Juvenile Pink Salmon Distribution in the Coastal Area of Taui Bay in the Sea of Okhotsk

Igor L. Izergin, Vladimir V. Volobuev, Lev I. Izergin, Evgeny A. Fomin, and Sergey L. Marchenko

Magadan Research Institute of Fisheries and Oceanography, (MagadanNIRO), Portovaya St., 36/10, Magadan 685000, Russia

Keywords: juvenile pink salmon, Taui Bay, migration, estuarine habitat, survival

The Ola River is one of the largest of all river basins that produce runs of pink salmon and drain the continental shore of the Sea of Okhotsk. During odd-numbered years, the number of pink salmon in the spawning run ranges up to 11 million fish, and during even-numbered years the run can be 21 million fish. Downstream migration of juvenile pink salmon takes place from the end of April until the middle of July. The major portion of downstream migrants enter the coastal area by the middle of June.

From the 1980s until the 2008, the Ola River drained into a large estuary of 37.8 km$^2$. The estuary was characterized by a high degree of fresh and seawater mixing, shallow depths, and warm temperatures. The combination of these factors had a positive effect on juvenile pink salmon survival because conditions favored the fish’s adaptation to a saline environment and provided favorable feeding conditions for the early marine period of life (Fig. 1).

In general, the timing of movement of pink salmon into the estuary was such that as they adapted to salt water, major aggregation of juvenile pink gradually shifted to warming shallow waters during the first 10 days in June (Fig. 2). The fish moved progressively to deeper waters of the northern part of the estuary in the second 10-day period in June. Juvenile pink salmon migrated towards the exit of the estuary in the third 10-day period in June, and they left the estuary and moved into Taui Bay in the first 10 days in July. By the beginning of July, density of juvenile pink salmon in the estuary was low. In 2007, the abundance of pink salmon making these movements was 0.36 million fish in the first 10-day period in June, 69.1 million fish in the second 10-day period in June, 54.3 million in the third 10-day period in June, and 0.36 million in the first 10-day period in July. Observations from 2002 to 2008 indicated the abundance of even-year juvenile pink salmon was
lower than odd-year fish. Although the number of juveniles varied considerably over the years, the general migration scheme remained unchanged. Juvenile pink salmon were feeding in Olskaya Lagoon Bay in June and shifted to Taui Bay at the end of June and beginning of July, at which time the juveniles showed the phenotypic characteristics typical of smolts. After leaving the estuary, juveniles migrated actively along the shore in a southeasterly direction to the waters of the Odyan Gulf (Fig. 3).

**Fig. 2.** Juvenile pink distribution in the Olskaya Lagoon Bay in June and the first 10-day period in July.

Prior to 2008, the migration scheme of juvenile pink salmon from the Ola River estuary was to move along the coast in a southeasterly direction towards the Odyan Gulf.

**Fig. 3.** Prior to 2008, the migration scheme of juvenile pink salmon from the Ola River estuary was to move along the coast in a southeasterly direction towards the Odyan Gulf.
In 2008 a sharp change in the hydrologic regime of the Ola River was associated with the washout of a dike that had separated the river from direct connection with the sea. As a result, the Ola River began to flow directly into Taui Bay, by-passing Olskaya Lagoon Bay. Disconnected from the freshwater input of the Ola River, salinity in the lagoon increased. With the change in the outlet of the river, juvenile pink salmon began to migrate directly to the sea, where they were exposed to high salinity (25-33‰) rather than rearing in the estuary in conditions of high food capacity and variable lower salinity (3-18‰).

Fig. 4. After 2008 the Ola River had a direct connection to the sea and the migration scheme of juvenile pink salmon changed. Fish moved in a westerly direction towards the Krasni Cape of the Staritzki Peninsula.

In compliance with these hydrographic changes, the distribution of juvenile pink salmon changed. Juvenile pink salmon pushed downstream by flash floods of the Ola River were caught in a branch of coastal cyclonic current and the fish moved in a westerly direction towards the Krasni Cape of the Staritzki Peninsula. The pink salmon aggregated in Batareinaya Bay and Staraya Veselaya Bay, which were favorable areas for initial feeding and for smoltification (Figs. 4 and 5). Near the shore, major aggregations of juveniles were noted in zones that were not strongly affected by currents. Large groups of fish have been observed in shallow warm sandy bottom areas during low tide and near streams outflows. During the period of observation, it was noted that juvenile pink salmon preferred habitats with water temperatures of 6-8°C and salinities of 31-32‰.

Fig. 5. Juvenile pink distribution along the eastern part of the Staritzki Peninsula during June and the first 10-day period in July.
The number of pink salmon gathering along the eastern shore of the Staritzki Peninsula in odd-numbered years changed in the following way: 45.0 million fish in the first 10-day period in June, 27.0 million fish in the second 10-day period in June, 31.5 million fish in the third 10-day period in June, and 0.24 million fish in the first 10-day period in July. The abundance of juvenile pink salmon gathering at the same location in even-numbered years was much lower: 0.063 million fish in the third 10-day period in May, 0.727 million fish in the first 10-day period in June, 0.346 million fish in the second 10-day period in June, 0.241 million fish in the third 10-day period in June, and 0.104 million fish in the first 10-day period in July.

To compare habitat conditions and biological indices of juvenile pink salmon before and after 2008, it is necessary to mention the following. After 2008, the conditions for juvenile pink salmon feeding became worse. Salmon feeding in the Olskaya Lagoon Bay took place at average water temperatures of 11.3°C and salinity of 18.9‰. However, under present conditions pink salmon appear to be feeding in habitats that are cooler (5.4°C) and typical for a polyhaline basin with an average salinity of 29.5‰ (Figs. 6 and 7). The number of feeding aggregations has decreased by two times, and size and weight indices of juvenile pink salmon have decreased as well. For example, for the time period that juveniles were feeding in Olskaya Lagoon Bay, the length and weight of pink salmon increased to 60-70 mm and to 1.5-2.0 g, respectively. However during the time period that juveniles were feeding along the eastern shore of the Staritzki Peninsula, they attained only 58.5 mm in length and 1.49 g in weight.

Fig. 6. Average indices of temperature and salinity in Olskaya Lagoon Bay during the time when juvenile pink salmon would be residing in the estuary.

Fig. 7. Average indices of temperature and salinity of water in Batareinaya Bay during the time when juvenile pink salmon would be residing in the area.
To estimate survival of juvenile pink salmon exposed to abruptly changing salinity conditions, halinic tolerance of juvenile fish were experimentally evaluated. Study of the physiologic status of juvenile pink salmon, taking into consideration the level of erythropoiesis, the leukocytic formula, and indices of thrombocytes and leukocytes in peripheral blood, showed fish are rather resistant to sharp salinity changes. Mortality during the experiment did not exceed 10% (Izergina and Izergin 2009).

We note that hydrological changes in the outflow of the Ola River affected qualitative indices of juvenile pink salmon and their survival in the early sea period. However, the high salinity tolerance of pink salmon enables them to maintain a high level of abundance, as compared to other salmon species in rivers of the Magadan region.

REFERENCES