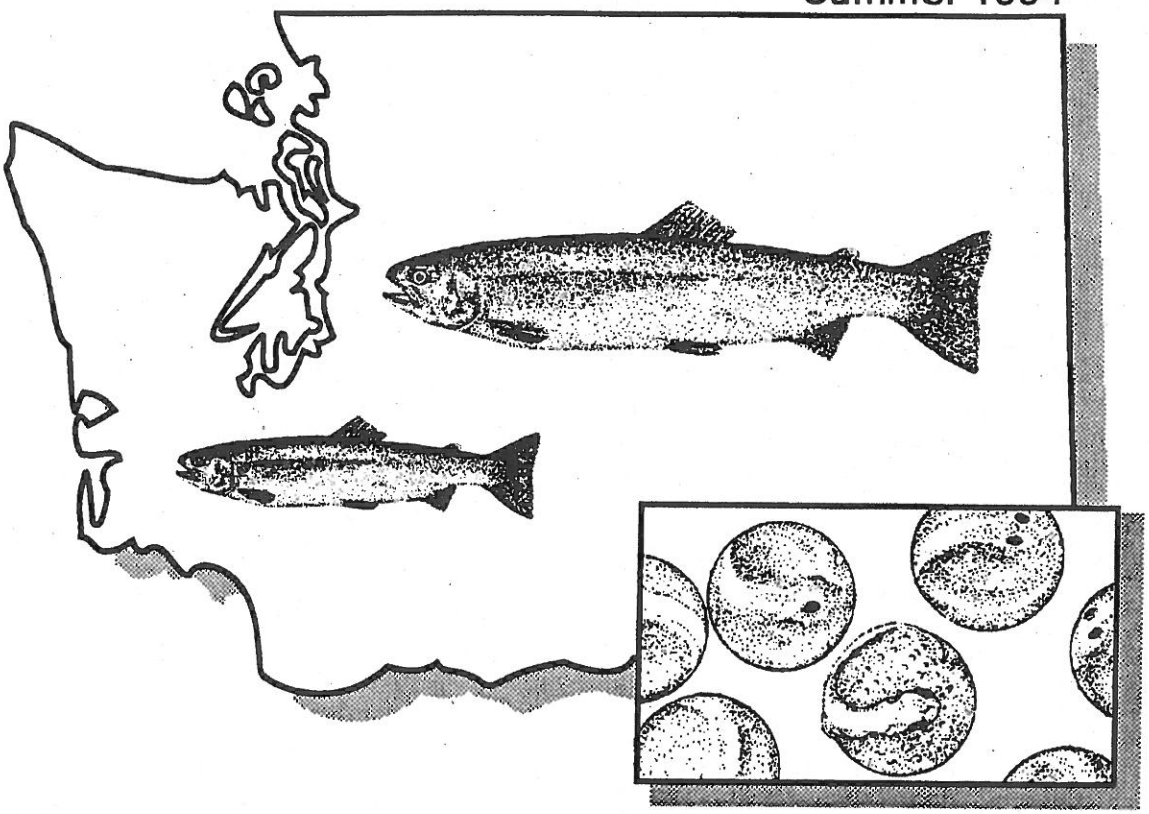
DEPARTMENT OF FISH AND WILDLIFE

Washington

Summer 1994



GENETIC ANALYSIS OF WASHINGTON STEELHEAD: INITIAL ELECTROPHORETIC ANALYSIS OF WILD AND HATCHERY STEELHEAD AND RAINBOW TROUT

Report # 94-9
FISHERIES MANAGEMENT PROGRAM
By: Stevan R. Phelps, Bruce M. Baker, Patrick L. Hulett and Steven A. Leider

Lake Washington Group

The primary stocks in this analysis were associated with the coastal steelhead form, emphasizing winter-run in the Puget Sound area that included the Cedar and Green rivers. Alleles characteristic of hatchery steelhead were observed at three of the eight "marker" loci in the Cedar River collection, but they were rare, at a frequency of about 10% that of the hatchery strains (which is about the detection level given the sample size). An average of 13.75 loci were significantly different in pairwise G-tests comparing the Cedar River with the four hatchery strains, and eight were different when the hatchery strains were tested against the Green River. Based on these results, and the presence of an allele (*sMEP-1*71*) that was observed in none of our other collections, we suggest that the Cedar River stock has received a limited amount of hatchery introgression. Because we found little evidence of hatchery contribution, we used this collection as a statistical surrogate for a "pure" Puget Sound wild winter-run stock in calculating maximum likelihood estimates of hatchery-like fish within this group and within the Tolt River group.

The Green River collection had characteristic hatchery steelhead alleles at four of the eight loci. The frequencies of these alleles were higher in this collection than in the Cedar River. The average number of significant loci in the G-tests was 9.5. This collection was not significantly different from the mainstem Skykomish River collection (putative winter-run) and was significantly different at P between 0.01 and 0.05 from the Tolt River collection (Table 4). Our estimate of hatchery contribution based on maximum likelihood procedures was 29%. From these results, we suggest that Green River winter-run steelhead have been moderately introgressed with hatchery steelhead.

Deer Creek Group

This analysis targeted Deer Creek, which is the predominant wild summer-run stock in Washington outside of the Columbia River basin. Other key stock components in this group were North Fork Stillaguamish winter-run and mixed races in the Skykomish river system. In the Skykomish River, one collection was obtained from the lower mainstem (which was thought to be a likely winter-run representative), and one collection was obtained from the North Fork (which was thought to represent a native summer-run stock).

The Deer Creek summer-run collection was significantly different ($P < 0.001$) from the Skykomish Hatchery summer and winter strains (Table 5). Moreover, based on CSE chord distances (D), Deer Creek steelhead appeared to be more closely related to the North Fork Stillaguamish wild winter-run collection ($D = 0.067$) than it was to either the summer-run ($D = 0.069$) or winter-run ($D = 0.089$) strains from the Skykomish Hatchery. The collection of summer-run steelhead from Deer Creek appears to have little or no evidence of hatchery introgression. Deer Creek has not been stocked with steelhead except for sporadic plantings that occurred between 1937 and 1970 (DeShazo 1974).

We compared North Fork Stillaguamish winter-run steelhead to the summer and winter-run strains from the Skykomish Hatchery. A G-test analysis indicated that this collection differed to a similar degree from the Skykomish Hatchery winter-run (8 loci significantly different, overall $G = 122$, 47df, $P < 0.0001$) and summer-run (9 loci significantly different, overall $G = 120$, 46df, $P < 0.0001$) strains. Although we found North Fork Stillaguamish River steelhead had the same alleles as did the hatchery strains at numerous loci, occurrences of such alleles were rare. At two loci, we observed alleles (*sAH*50, ALAT*105*) in the hatchery strains at a frequency greater than 5% that were not detected in the wild sample. Based on these results, we suggest that the winter-run steelhead in the North Fork Stillaguamish River have been introgressed by hatchery steelhead to a limited extent.

Tolt River Group

The Tolt River analysis focused on collections from the Puget Sound area. Component steelhead stocks besides the Tolt River (a putative mixed winter and summer-run group), included winter-run in the Raging (a tributary of the Snoqualmie River) and Pilchuck rivers, and summer-run in the North Fork Skykomish River.

The stocks forming the Tolt River group tended to appear relatively similar to one another, and appeared to be introgressed with hatchery steelhead to a moderate to large amount. Among all pairwise comparisons (G-tests) in our study, those involving collections in this group comprised the majority that were non-significant, as well as those that were significant with P between 0.01 and 0.05 (Table 4). The collection of summer-run from the North Fork Skykomish River was the most distinct, and based on inspection of dendrograms (Figures 2 and 3), was most closely related to the hatchery summer-run collections. In general, Figure 4 also suggests that the North Fork Skykomish River summer-run is related to hatchery and wild summer-run stocks in western Washington. Thus the fish in this collection appear to be mainly summer-run steelhead. This is consistent with the expectation that Bear Creek Falls (below the collection site) acts as a partial or complete barrier to passage of winter-run steelhead into the upper North Fork Skykomish River. In contrast, the mainstem Skykomish River collection (as expected due to sampling location), was most similar to fish in the other winter-run collections in this group. The collection from the Tolt River was potentially of mixed racial origin. However, our results suggest that fish in this collection were most closely related to winter-run steelhead of the coastal form. Steelhead from the Pilchuck River had the *LDH-B1*132* allele that occurred in no other collection in this study. Moreover, this allele has not been observed in any steelhead and rainbow trout we have examined previously.

Maximum likelihood estimates of hatchery contribution from were 76% for the Skykomish River mainstem, 58% for the Tolt River, 33% for the Raging River, and 27% for the Pilchuck River collections. With the exclusion of the North Fork Skykomish River collection, all collections in this group appeared to have had a large to moderate amount of introgression from hatchery strains. But as noted for the Pilchuck River collection, even given moderate amounts

of hatchery introgression, additional genetic diversity not observed in other populations may exist.

Big White Salmon River Group

Few stocks in the Columbia River besides Big White Salmon River summer-run were sampled for this study in 1993. Other collections of wild summer-run steelhead were made from the Washougal and Wind rivers, and a hatchery collection was obtained from the Wells Hatchery.

Our analysis of the Big White Salmon River utilized data from a collection made in 1992 as well as in 1993. Significant differences (G-tests) were observed at six loci as well as overall between the two annual collections. Although relatively few comparative collections from Columbia River subbasins were included in this study and some inconsistencies occurred using different analytical methods, the Big White Salmon River collection appeared to be more similar to inland steelhead (e.g., collections from the Klickitat River in 1991 and Wells Hatchery steelhead) than to steelhead sampled from the Wind and Washougal rivers (Figures 2, 3, 4).

Our analysis of Wells Hatchery steelhead utilized data from a collection made previously (1991) as well as our new collection from 1993. These collections represent the inland steelhead form. Genetic variation between each sampling year was significant, but was less than that between Wells collections and other stocks. The relationship of Big White Salmon River steelhead to those at Wells Hatchery is inconclusive using different analyses. It is possible that steelhead from Wells Hatchery (or other genetically similar stocks) strayed into the Big White Salmon River to a greater extent in 1992 than in 1993, as suggested by their intermediate relationship as shown in Figures 2, 4, and 5.

Steelhead from the Wind and Washougal river collections appeared to be genetically distinct from all other populations compared in this study, but were most closely related to steelhead of the coastal form rather than the inland form (Figures 2, 3, 4). The wild populations in this group appeared to have a slight, if any, genetic influence from hatchery strains.

DISCUSSION

Even though most of the steelhead stocks analyzed in this study have had a long history of hatchery stocking, they generally did not appear to have exhibited a loss of genetic variation often associated with low population sizes and hatchery practices (Waples 1991a). The lowest percentage of polymorphic loci at the 1% criterion in coastal/Puget Sound collections was observed in summer-run collections (Deer Creek and North Fork Skykomish River). However, some of the variation at this level in collections from other streams may have been due to alleles introduced through hatchery stocking. The Deer Creek stock is known to have suffered