Estimating rates of predation on steelhead smolts during early marine migrations

Megan Moore and Barry Berejikian

**Abstract**: Steelhead populations are threatened by degraded freshwater conditions and climate-induced changes in the Pacific Ocean. But, within the Salish Sea, more than half of the steelhead smolts die during the week or two after emigrating from rivers and before entering the ocean. Nearly a decade of acoustic telemetry research suggests that predation by harbor seals occurs across various habitats within the Salish Sea and can account for a significant fraction of steelhead mortality; over 50% in some cases. The implantation of coded acoustic transmitters capable of detecting pressure (a proxy for depth) and temperature in steelhead smolts, combined with instrumenting harbor seals with hydrophones and GPS devices have provided the capability to infer individual predation events on very fine spatial and temporal scales. Steelhead emigrating from the Nisqually River in South Puget Sound (SPS) typically transit through the estuary in less than one day. During that time harbor seals were estimated to consume between 11 and 25% of tagged smolts between 2014 and 2020. A complementary diet and bionergetic-based analysis conducted from 2016-2018 estimated that harbor seals consumed between 9 and 33% of the steelhead smolts in South Puget Sound (including the Nisqually estuary and Puget Sound south of the Tacoma Narrows bridge), calculated using mid-point estimates of the harbor seal population in that region. Further along the migration route in Central Puget Sound, estimates based on tags recurrently returning and deposited near haulouts suggested that 20% of smolts were consumed by harbor seals in 2014, which was in a year of low steelhead survival. In 2016, when steelhead survived through Puget Sound at the highest rates in the past 15 years, none of the tags were detected near the same haulouts. In Hood Canal, a floating bridge delays migration of steelhead smolts and has resulted in mortality of 44% and 51% of all smolts arriving at the bridge, and 83% to 85% of that mortality was attributed to harbor seal predators. The telemetry based estimates of predation may be affected by tag burdens (presence and weight of the tag) on implanted steelhead. However, those effects do not include tag noise, which has been shown to have no effect on survival in three separate investigations. With a substantial amount of information on the impact of harbor seals on steelhead smolt mortality, we now have a much better understanding of predation hot spots, how environmental variation influences predation rates, and the fraction of mortality that can be attributed to other factors. Some mitigation strategies are now being tested to reduce mortality in human altered habitats.