

Comparing the health, performance, and welfare of juvenile Chinook salmon *Oncorhynchus tshawytscha* raised in a pilot partial water reuse system versus a flow-through raceway

Christopher Good, Director of Aquatic Veterinary Research

The Conservation Fund's Freshwater Institute, 1098 Turner Road, Shepherdstown, WV 25443. PH: 304-876-2815 FAX: 304-870-2208 email: c.good@freshwaterinstitute.org
and

Brian Vinci¹, Steven Summerfelt¹, Kevin Snekvik², Ian Adams³, and Samuel Dilly³

¹The Conservation Fund's Freshwater Institute, Shepherdstown, WV

²Washington Animal Disease Diagnostic Laboratory, WSU, Pullman, WA

³Chelan County Public Utility District, Wenatchee, WA

The Chelan County Public Utility District installed a pilot partial water reuse system at the Eastbank Hatchery in Wenatchee, Washington in 2008, as a potential alternative to the existing traditional flow-through raceways. The anticipated benefits to adopting reuse aquaculture systems are a reduction in water usage (which is becoming increasingly restricted in the region) and a reduction in phosphorus and nitrogen to the environment following effluent treatment. To assess the suitability of water reuse technology for raising anadromous salmonids for stocking into the Columbia River basin, The Conservation Fund's Freshwater Institute was requested to evaluate the performance, health, and welfare of juvenile Chinook salmon *Oncorhynchus tshawytscha* reared in the partial water reuse environment relative to those from the same spawn reared in a comparison raceway. The hypothesis was that fish reared in the pilot system would have comparable growth, survival, and health to fish raised in a raceway environment.

This observational study began in June, 2008 at the time of ponding, and involved repeated assessments of reuse and raceway cohorts over a 21-week period before all fish were moved off-site in November. Fish were sampled on three occasions and screened for subclinical infections by important bacterial and viral fish pathogens. During the same assessment events, fish from each cohort were sampled and fixed in formalin for histological evaluation of multiple tissues, including gill, heart, liver, spleen, and kidney. To assess fin erosion, at 4- and 21-weeks post-ponding the dorsal and caudal fins of fish sampled from each cohort were measured and standardized to fork length to compare fin indices. During final sampling at 21-weeks a sample of fish from each cohort was bled via caudal venipuncture for evaluation of blood gas (pO₂, pCO₂, O₂ saturation, etc.) and chemistry (sodium, chloride, glucose, etc.) parameters.

No listed bacterial or viral fish pathogens were isolated from either cohort during the three sampling events. By 21-weeks post-ponding, length and weight were comparable between the reuse and raceway cohorts (114.07mm and 110.72mm, and 16.98g and 17.39g, respectively), and survival was excellent in both groups (99.3% and 99.0%, respectively). Condition factor was higher in raceway fish (1.28 vs. 1.14 in reuse fish), and length coefficient of variation was higher in raceway fish. Fin indices were lower in reuse fish, although fin erosion was not grossly apparent on either cohort. Histological evaluation revealed a higher prevalence of liver lesions in raceway fish; however, the

most noticeable histological difference between the two cohorts was epithelial hypertrophy of the gills in reuse fish. Blood chemistry and gas measurements revealed differences consistent with the histological findings. Overall, by study's end both cohorts were generally comparable in performance, health, and welfare indices.

The study was repeated from June-November, 2009, using the same methodologies but rearing fish at twice the density as in 2008. By study's end, managers had been able to grow both cohorts to acceptable and comparable sizes prior to movement off-site for acclimation. Length and weight for reuse and raceway cohorts were 111.2mm and 110.2mm, and 17.8g and 18.9g, respectively. Reuse fish were relatively leaner than raceway fish, although less noticeably than in 2008 (condition factors of 1.30 and 1.41, respectively). As in 2008, reuse fish had a lower coefficient of variation (13.76, vs. 17.1 in raceway fish) and were therefore more uniform in size. Results of the histological evaluations indicated that the majority of tissues examined were normal, with mild pathologies only noted in gill, liver, skeletal muscle and mesentery. Gill epithelial hypertrophy was not observed in reuse fish to the same degree as seen in 2008; in this study, only 3/10 reuse fish exhibited this pathology and only at a very minimal level. Similarly, very mild lymphocytic branchitis was observed in a few reuse fish. Minimal liver lesions were also present in a small proportion of both study cohorts. Acute myositis was observed in one sampled raceway fish, and this was most likely due to handling at the time of sample collection. Very minimal mesenteric peritonitis in one fish from each cohort appeared to be associated with the presence of PIT tags in the coelomic cavities. Fin erosion assessment revealed no significant differences between cohorts in the indices of either pole of the caudal fin; however, as in 2008 the dorsal fin indices of reuse fish were statistically lower than the same indices in raceway fish. Despite the statistical difference in this parameter, no fin erosion was grossly apparent on any sampled fish from either study cohort. The analyses of blood parameters revealed several significant differences between the two cohorts: sodium, glucose, hematocrit, hemoglobin, and lactate were all higher in the whole blood of raceway fish, while reuse fish had higher potassium, pCO₂, bicarbonate, and total CO₂. All parameters assessed were within expected salmonid ranges for both study cohorts.

Overall, results of the two pilot system evaluations indicated that partial reuse technology can be employed to raise comparably healthy and performing juvenile Chinook salmon to acclimation size, and that no adverse outcomes were noted in either study year.

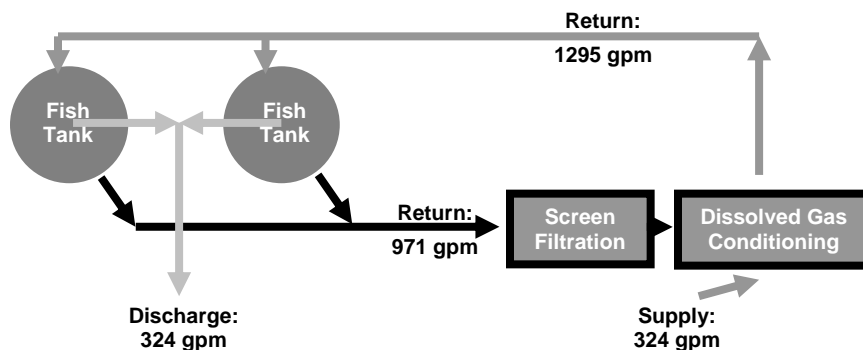


Figure 1. Schematic (not to scale) of the partial water reuse aquaculture system installed at the Eastbank Hatchery in Wenatchee, WA in early 2008.