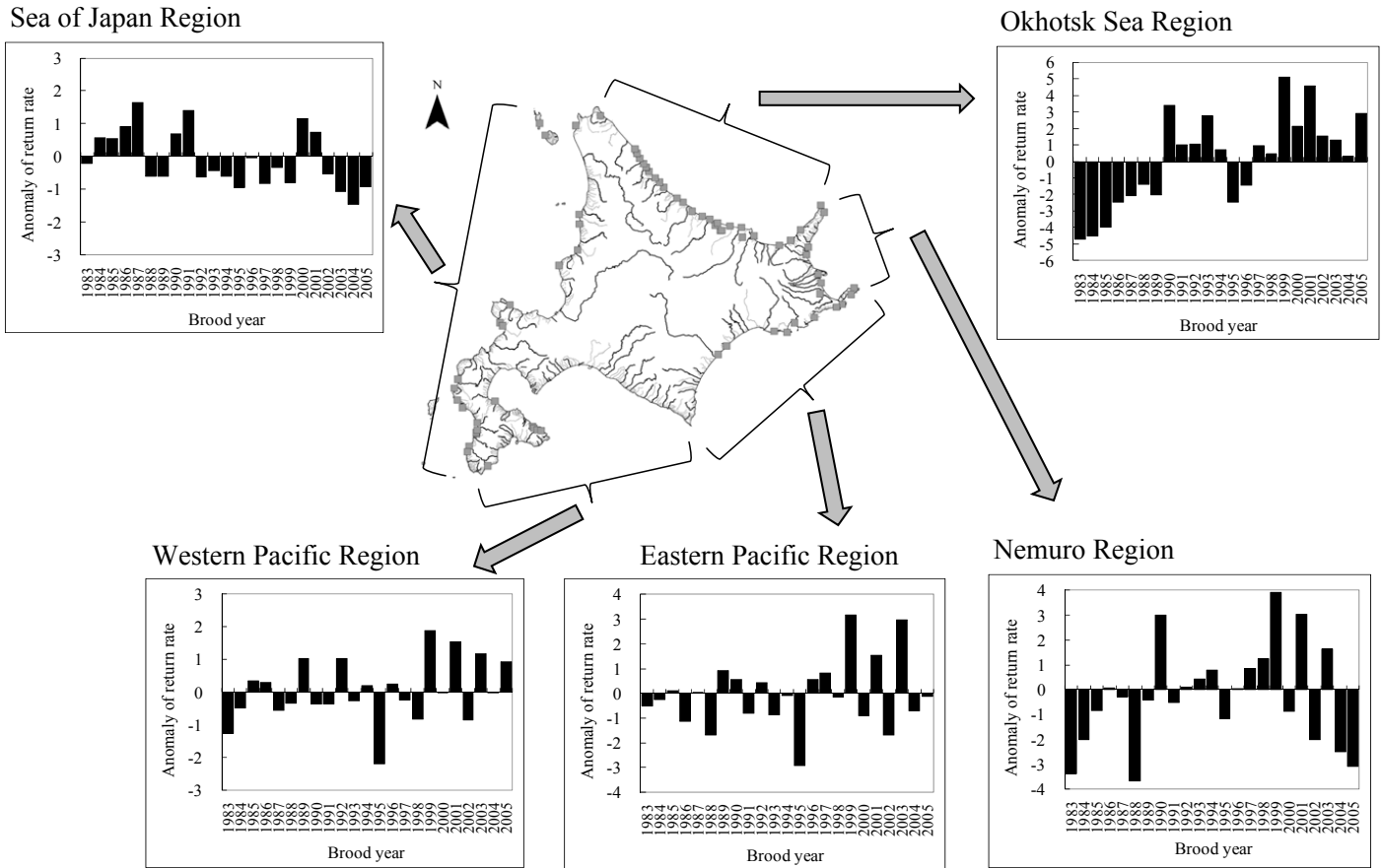


Fig. 2. Anomalies in the rate of return of adult chum salmon to the Okhotsk Sea, Sea of Japan, and Pacific Ocean regions of Hokkaido by brood year, 1983-2005.

Hokkaido hatchery practices continue to be modified and improved. Release size has been increased by improvement of rearing techniques and expansion of rearing facilities. The mean size of chum salmon fry was 0.8 g in 1987, exceeded 1.0 g in 1991, and attained 1.3 g in 2009. Although mean size has increased, release size differs among regions, and the effect of release size on return rate is highly variable in fish weighing over 1 g (Nagata and Kaeriyama 2004). Rearing density at hatcheries also differs greatly among regions, which may affect the quality of fish upon release. In the last decade, the proportion of hatchery-reared fish being released from net-pens increased, although the annual number of fish released has been constant. Contrasting hatchery stocking practices and differing regional coastal environments may affect the patterns in recent return rates of chum salmon to Hokkaido.

Although the hatchery program has been the major management tool for chum salmon in Hokkaido, assessment of naturally-spawning chum salmon has begun (Miyakoshi et al. 2012). Thus far, assessments have emphasized the distribution of naturally-spawning chum salmon. Results indicate that chum salmon spawn naturally in many rivers. A number of research areas have been identified for future examination including variation in run timing, quantitative estimation of run sizes, condition of spawning habitats, straying, and the genetic structure of naturally-spawning chum salmon (Miyakoshi et al. 2012).

In the future, Hokkaido's hatchery program will continue to be a major management tool for chum salmon and the program will continue to be evaluated scientifically and modified as necessary to adapt to climate change, conserve natural spawning populations, and support sustainable fisheries.

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