

**ENERGY RESERVES AND NUTRITIONAL STATUS
OF JUVENILE CHINOOK SALMON
EMIGRATING FROM THE SNAKE RIVER BASIN**

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EXTENDED ABSTRACT ONLY—DO NOT CITE

Salmonid smolts migrating seaward from the Snake River basin in Idaho and Oregon, USA must pass through eight dams and reservoirs on the Snake and Columbia Rivers. The physiological consequences of an extended three- to nine-week migration through the hydropower system—two to six weeks longer than under natural river conditions—are poorly understood. A prolonged migration, in concert with the energy costs associated with dam passage and poor feeding conditions in the reservoirs, could deplete energy reserves needed by smolts for acclimation to the marine environment. This study was undertaken to determine the effects of initial (pre migratory) fish condition, river flow, and distance traveled on the lipid and protein reserves and on the nutritional status of migrating smolts.

Methods

In 1998 and 1999, spring chinook salmon *Oncorhynchus tshawytscha* reared at three hatcheries in the Snake River Basin were sampled prior to release and from bypass systems at selected hydroelectric dams on the Snake and Columbia Rivers. Carcass and gut water, lipid, and ash concentrations and total quantities were determined by standard methods. Body protein quantities were estimated as total dry weight – (lipid weight + ash weight). Plasma triglyceride, cholesterol, and total protein concentrations were determined by autoanalyzer,

as were also plasma activities of the enzymes alanine aminotransferase, aspartate aminotransferase, lactate dehydrogenase, creatine kinase, and alkaline phosphatase. Data were analyzed by analysis of covariance, with fish length as a covariate and with sampling site and hatchery of origin as the independent factors. Only results for 1999 are discussed here, with emphasis on changes occurring after fish entered the hydropower system.

Results

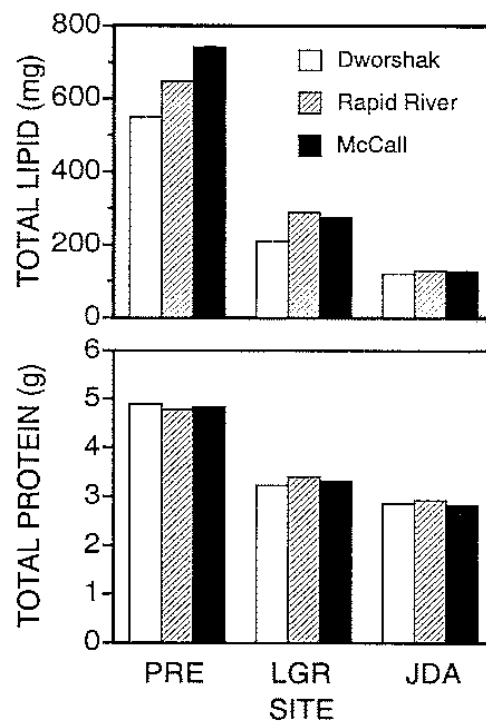


Figure 1. Whole body lipid and protein stores (standardized to fish length of 130 mm) for juvenile chinook salmon sampled prior to release (PRE), and after migrating to Lower Granite Dam (LGR) or John Day Dam (JDA). The fish originated from three Idaho hatcheries (Dworshak, Rapid River, or McCall).

Mean lengths for the three groups of hatchery fish increased slightly (< 3 mm) as the fish migrated from Lower Granite Dam (the first dam encountered on the Snake River) to John Day Dam (the sixth dam, 348 km downstream on the lower Columbia River), but dry weights decreased by 13, 14, and 17% (changes in means for fish from Dworshak, Rapid River, and McCall hatcheries). Lipid reserves declined by 43, 55, and 54% ($P < 0.001$ for site comparison) and protein reserves by 11, 14, and 15% ($P < 0.001$) as the fish migrated between the two dams (Figure 1). Mean lipid concentrations in fish sampled at John Day Dam were 0.74, 0.90, and 0.84% of wet body weight. Declining lipid reserves were accompanied by declining plasma triglyceride, cholesterol, and total protein concentrations ($P < 0.001$ for each). Gluconeogenic enzymes (alanine aminotransferase, aspartate aminotransferase, and lactate dehydrogenase) were significantly elevated relative to prerelease activities in fish sampled at Lower Granite Dam, suggesting an increased rate of conversion of body protein and lipids to glucose, but subsequently declined ($P < 0.01$) in fish arriving at John Day Dam. The activities of enzymes associated with feeding activity (alkaline phosphatase) and with muscle energy metabolism (creatine kinase) also declined significantly as the fish migrated downstream.

Discussion

Juvenile chinook salmon were in negative energy balance throughout the downstream migration. Body lipids were largely depleted in fish arriving at John Day Dam on the lower Columbia River. Total body protein also declined during the migration, a change unlikely to be due only to increased catabolism of energy stores during the parr-smolt transformation. Declining plasma concentrations of triglycerides, cholesterol, and total protein were consistent with food deprivation. Declining activities of alkaline phosphatase, an enzyme which is elevated in actively feeding fish, also indicated low levels of feeding activity. Although plasma activities of gluconeogenic enzymes were elevated in fish entering the hydropower system, activities of these enzymes declined after several additional weeks of migration. These decreased activities, and the concurrent decline in plasma creatine kinase activity, are believed to have been a consequence of increased protein catabolism.

Depletion of lipid reserves and loss of body protein may adversely affect the viability of smolts migrating through the Snake/Columbia River hydropower system. Adverse effects would be most prominent in years of poor feeding conditions in the near-shore marine environment.

