

Frequently Asked Questions on Salmon Smolt Migration and Survival

- 1. What are some of the key challenges faced by wild sockeye and Atlantic salmon smolts during their migration from freshwater to the ocean?** Wild salmon smolts face numerous challenges during their downstream migration. In freshwater, they are vulnerable to predation, particularly in clear and shallow river reaches where visual predators like trout can easily spot them. Tagging studies have revealed high initial mortality in these river segments. As they move into larger, more turbid rivers, migration speeds increase, and nocturnal movement patterns often cease. Upon reaching the estuary and the marine environment, they face new predators, changes in salinity, and the need to adapt their physiology. Laboratory experiments suggest that even when physiologically prepared for saltwater, mortality can occur, potentially exacerbated by factors like tagging and the stress of captivity. Overall, survival rates from natal freshwater areas to the ocean can be quite low and highly variable among years.
- 2. How does the time of day of smolt release affect their survival, particularly in the context of hydropower facilities?** Releasing smolts during daylight hours, a common practice in fisheries management due to safety and resource limitations, can expose them to higher predation rates. Smolts often exhibit nocturnal migration behavior in freshwater to avoid visual predators. A novel automatic release cage (ARC) designed to release Atlantic salmon smolts at night demonstrated significantly higher survival rates (over 40% higher) compared to day-released smolts. This suggests that nighttime release can be a cost-effective mitigation strategy to improve smolt survival, especially in areas with known predator aggregations.
- 3. What role does acoustic telemetry play in understanding salmon smolt migration and survival?** Acoustic telemetry has become a crucial tool for tracking the movements, behavior, and survival of wild salmon smolts over large spatial scales in both freshwater and marine environments. By surgically implanting small acoustic transmitters into smolts and deploying networks of fixed receivers, researchers can monitor their migration routes, speeds, and estimate survival rates across different riverine, estuarine, and coastal segments. This technology allows for the collection of detailed quantitative data that can help identify critical habitats, periods of high mortality, and the effectiveness of conservation and management strategies, such as downstream transportation.
- 4. Does the act of tagging or the size of the acoustic tag significantly impact smolt survival and behavior?** Studies have investigated the potential effects of tagging on smolt survival and behavior through laboratory experiments and comparisons of different tag sizes. Short-term freshwater survival of tagged smolts is generally high, and immediate impacts on burst swimming performance appear minimal at tag burdens below certain thresholds (e.g., <11% in air). However, laboratory studies have shown that dummy-tagged fish can experience higher mortality in saltwater compared to controls, suggesting a potential interaction between tagging and the marine environment. While larger tags might have a small negative impact on overall freshwater survival in some years, the general mortality patterns observed in the field do not appear to be solely attributable to tagging effects. Smaller tags (V5 and V6) showed similar survival patterns to larger V7 tags in freshwater segments.

5. **How does downstream transportation affect the survival of salmon smolts?** Transporting smolts downstream to bypass areas of high mortality in the upper river reaches has been shown to have a positive effect on their overall survival to the marine environment. Studies on sockeye salmon smolts revealed that transportation to the lower Fraser River significantly increased survival to the river mouth and the final marine array. This strategy aims to reduce predation pressure experienced in the initial freshwater migration. While mass transportation is a common management tactic in river systems with dams, its feasibility in free-flowing rivers like the upper Fraser is limited. Potential disadvantages of transportation include increased disease transmission and impaired homing ability in returning adults.

6. **Are wild salmon smolts physiologically prepared for saltwater entry immediately upon starting their migration?** Experiments conducted on non-tagged sockeye salmon smolts showed that they exhibit 100% survival when directly exposed to saltwater shortly after beginning their freshwater migration. Their plasma chloride levels, an indicator of osmoregulatory capacity, remained stable and comparable to those of fish held in freshwater. This suggests that these smolts are physiologically prepared for the transition to saltwater relatively early in their journey, long before reaching the marine environment. However, despite this preparedness, mortality can still occur in saltwater, as observed in laboratory holding studies, indicating that other factors besides initial physiological readiness play a role in marine survival.

7. **What factors contribute to the variability in smolt survival rates among different years?** Smolt survival rates are highly variable from year to year, influenced by a complex interplay of environmental and biological factors. These can include predator abundance and behavior, water temperature, river flow and currents, food availability, and potentially even subtle effects of tagging in certain years. In freshwater, predation in clear upper river reaches appears to be a significant source of mortality. In the marine environment, factors affecting survival are less well understood but likely involve predation, food availability, and physiological stresses. Large interannual variability in marine survival, in particular, highlights the need for more focused research on the drivers of mortality in this phase.

8. **What are the implications of smolt survival studies for fisheries management and forecasting adult returns?** Understanding smolt survival is crucial for improving the accuracy of fisheries models that forecast the number of adult salmon returning to spawn. Traditional forecasting methods often rely on historical spawning stock sizes and recruitment, which are broad measures. Smolt-to-adult survival data can reduce uncertainties by focusing on a shorter, yet still critical, life stage. Studies showing significant annual variability in smolt survival, both in freshwater and marine environments, emphasize the importance of incorporating smolt tagging studies into routine monitoring and stock assessments. Identifying the factors driving this variability can further refine forecasting models and help fisheries managers implement more effective conservation strategies, potentially including targeted efforts to mitigate mortality in critical migration segments.