

Factors affecting the migration of juvenile chum salmon (*Oncorhynchus keta*) from the coast of Hokkaido to the Okhotsk Sea

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INTRODUCTION

Japanese juvenile chum salmon (*Oncorhynchus keta*) migrate from the coastal water to the Okhotsk Sea during late spring/early summer. The Oyashio current flows southwestward off the Pacific coast of Hokkaido, while the Tsushima warm current flows northward off the Japan Sea coast (Fig. 1). Thus the migration direction of juvenile chum salmon is along with the current in the Japan Sea coast, but opposite in the Pacific coast. In this study, factors affecting the migration of juvenile chum salmon from the Japan Sea coast and the east Pacific coast of Hokkaido to the Okhotsk Sea were investigated using a juvenile salmon migration model.

MATERIALS AND METHODS

The juvenile salmon migration model was driven by the active swimming and the passive transport by the currents which were hydrodynamic model's outputs. In the migration model, particles was assumed to be juvenile chum salmon. Integrated period of the model was from March to August. Starting positions of the migration were in the coast of Japan Sea and the east coast of the Pacific of Hokkaido (Fig. 1), and 44 particles from the coast of Japan Sea and 134 particles from the east of coast of the Pacific of Hokkaido were released every day during the model integration, respectively. The directions of active swimming and swimming speeds of juvenile were assumed to be opposite to the current and the constant during the model integration, respectively. The migration routes in each case of 5cm/s interval of the swimming speed from 5 cm/s to 100 cm/s were examined.

RESULTS

- ✓ The juvenile chum salmon migration model reproduced the actual distribution of juvenile chum salmon in the Japan Sea coast of Hokkaido (Fig. 2 and Fig. 3(red lines)).
- ✓ In the Japan Sea coast, juvenile chum salmon reached the Okhotsk Sea with the passive transportation by the Tsugaru warm current.
- ✓ In the Pacific coast, juvenile chum salmon reached the Okhotsk Sea by their active swimming (Fig. 3(green lines)).
- ✓ Particles, which released in the period of the suitable water temperature range (8°C-13°C) of juvenile chum salmon in the coast of Japan Sea, entered the Okhotsk Sea (Blue, Green and Red bars in Fig. 4).
- ✓ As particles were released in the first half period of the suitable water temperature, the particle experienced temperatures from the release points to the Okhotsk Sea were within the chum salmon habitat temperature range (2.7°C-15.6°C) (Green in Fig. 4).
- ✓ Particles with swimming speed more than 35 cm/s, which released from the east coast of the Pacific of Hokkaido, entered the Okhotsk Sea (Fig. 5).
- ✓ With the increasing swimming speed, the number of particles which entered the Okhotsk Sea increased and the residence time became shorter (Fig. 6).

CONCLUSION

Juvenile chum salmon migrate from the Japan Sea coast to the Okhotsk Sea by the passive current transport without dependence on their active swimming speed. Meanwhile, the active swimming speed affects the migration of juvenile chum salmon from the Pacific coast to the Okhotsk Sea. The results suggest that an important factor for successful migration and survivals of juvenile chum salmon is release timing in the Japan Sea coast and the body size of released fry in the Pacific coast.

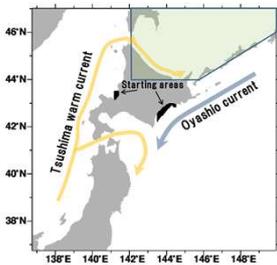


Fig. 1 Schematic view of the current system around Hokkaido and the migration starting areas of juvenile chum salmon (black dots) in the migration model. Number of particles, which entered the hatch area in the Okhotsk Sea, was counted in the migration model.

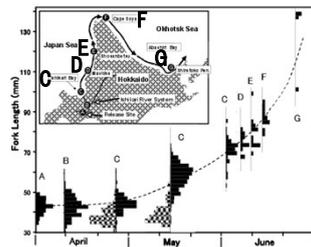


Fig. 2 Seasonal changes in fork length distribution of juvenile chum salmon originating from the Ishikari River System, 1979. Histograms show lengths of juvenile chum salmon caught on beaches (left side) and offshore(right side) along the Ishikari coast. (Data from Ito et al. 1980.; Kato and Mayama 1980, 1982; Mayama et al. 1982)

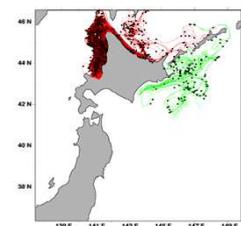


Fig. 3 Particle trajectories from the coast of the Japan Sea (red line) and the east coast of the Pacific (green line) of Hokkaido. Black circles indicate the positions of particle of 10 days interval. The particles from the Japan Sea are transported passively and particles from the east coast of the Pacific of Hokkaido are transported by active swimming.

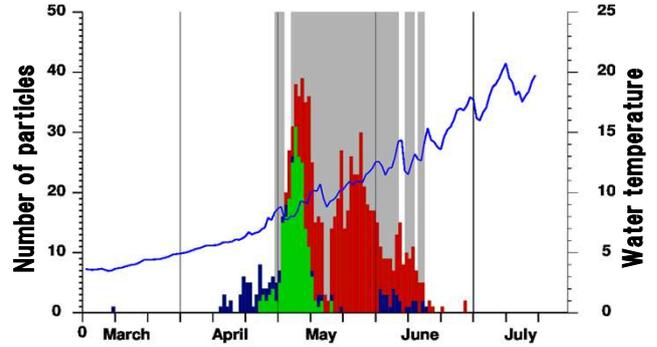


Fig. 4 Number of particles which migrated into the Okhotsk Sea from the Japan Sea coast of Hokkaido by release timing. Red (Blue) bars show that the experience temperature from the release points to the Okhotsk Sea is higher (lower) than chum salmon habitat temperature range (2.7°C-15.6°C). Green bars show that the particle experience temperature from the release points to the Okhotsk Sea is within the chum salmon habitat temperature range. Gray shows the periods that temperature (blue line) of the particles release areas is within the suitable water temperature range of juvenile chum salmon (8°C-13°C).

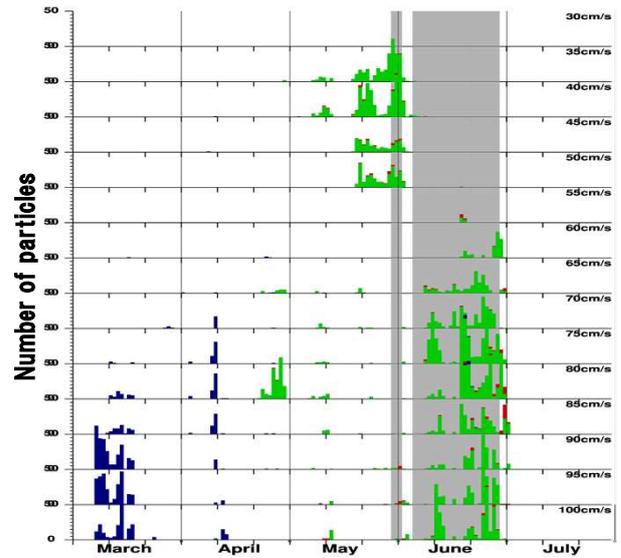


Fig. 5 Number of particles which entered the Okhotsk Sea from the east coast of Pacific of Hokkaido by release timing and swimming speed. Red (Blue) bars show that the experience temperature from the release points to the Okhotsk Sea is higher (lower) than chum salmon habitat temperature range. Green bars show that the particle experience temperature from the release points to the Okhotsk Sea is within the chum salmon habitat temperature range. Gray shows the periods that temperature of the particles release areas is within the suitable water temperature range of juvenile chum salmon.

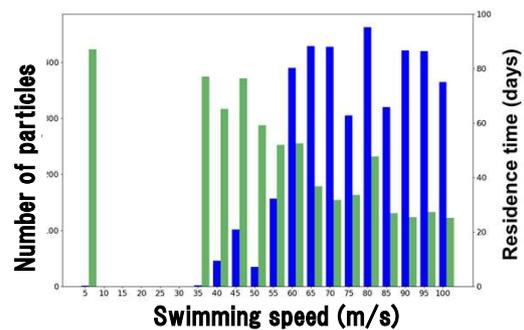


Fig. 6 Number (blue bars) and residence time (green bars) of particles migrating from the east Pacific coast of Hokkaido to the Okhotsk Sea by swimming speed.