**Energetics and Physiology of Columbia/Snake Steelhead Provide Insight to Likely Iteroparity**

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Many studies of steelhead trout (*Oncorhynchus mykiss*) address the migration, genetics, and population dynamics of steelhead using a variety of tools and modeling approaches. Management goals to improve the recovery of steelhead stocks at risk of extinction in the Columbia/Snake River systems include objectives of increasing the proportion of post spawning fish that survive and spawn again. Although a plethora of physiological studies conducted on juvenile and smolts steelhead provide profiles of biochemical and hormonal indices that have been useful in evaluating factors affecting juvenile survival and migration success, few studies have been conducted on post spawning steelhead (kelts). We conducted a comprehensive evaluation of mature and kelt steelhead trout from an ESA-listed population in the Snake/Columbia River system to assist in understanding physiological factors affecting their capacity for repeat spawning. To be successful, post-spawning steelhead migrating downstream to the ocean must prepare physiologically and physically for a seawater transition. We used histological analysis to assess the cellular architecture in the pyloric stomach, ovary, liver, and spleen in sexually mature and kelt steelhead trout. We observed 38% of emigrating kelts contained food or fecal material in the gastrointestinal tract and that evidence of feeding was more likely in good condition kelts. We found a significant renewal of villi in the pyloric stomachs of kelts was associated with feeding. No vitellogenic oocytes were observed in sections of kelt ovaries, but perinucleolar and early/late stage cortical alveolus oocytes were present suggesting iteroparity was possible. We documented a negative correlation between the quantity of perinucleolar oocytes in ovarian tissues and fork length of kelts suggesting that larger steelhead trout may invest more into a single spawning event. Liver and spleen tissues of both mature and kelt steelhead trout had minimal cellular necrosis. Our findings indicate that the physiological processes causing rapid senescence and death in semelparous salmon are not evident in steelhead trout, and recovery begins in fresh water. We sampled blood, gill filaments, and evaluated the external condition of migrating kelts from an ESA-listed population in the Snake/Columbia River system to evaluate their physiological readiness for transition to seawater. We chose attributes often considered as measures of preparation for seawater in juveniles, including gill Na+K+ ATPase activity, plasma electrolytes, and hormones to consider factors related to external condition, size and sex. We found kelts in good external condition had plasma profiles similar to downstream migrating smolts. In addition, we evaluated proximate constituents of steelhead sampled at selected intervals during upstream migration in the Snake/Columbia River system, overwintering in Idaho tributaries, and kelt migration downstream at Lower Granite Dam to determine the rate of depletion of energy stores in the muscle tissues. At a basin-wide scale, we estimated that between early freshwater entry and post-spawning (kelt) emigration, the lipid content of white muscle was reduced by 94% to levels less than 1% of wet tissue weight. Lipid was depleted more rapidly than protein during the reproductive cycle, and afterward provided the only remaining somatic energy source for post spawning migration. We found that protein content was consistently higher in sexually mature male steelhead compared to females suggesting variations in energy allocation prior to reproduction between sexes. In kelts, lipids, protein, and energy densities of white muscle were significantly higher in good condition kelts over levels measured in poor condition fish. Fork length was positively correlated with both protein and energy density suggesting that larger steelhead may have higher somatic energy over smaller kelts. We found no evidence of significant inter-annual variation in lipid, protein, and energy density of sexually mature and kelt steelhead. Post-spawning survival of steelhead is likely limited by the low energy density of kelts, and our data lend support to observations of low rates of iteroparity in this and other populations of inland stream-maturing steelhead. We compared selected physiological attributes of Snake/Columbia River kelts with those of the Situk River, Alaska, a coastal steelhead system with higher proportion of repeat spawning. We observed that plasma cholesterol and triglycerides were significantly higher in coastal kelts suggesting that somatic lipid stores after spawning were higher than in inland kelts. Plasma protein content was below detection limits in a large number of inland kelts (27–68%), whereas plasma protein levels were above detection limits in nearly all (92%) coastal kelts. We found that lipid, protein and energy density of white muscle tissues from natural kelt mortalities were similar between coastal and inland steelhead. Based on selected nutritional metrics measured with plasma biochemistry we suggest that although many Snake River kelts are preparing for seawater reentry and recovery, they may be energetically limited. Compounded with these factors, the additional distance and impoundments encountered by Snake River kelts during their downstream migration make them less likely to immigrate to the ocean and recover to repeat spawn.