Using physiological tools to forecast life-history types to aid in management of hatchery and wild *Oncorhynchus mykiss*.

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Steelhead (*Oncorhynchus mykiss*) exhibit a high degree of life history plasticity including variation in age of smoltification and maturation, freshwater residence time, and seasonality of adult upstream migration and spawning. While stock specific life history patterns have a genetic basis, the proportion of fish expressing various life-history phenotypes in the same stock can vary year to year due to environmental factors (e.g. temperature, food availability) that influence early development rate, emergence timing, growth and body energy stores. This is most apparent in steelhead reared in hatcheries where rearing environment and feeding rates differ considerably from that in nature. For example, wild steelhead typically remain in fresh water for two to three years before smolting and migrating to sea, while hatchery steelhead are typically released as yearlings. Hatchery steelhead that either fail to reach minimum size thresholds for smolting or exceed size thresholds for maturation fail to migrate and remain resident in fresh water (‘residualize’) where they may pose genetic and ecological risks to native salmonids. We have developed a suite of physiological indices to quantify the life-history pathways of S1 and S2 reared summer-run steelhead released from Winthrop National Fish Hatchery, Methow River, Washington (see talk by Tatara et al. at this meeting) and S-1 reared winter-run steelhead released from Parkdale Hatchery, Hood River, Oregon. Here we report on our efforts to quantify the proportions of fish expressing various life-history pathways in winter-run steelhead in the Hood River. Using a combination of smolt indicators (body silvering and gill Na+/K+-ATPase activity) and reproductive development (sex, gonad histology, GSI, plasma hormone levels and gene expression in both the pituitary gland and testis) we identified several phenotypes: 1) immature male and female parr, 2) mature male parr, 3) male smolts with testes in early to mid-spermatogenesis with elevated expression of reproductive hormones that are likely to spawn after < 1year in the ocean, 4) male fish that attempted maturation, but failed, 5) immature male and female smolts that are likely to mature after >1 year in the ocean. The Parkdale hatchery releases approximately 50,000 S1 steelhead annually in to the Hood River basin. A survey of 300 fish prior to release from the Parkdale Hatchery showed very similar results over two brood years (2011 and 2012). We calculated that approximately 3% of the population (1,500 fish) could potentially residualize, 12% (6,000 fish) could mature < 1 year in the ocean (1-salt males) and 85% (42,500 fish) could mature after >1 year in the ocean (2-3 salt males and females). In the future these physiological indices may be used to assess the impacts of environmental factors on steelhead life history in their native habitat as well.