ARTIFICIAL SPAWNING CHANNELS:

ANOTHER HATCHERY CONCEPT

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EXTENDED ABSTRACT ONLY – DO NOT CITE

Concern about hatchery fish, their suitability for the natural environment, their impact on wild fish, and the readiness to use hatcheries instead of addressing habitat needs, has been a controversial issue from the time that hatcheries first appeared on the west coast. At the turn of the century, when harvests of salmon resources were far in excess of their sustaining ability, hatcheries were developed to rehabilitate overexploited salmon runs because of the hatchery's ability to increase survival while in captivity tenfold over wild fish. Consequently, based on these performances, and with new developments in fish nutrition and fish health, hatcheries have become numerous on the Pacific Coast from California to Alaska. Although hatchery success in producing more returning salmon has varied considerably, present runs of coho and chinook salmon in Georgia Strait, Puget Sound and the Columbia River would not be what they are today without hatcheries. Approximately 90% of the fish returning to Puget Sound and the Columbia are of hatchery origin. That is not to say that had we given sufficient attention to maintaining natural habitat wild salmon would be in much better condition today. However, that didn't happen, and with the loss of habitat hatcheries have maintained salmon runs and their fisheries that would have otherwise disappeared.

Those facts don't change the ongoing controversy over whether hatcheries work to enhance wild runs or contribute to their loss. There is evidence on both sides, but hatcheries have not fulfilled the optimism that was held for them. Steward and Bjornn (1990) reviewed over 300 hatchery supplementation projects and concluded that few were successful in building natural runs. Similarly, a study on hatchery and wild steelhead on Kalama River (Chilcote et al. 1986) concluded evidence showed that reproductive performance of returning hatchery fish was only 28% as successful as the wild fish. However, when we look more closely at this often quoted study, rather than being concerned about their comparatively poor performance, we should be surprised that the hatchery fish did even that well. Skamania steelhead, not Kalama steelhead, were used as their comparative hatchery source. Moreover, to promote large size and earlier return, Skamania steelhead had been subjected to strong selection for over 30 years, and consequently were moved earlier in spawning time by at least two months compared to the Kalama stock. No, it was not a comparison of hatchery and wild fish, but rather the performance of a native population compared with one that was introduced into an environment totally asynchronous with its inherent attributes. In spite of having been moved at least two months earlier in spawning than the native stock, the "inferior form" still demonstrated a reproductive success 28% as good as the wild fish!

The Kalama study gave us two important lessons. The first is that problems attributed to hatchery fish are not because fish that experience some level of artificial propagation are inherently inferior to wild fish. They have all originated from wild runs, and we submit that they still represent the evolutionary and historical legacy of the species. We are too quick to judge when motivated to prove a preconception. The second lesson is that the critical synchrony required between salmonid life history and the environmental template of the natal habitat hasn't been given the attention it deserves by fisheries managers. Performance differences will be observed even when wild fish are introduced into an environment unsuitable for their genotype, as we have frequently seen demonstrated.

Supplementation and recovery programs must give attention to the synchrony between the population and the environmental template, and to those factors limiting the population from successfully sustaining itself. The biological requirements of the stock under consideration for supplementation must have priority above all other considerations, and when environmental changes are causing survival problems for the population, those elements must be addressed by the management team. A clear example of this was demonstrated with the Weaver Creek sockeye salmon population. Weaver Creek post-emergent sockeye fry demonstrate a unique migratory behavior (Brannon 1972). Upon emergence they show a strong negative rheotaxis that takes them down Weaver Creek to the Harrison River, and then they reverse to a positive rheotaxis that leads them upstream to Harrison Lake, used as the nursery area (Figure 1).

Adult sockeye returning to Weaver Creek historically provided a total of over 100,000 fish to the catch and escapement. Then starting in the 1950s extensive logging was undertaken in the Weaver Creek watershed that markedly altered runoff and flow cycles. The problem was reduced quality and stability of the spawning grounds, resulting in insufficient production of fry to sustain the population. Consequently the run size was significantly reduced down to an average run of a few thousand spawners. The nursery lake was not affected, and could carry much larger numbers than even what the historical population produced. The managers at that time were with the International Pacific Salmon Fisheries Commission, and the problem addressed by building a 3 km long spawning channel adjacent to Weaver Creek.

The problem was the changes in the natural habitat had disrupted spawning and incubation success. Sockeye, as lake dwellers during juvenile residence, are generally limited by spawning area rather than stream carrying capacity, characteristic of stream resident species such as juvenile chinook and coho. Weaver Creek sockeye inhabit Harrison Lake during their nursery phase, and thus use the creek only for spawning and incubation. The managers believed, therefore, the problem could be solved by providing secure spawning and incubation habitat. The IPSFC built a 17,429 m^2 spawning channel, that accommodated 10,900 females, at 1.6 m^2 per spawning pair. The channel followed a serpentine path about 2932 meters long by 6 meters wide. The channel falls 7 meters in elevation from the upper to lower end, consisting of 27 drops of 15 to 30 cm between spawning reaches. The substrate is screened gravel, between 1.3 to 7.6 cm diameter, spread 40 cm deep over the length of the channel. The design was for a discharge a little over 0.5 m/sec, and the water first conditioned by passing through a settling basin.

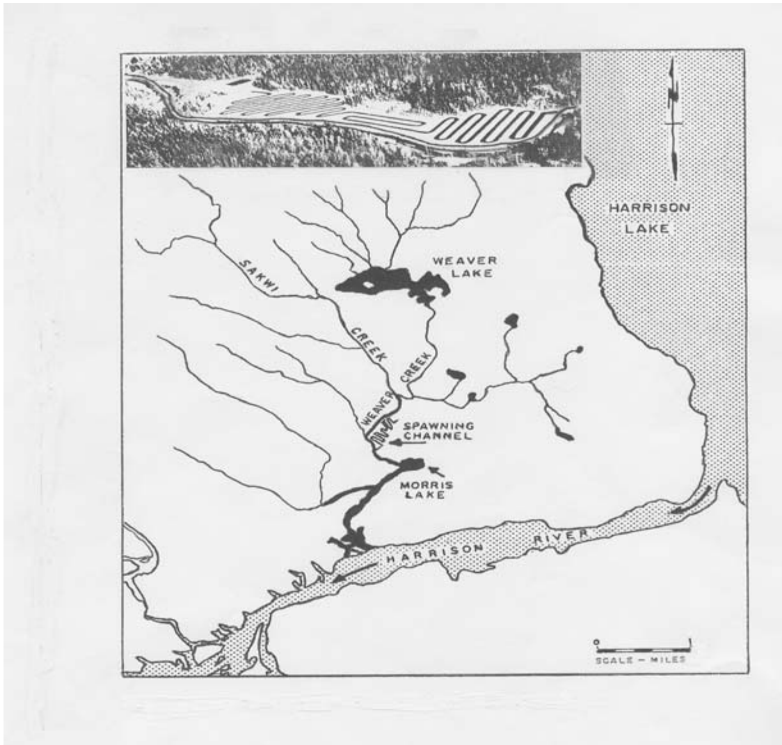

Figure 1. Map of Weaver Creek, Harrison River and Harrison Lake with insert showing Weaver Creek spawning channel. (From IPSFC Prog. Rept 36).

Supplementation via the spawning channel markedly increased survival success of spawning and incubation, and has resulted in the recovery of the Weaver Creek sockeye population. Mean total return for the eight years immediately preceding channel construction was less than 30,000 adults annually. Mean total return for the 35 years following channel construction has been 345,000 (Figure 2). In essence, by controlling the flow and accumulation of silt load, incubation survival increased from less than 7% in Weaver Creek to nearly 70% of the eggs deposited in the channel.

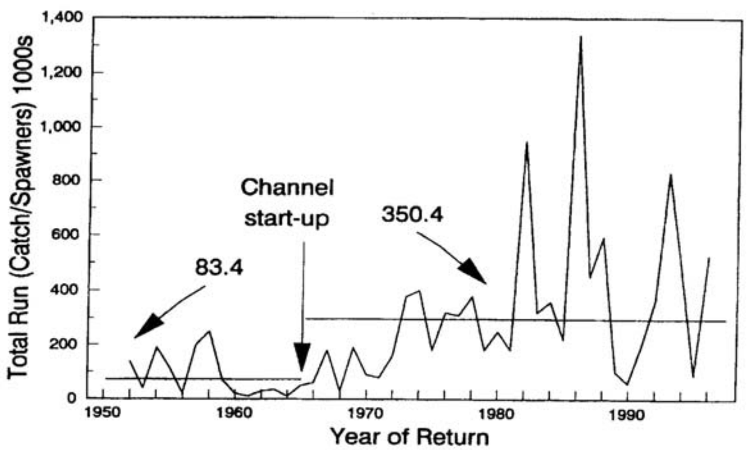

Figure 2. Weaver Creek sockeye salmon pre-channel and post-channel adult production. Horizontal lines represent mean adult production in thousands for pre-channel years from 1950 to 1964 and post-channel years from 1965 to 1999.

In the case of Weaver Creek sockeye, this was a relatively straight forward solution to a man made problem created in the watershed that would have been very difficult to address by changing land use practices, and certainly not in the timeframe demonstrated. Furthermore, the crisis that we have seen recently in adult pre-spawning mortality among all late-run sockeye stocks entering the Fraser River has had a reduced impact at Weaver Creek because of spawning channel incubation success. Although in excess of 95% adult pre-spawning mortality occurred within Weaver Creek and other late-run populations in the fall of 2001, through increased egg survival among the remnant Weaver Creek population entering the channel, a stock that could have otherwise been completely lost is being sustained.

The fact-of-the-matter is that Weaver Creek spawning channel is a hatchery, although not the hatchery typically associated with artificial propagation. In essence this is a hatchery that was applied to address a supplementation need by working in concert with the biological requirements of the local stock. The Weaver Creek population was unique, as discussed previously, and the specific problem confronting the Weaver Creek run was handled in a manner that deviated least from natural production. The channel only assisted in spawning and incubation success, and left to nature all other components of their life history and genetic uniqueness.

Understandably, problems with species that involves stream residence of their juveniles cannot be addressed in such a fashion as a spawning channel, since it is the rearing phase that most often is the problem. However, there are other engineering/biological approaches that can be undertaken as "hatcheries" that can be as non-intrusive on population synchrony with the environmental template as spawning channels are with sockeye. Although not new, this approach requires developing such systems as the new hatchery concept where supplementation and recovery of local anadromous salmonid populations can be undertaken with little or no change from natural production. When dealing with hatcheries, appropriate technology is the key in sustaining the fish's ability to meet their biological and unique life history requirements as a natural population.

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