Mapping migration routes, swimming depths and rate of progression of Atlantic salmon post-smolts through a fjord system in Norway

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Salmon lice may be responsible for causing serious diseases in salmonids. During the past few decades, intensive fish farming in fjord and coastal areas may have led to higher concentrations of salmon lice in these areas. Salmon post-smolts utilize the fjord areas in their migration to the ocean. Laboratory experiments have shown that sea lice tend to avoid low-salinity water. In the fjord areas during spring there is often a brackish water layer. The number of salmon lice that a salmon smolt will pick up during its migration to the ocean depends on the sea lice infestation pressure in the different parts of the fjord and on the time spent crossing the fjord. We have used telemetry techniques to map the migratory routes, the swimming depth and the rate of progression of hatchery-reared Atlantic salmon post-smolts during their migration through the fjord towards the ocean.

Methods and results

Migration routes and rate of progression

Seventy one hatchery-reared Atlantic salmon post-smolts were tagged with acoustic coded transmitters (V85C-6L-R256, VEMCO, Canada) and released near the mouth of the river Eira. Fish were recorded by 19 automatic data logging stations (VEMCO model VR2) moored at sites 9.5, 37.0 and 65.0 km from the fish release site at the estuary of the River Eira (Fig. 1).

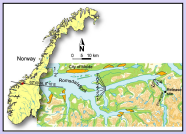

Fig 1. Map of the fjord area showing the VR2 locations

Fifty-five, 35 and 4 percent of the fish were recorded 9.5, 37 and 70 km respectively from the release site. In the three VR2 locations smolts passed close to the shore as well as in the middle of the fjord. Most of the smolts had a straight migratory route through the fjord. In Table 1, values for the mean and the range of post-smolts' progression rate and time from release to first recording are shown.

Group	Mean time (h) from release to first recording 9.5 km from release site	Mean rate of progression (bl s^{-1}) from release to first recording 9.5 km from release site	Mean time (h) from release to first recording 37.0 km from release site	Mean rate of progression (bl s^{-1}) from release to first recording 37.0 km from release site	Mean time (h) from release to first recording 65.0 km from release site (h)	Mean rate of progression (bl s^{-1}) from release to first recording 65.0 km from release site
Hatchery-reared salmon	80 (7-949, 27)	0.56 (0.01-1.62, 0.07)	168 (26-670, 40)	0.77 (0.08-1.85, 0.12)	154 (82-201, 37)	0.64 (0.40-1.00, 0.18)

Table 1: Hatchery reared Atlantic salmon post-smolts tagged with acoustic transmitters and released at the mouth of the River Eira in the Romsdalsfjord system in 2004.

Cage experiment

Sea lice infestation was estimated by placing Atlantic salmon post-smolts in cages in Eresfjord, Langfjord and Romsdalsfjord for two weeks. This experiment was repeated three times during the smolt migration period. Salmon Lice infections were only seen in some fish in the outermost cage in Romsdalsfjord.

Finn following a smolt with a VR28 unit

Niels showing one of the cages used in the experiment

Swimming depths

Four hatchery-reared Atlantic salmon post-smolts were tagged with sensor acoustic transmitters (Acoustic Pressure Transmitter, THELMA, Norway). Depth and movements of the fish were recorded with a receiver (VR28, VEMCO, Canada); surface water current and water salinity were measured every 10 and 30 minutes, respectively. When modeling sea lice infestation pressure it is important to record the water salinity as well and calculate how much time the post-smolts spend in low-salinity waters, where sea lice are not commonly found. If Atlantic salmon post smolts use the brackish water layer to migrate, they may have a lower risk of salmon lice infestation than if they use higher salinity layers. Atlantic salmon post-smolts often swim in the upper three meters of the water column, which may include part, whole or none of the brackish water layer. The brackish water layer depth decreased with increasing distance from the mouth of the River Eira. Salinity varied along the fjord area between 7.7 and 31.9 ppt (mean 25.5).

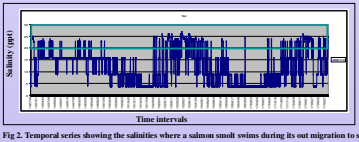

Fig 2. Temporal series showing the salinities where a salmon smolt swims during its out migration to sea.

Conclusions

Assuming that all salmon passing through the fjord areas were recorded by the receivers, the low-survival values obtained in this study are consistent with other studies that show that the first phase of marine migration is critical for the salmon survival.

Salmon lice infestation rate was low and post-smolts were only in the outer parts of the fjord system. Post-smolts did swim in the upper part of the water-column, probably lowering the infestation risk by salmon lice.

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