

Pacific Salmon: Setting Ecologically Defensible Recovery Goals

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Gende and colleagues (2002) provided a thorough summary of the existing knowledge of the ecological role of anadromous salmonid-derived marine nutrients in freshwater and terrestrial ecosystems. As they noted, many Pacific Northwest salmon (*Oncorhynchus* spp.) runs are currently listed as threatened or endangered, and all stocks have declined from historical levels, representing a significant reduction of salmon-derived nutrients to freshwater and riparian systems. We are just now starting to understand the key role salmon have played in the productivity of Pacific Northwest systems, and we must consider information of this type when setting recovery goals.

Pacific salmon provide an opportunity to set ecologically defensible recovery goals that will assure species persistence and preserve their ecological roles within ecosystems. Salmon meet the definition of a highly interactive species (Soulé et al. forthcoming), since they are key elements of freshwater aquatic and terrestrial ecosystems and their loss can result in several systemwide changes, particularly to nutrient dynamics and potentially to primary productivity. Several factors disrupt the ability of salmon and associated nutrients to interact within their ecosystem. These factors include extirpation or severe declines in populations, loss of nutrient transfer mechanisms (e.g., bears), and loss of nutrient retention mechanisms such as down wood (e.g., Gende et al. 2002). All of these factors occur with listed Snake River chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*Oncorhynchus mykiss*).

Recovery goals for Snake River steelhead have yet to be established. An initial proposed recovery goal for Snake River chinook salmon populations was 60 percent of the pre-1971 estimate of spawner abundance (based on existing redd counts) or, secondarily, a geometric mean return of 31,440 spring and summer chinook salmon (based on 60 percent of the mean 1962–1967 population size) and 2500 fall chinook salmon natural spawners (NMFS 1995), or approximately 17,000 returning females, assuming a 1:1 sex ratio. However, because of the inability to precisely locate and identify redds, an estimated population of 17,000 female spawners could actually be as low as 8500. The 34,000 natural spawners represent just 2 to 3 percent of the estimated historical abundance of chinook salmon in the Snake River (Chapman 1986, NMFS 1995), and this number seems insufficient to rebuild the salmon–system interactions across the approximately 7000 to 8000 kilometers (km) of remaining accessible spawning and rearing habitat (NPPC [1986] 2000). The proposed recovery goal equates to about 22 to 27 kilograms (kg) of fish per km, based on an average weight of 5.5 kg (± 0.4 kg, $n = 84$) for chinook salmon carcasses from the South Fork Salmon River, Idaho. Bilby and colleagues (2001) suggested that a density of 120 coho salmon carcasses per km (0.1 kg per square meter [m^2]) would produce a saturation level for marine-derived nitrogen in western Washington streams. With an estimated weight of 1.9 to 2.9 kg per coho salmon carcass (Schoonmaker et al. 2003), this represents a minimum biomass input of 228 kg per km of

stream, about an order of magnitude more than what the proposed recovery goal would provide for Snake River chinook salmon. Although that example may not be directly comparable to the situation of chinook salmon in the Snake River Basin, it provides a frame of reference as to what may be an optimal seeding rate for salmon carcasses in western streams. Not only are salmon dependent on aquatic and terrestrial habitats, but these habitats are dependent on salmon to maintain function and biodiversity. For example, the effects of reduced salmon carcasses and derived nutrients on threatened bulltrout and westslope cutthroat trout, which have been proposed for listing, may be major, especially in nutrient-deficient high mountain streams such as those in the upper Clearwater and Salmon River drainages of the Snake River Basin.

We believe that recovery goals of the magnitude suggested in the draft recovery plan (NMFS 1995) fall short of providing for systemwide nutrient requirements. Setting recovery goals below historical population numbers, or even below levels that existed at the time of listing, is common (Tear et al. 1993). Terms like “minimum viable population” and “critical habitat” reflect a minimalist attitude that rarely accounts for ecologically viable populations as discussed by Soulé and colleagues (forthcoming) for highly interactive species. Gende and colleagues (2002) illustrated how salmon significantly influence the behavioral demographics of other species and the structure, composition, and ecological processes of the communities in which they reside.