

## Effects of Duration of Net-pen Acclimation and Timing of River Stocking on Early Growth and Adult Return of Chum Salmon along the Pacific Coast of Honshu, Japan

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The number of chum salmon (*Oncorhynchus keta*) returning to the Pacific coast of Honshu, Japan, in the southernmost part of this species' distribution, has decreased notably in recent years. One reason is the decline in stocked fry following the tsunami disaster of March 2011; another possible reason is the changing coastal environment. A recent study pointed out that warm water during the coastal residence period of juvenile chum salmon could be negatively affecting their early survival off Iwate Prefecture, northeast Honshu, Japan (Wagawa et al. 2016). To adapt to the changing coastal climate, we should reconsider the release timing of stocked salmon fry from rivers. Along the Pacific coast of Honshu, however, salmon fry are also stocked from net pens in near-shore areas, as well as from the rivers, because of local geographic conditions: a deeply indented rias coastline has developed in this area, and many of the small inlets and bays are suitable for net-pen acclimation. Net pens can supply the fry capacity of hatchery ponds and maintain hatchery fry densities at the appropriate level, but there are costs for feeding fry and maintaining the pen nets. To facilitate cost-effective fry production and improve adult return of chum salmon, we modified the present stocking program and developed new strategies, especially focusing on the duration of net-pen acclimation and the timing of river stocking.

For the 2012–2016 year classes, we tested two stocking programs in Iwate Prefecture, one in Yamada Bay and the other in the Orikasa River: 1) short-term net-pen acclimation, where fry were acclimated to seawater in a net pen for one week before release in the bay (shorter than the usual four weeks), and 2) early release, where fry were released into the river in February (earlier than the usual middle March–early May). We collected juveniles in the bay for about 40 days after release and measured growth rates by otolith daily-ring analysis. Fry capture and growth rates, and adult return rates of the test groups were compared to those of control groups (the usual river release, and four-week net-pen acclimation, released in April or May). Capture rates of both short-term and four-week acclimation were slightly higher than those of usual river release, suggesting that net-pen acclimation decreases early mortality. On the other hand, growth rates of fry of four-week net-pen acclimation in 2012 and 2013 year classes were substantially lower than those of one-week net-pen acclimation and usual river release. In age-4 adults of both 2012 and 2013 year classes, river return rates from one-week net-pen acclimation were 1.9 times that from the usual four-week acclimation. The return rate from usual river release was at a level similar to that of one-week net-pen acclimation in the 2012 year-class, but double in the 2013 year-class. One possible reason for lower growth and return rates in the four-week net-pen group compared to the one-week group is deterioration of habitat inside the net pen during the four-week acclimation, caused by bio-fouling of the net, and/or an excess of fry biomass after four weeks of growth. Growth rates of the early release group were generally lower than those of the April–May release groups. The low growth rate of fry released in 2014 was probably because of low temperature, but those in 2015 and 2016 may have been caused by low food availability. The return of adults of the early release group will be monitored. These results indicate that the duration of net-pen acclimation and the timing of stocking are important in determining early growth and survival of chum salmon. This study was supported by the Great East Japan Earthquake Reconstruction Project sponsored by the Agriculture, Forestry, and Fisheries Research Council, Japan.

**REFERENCES**

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