Northwest Indian Fisheries Commission

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SUBJECT: **When to start a conservation hatchery for Chinook salmon from the South Fork of the Stillaguamish River?**

The HSRG Technical Discussion Paper #3 "When Do You Start A Conservation Hatchery Program?" gives guidelines for taking declining populations into a new hatchery program. The guidelines involve biological significance, genetic diversity, population trends, numerical thresholds, and numerical concerns for the effect of new hatchery population on the wild population. The biological significance of the SF Stillaguamish stock can be somewhat assessed in limited terms of genetic and life history diversity. As a northern Puget Sound population of fall run Chinook with limited but definite Green River influence, the population has been somewhat introgressed but retains a substantial portion of its native gene pool. Its biological significance can therefore be at least equated with that of other fall run Chinook salmon populations from north of the Snohomish basin. Additional life history characteristics may be measured.

The HSRG document lists rules of thumb to estimate the value or risk of particular levels of effective population size. The SF Stillaguamish fall run of Chinook variance effective population size (NeV) estimates are well above the N_e=50 threshold suggested as necessary to maintain inbreeding depression and detectable decrease in viability over a 2-5 generation period, the minimum criterion suggested for viability of an individual population within ESU. Additionally, the HSRG guideline suggests that when population numbers are rapidly declining, N_e V may be substantially lower than the inbreeding effective population size (N_e I). The South Fork Stillaguamish Chinook population appears to have very similar estimates of N_e I and N_e V (90-150 and 88-200, respectively), implying that the population is relatively stable. The age structure of spawners in the North Fork of the Stillaguamish suggests that there are equal contributions to a single spawning pool from four year-classes of adults, effectively quadrupling the effective number of breeders each year. These results suggest that the SF Stillaguamish fall run of Chinook is not at genetic risk requiring immediate remediation in a new hatchery program.

The next guideline involves population trend. Is the population actually steadily declining? The trend in escapement for the SF Stillaguamish fall Chinook was flat from 1986-2002, with notably lower returns in 2003 and 2004 according to the Washington state salmonid stock inventory (SaSI). Is the decline in 2003-2004 sufficiently significant to consider a new conservation hatchery program? The HSRG document's rules of thumb for genetic diversity suggest the SF Stillaguamish fall run has sufficient genetic diversity to weather risk from genetic drift over a 2-5 generation period, an 8-20 year span. If a mechanism for the recent downturn in escapement is suspected, it might be easier to remedy that factor (additional spawning or rearing habitat restoration, for instance) while waiting to see if the population rebounds, rather than to immediately begin a new hatchery program.

The numerical thresholds are heavily dependent on rules of thumb and the assumption that the effective population is one tenth to one third the census population. The mean of two point estimates of the effective population is 57% of the harmonic mean escapement over the period the effective population size data were collected. The rule of thumb for numerical threshold is that the census population should equal 500*(ratio of effective population to census population) divided by generation length. In the case of SF Stillaguamish fall Chinook, that threshold is roughly 70 fish census size (500*0.57/4) per year for a stretch of four years, according to the current estimate of Ne. In that respect the SF Stillaguamish fall population seems quite healthy and not in need of rescue from demographic hazard.

To avoid broodstock mining, the HSRG document recommends leaving at least ¾ of the natural population to spawn in the wild. To avoid founder effect and inbreeding in the proposed hatchery population, at least 125 adults should be taken into the hatchery per year. Given that the SF Stillaguamish population appears to have about double the ratio of effective to census population that is assumed in other rules of thumb, perhaps that figure could be halved, and at least 60 adults should be taken into a proposed conservation hatchery in order to minimize founder effects (as long as 180 adults are available to be allowed to spawn in the wild. That is about the exact population size the SF Stillaguamish maintained from 1986-2002. There is risk in taking a quarter of a population that has been self-sustaining and introducing it to a new set of demographic and stochastic risks in a new hatchery program (in addition to the risk of introducing domestication selection to a proportion of the run), and simultaneously reducing the number of fish allowed to spawn in the wild, increasing their susceptibility to both demographic risk (low flow during egg incubation, say) as well as genetic drift.

In sum, the SF Stillaguamish fall run of Chinook meets or exceeds genetic diversity and numerical thresholds below which HSRG guidelines indicate that populations should not fall. The population is potentially exactly the right size that it could support taking a quarter of the run to spawn in a hatchery program, but at a cost of increased risk to the two segments of the population (hatchery and natural spawners). The main question remaining regards the trend of population size. Was the population coasting from 1986-2002 and is finally crashing, (assuming there was not an immediately obvious reason for the decline in escapement, such as increased fishery, or loss of known spawning or rearing habitat), or was the low escapement in 2003 and 2004 simply a blip that will be passed right over in subsequent generations, as long as sufficient habitat remains available. If habitat restoration is ongoing in the drainage, it would be most conservative, from the standpoint of conservation genetics, to avoid the risk of splitting the population into two components (hatchery and natural reproduction) and let the returning fish expand out into restored habitat as it becomes available.

When should a conservation hatchery program be seriously considered? The two numerical thresholds suggested by HSRG are quite divergent; 70 fish per year for 4 years meets the minimal numeric threshold, but 240 fish per year would be preferred to minimize risk to separated hatchery and natural components of the population. The long-term harmonic mean escapement in the SF Stillaguamish happens to be 240 over the period 1986-2004. I would recommend considering a conservation hatchery program when the long term (1986-present) harmonic mean run size drops to 180 fish per year, which would equate to escapement of 100 adults per year each year from 2005-2011. This is more conservative than the HSRG recommendation, but I believe gives the population more time to respond both to natural variation in climate or other factors affecting spawner recruitment, and to occupy and make use of newly restored habitat in the river.

Finally, before starting a hatchery, consideration needs to be given to identifying the factors limiting Chinook return to the South Fork of the Stillaguamish. A hatchery is most likely to help if there is a problem identified at the egg to fry stage. If there is a problem with later-stage rearing habitat, or in saltwater, a conservation hatchery is not likely to provide meaningful support to the population. For that reason, some effort is needed to identify limiting factors during the next few years while observing the population's behavior from this point forward. In the best case, population recovery will proceed at the same rate as habitat recovery, with returning spawners occupying recovered habitat as it becomes available. In the worst case, if the population continues to decline, and egg-fry survival problems are identified, then a hatchery program may be further considered.