Genetic Sampling of *Oncorhynchus mykiss* in the Upper McCloud River Drainage

July 8th-11th, 2008

Heritage and Wild Trout Program
The Resources Agency
California Department of Fish and Game

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Introduction:

The McCloud River in northern California is a major tributary of the Sacramento River and is home to wild and native stocks of rainbow trout (*Oncorhynchus mykiss spp.*) (Figure 1). A portion of the McCloud River is designated as a Wild Trout Water, with restricted fishing regulations on the section of the river from Lake McCloud Dam downstream to the southern boundary of Section 36, T38N, R3W in Shasta County. However, there is a long history of stocking, movement of fish, and other human manipulation to this river system's fisheries, including the establishment of the first fish hatchery in California on the lower McCloud River in the late 1800's (Behnke 2002).

Ancestral forms of trout native to the headwaters of the Sacramento River that predate the more modern invasions of coastal rainbow trout (*O. m. irideus*) include the McCloud River redband (*Oncorhynchus mykiss stonei*) (Behnke, 2002). One isolated population of presumed McCloud River redband, in Sheepheaven Creek, is currently considered to be the most genetically differentiated form of redband trout in California and may, in fact, represent a distinct subspecies (Simmons 2008). Morphological characteristics of these fish vary greatly across this large watershed and there is a concerted effort to study the genetic composition of trout throughout the headwaters of the McCloud River drainage in order to better understand the phylogenetic relationships among these fishes. In July, 2008 the Heritage and Wild Trout Program (HWTP) sampled numerous McCloud River headwater streams in support of this effort and collected tissue samples from rainbow trout for genetic analysis.

Methods:

Survey locations were selected by the California Department of Fish and Game (DFG), North Coast Region biologists. From July 8th through 11th, 2008, teams of two to three HWTP staff visited various tributaries at specific station locations (stations were selected based on proximity to roads; see Figure 2). If water was present, HWTP personnel conducted single-pass backpack electroshocking of select fish habitat to determine the presence or absence of fish. All captured fish were identified to species and measured to the nearest millimeter (fork length). Tissue samples of rainbow trout were collected (currently assumed to be "rainbow" trout until further genetic analyses are performed).

Most streams were sampled at multiple access points to document flow levels, wetted connectivity, and to provide tissue samples from throughout the system. If water was present, temperature (both water and air, in the shade), specific conductivity, and water clarity were measured prior to electroshocking each stream. At each access point on a given stream, GPS coordinates and flow conditions were recorded. In addition, unique attributes such as dry stream segments, barriers to fish migration, and/or land use practices (such as logging) were noted. Likely fish habitats (mainly pools) were sampled with a Smith Root backpack electroshocker; settings were determined based on water conditions. The habitat type(s) sampled were recorded on datasheets, along with a visual estimate of streamflow. Fish were collected, processed, and immediately released back into the habitat from which they were sampled.

HWTP personnel did not attempt to collect all fish within a given stream segment or habitat unit. Instead, we tried to collect samples from various locations throughout each stream. This approach was implemented to both minimize the potential negative impacts to fish populations in these small streams which, at the time surveys were performed, were concentrated in deeper pool habitats and isolated by areas of intermittent or non-existent flow, as well as to increase the likelihood of obtaining samples that represented maximum genetic diversity in the system. All fish were identified to species and fork length measurements were recorded. Tissue samples were collected by removing a portion of the caudal fin with a pair of scissors, per University of California at Davis Genomics Variation Laboratory Tissue Collection Protocols (Stephens, pers. comm.). Each tissue sample was placed in a labeled envelope with a unique identification number that corresponded to information recorded for that fish on the datasheets. Representative photographs were taken of the specimens collected. Tissue samples were given to HWTP North Coast Region biologists at the end of the sampling week.

Figure 1. Location of McCloud River drainage

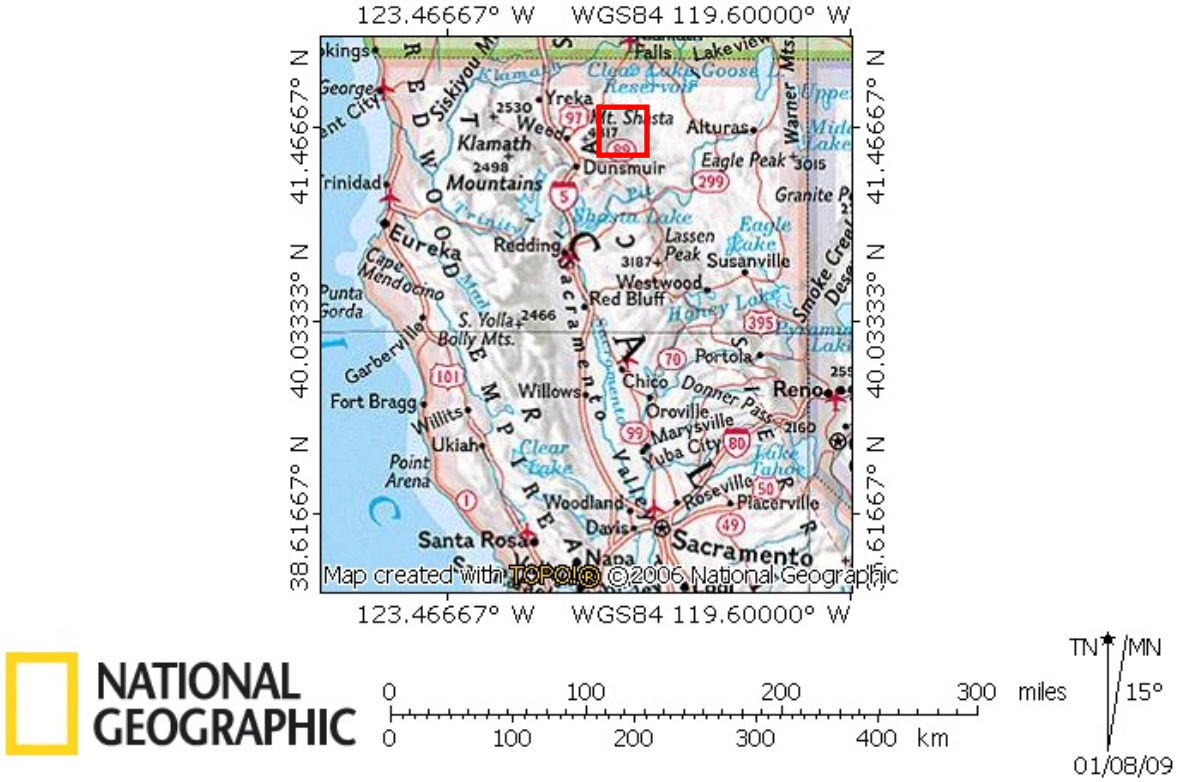
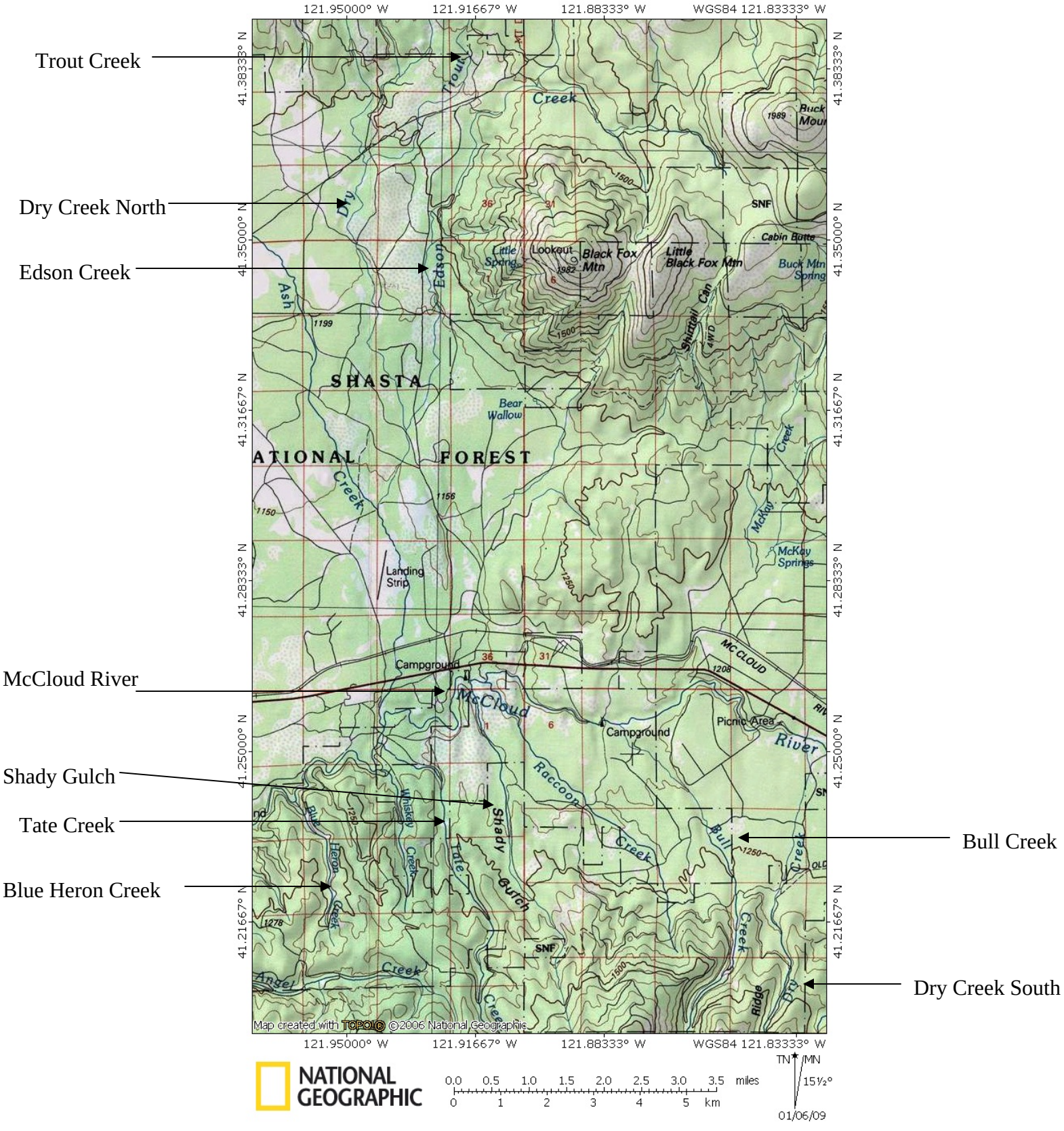


Figure 2. Location of streams surveyed in 2008 (McCloud River, Bull Creek, Shady Gulch, Tate Creek, Edson Creek, Blue Heron Creek, Trout Creek, Dry Creek North, and Dry Creek South)

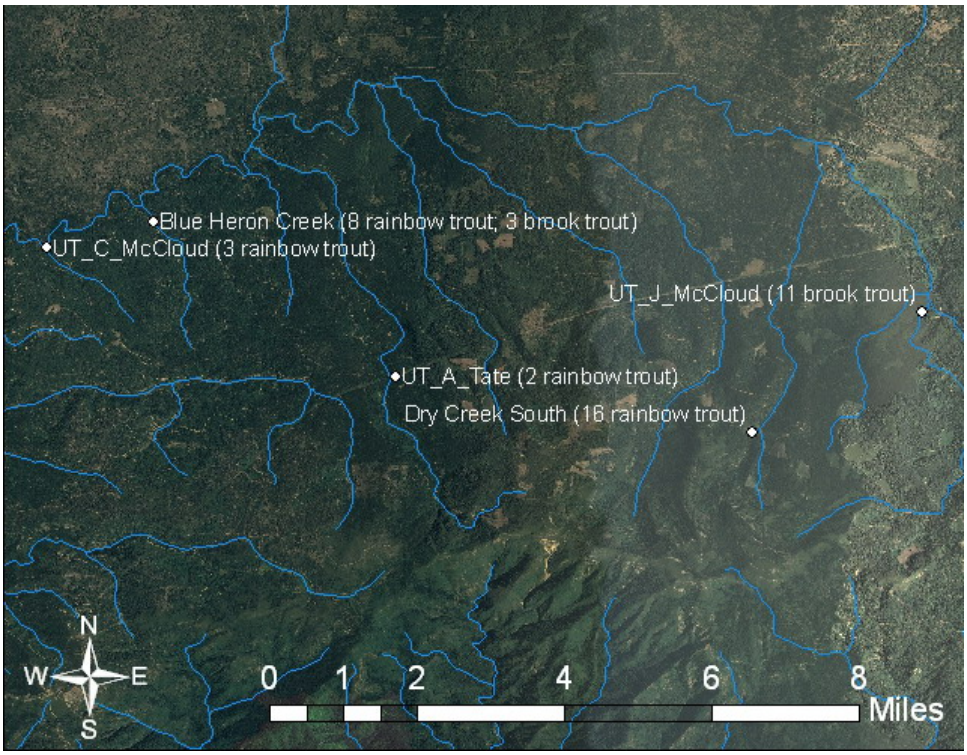


Results:

McCloud River tributaries

Six unnamed tributaries to the upper McCloud River were surveyed from July 9th through 11th (at 14 different stations), four of which had water present. Of the four tributaries that contained water, only two were shockable (heavy vegetation, minimal flows, and/or time constraints prohibited shocking on the others). Trout were captured in both streams containing sufficient water to shock (Figure 3). One of these streams (identified as UT_C_McCloud by DFG North Coast Region biologists) contained rainbow trout; three were captured and tissue samples were taken from each of these fish. Habitat sampled consisted of a pool with a water temperature of 11º Celsius (C) and approximately one cubic foot per second (cfs) of discharge. Fork lengths of the rainbow trout were measured between 94 and 124 millimeters (mm). The other shockable unnamed McCloud tributary, referred to here as UT_J_McCloud, contained pool and riffle habitat and was sampled at one station; 11 brook trout (*Salvelinus fontinalis*) were captured. Flow was estimated at one cfs and water temperature was 9.4º C. The brook trout ranged in size from approximately 20 to 170 mm fork length. Riparian vegetation was dense in this area, the stream was difficult to access, and electrofishing was only feasible in certain areas.

Figure 3. Map of station locations where fish were captured during the 2008 electrofishing effort



Bull Creek tributaries
On July 10th, 11 tributaries to Bull Creek were surveyed (one station per stream). Seven of these tributaries had water, all estimated at less than two cfs. The remainder of the survey stations were dry. Water temperatures ranged from 9º to 11º C. Zero fish were captured; however, there appeared to be excellent fish habitat including riparian vegetation so thick that walking along the stream was difficult, good canopy cover from alders, numerous benthic macroinvertebrates in the stream, and many small pools that were over one foot deep.

Shady Gulch tributaries
Two tributaries to Shady Gulch were surveyed on July 10th and 11th at various locations (seven stations). Both streams were intermittent; where flow was observed, it was estimated at less than two cfs. The riparian vegetation was thick, making electroshocking difficult. Water temperatures were between 7.5º and 10º C. The electrofishing effort and visual observation in areas where vegetation was too thick to electroshock yielded zero fish.

Tate Creek tributary
One tributary to Tate Creek was sampled at two stations on July 10th. Habitat consisted of riffles and pools with a discharge of approximately one cfs. Water temperature was between 5.5º and 8.9º C. Two rainbow trout were captured and tissue samples collected (fork lengths of 112 and 170 mm) (Figure 3).

Edson Creek tributaries
On July 8th, 11 tributaries to Edson Creek were sampled (12 stations). With the exception of one isolated pool at one station, all other stations were dry. The pool observed was spring-fed and too deep to safely electroshock; surveyors visually examined the pool and saw no fish.

Blue Heron Creek
Two stations on Blue Heron Creek were surveyed on July 9th. One station had approximately 1.5 cfs of water and eight rainbow trout and three brook trout were captured in a plunge pool (Figure 3). Tissue samples were collected from the rainbow trout. Rainbow trout ranged in size from 47 to 105 mm fork length; the brook trout were between 116 and 200 mm in length. Water temperature was 12.2º C. At approximately one-quarter mile upstream of this station, the streambed was dry. There was a culvert located at this station that may be a barrier to upstream fish migration. In the pool sampled downstream of the culvert, only brook trout were captured. Conversely, only rainbow trout were found above the culvert.

Trout Creek
Four tributaries to Trout Creek were surveyed on July 9th (12 stations). All stations were dry. There was evidence of extensive logging in this area and at numerous stations, there was no discernible channel.

Dry Creek North and tributaries

On July 8th and 9th, the main-stem of Dry Creek North and 10 tributaries were surveyed (23 stations). The main-stem was surveyed at five stations; there was flow at one of these stations, estimated at less than one cfs. Water temperature was 12.2º C and habitat consisted of flatwater (a run), riffle, and pool. The electrofishing effort yielded zero fish. The remaining four stations on Dry Creek North, including at the confluence with Trout Creek, were dry at the time of the survey. Trout Creek, near the confluence with Dry Creek North, was also dry. Two of the tributaries to Dry Creek North had water, both at less than .5 cfs. Zero fish were captured. The remaining survey stations were either dry or no streambed was found; this area has been heavily logged and there are numerous roads.

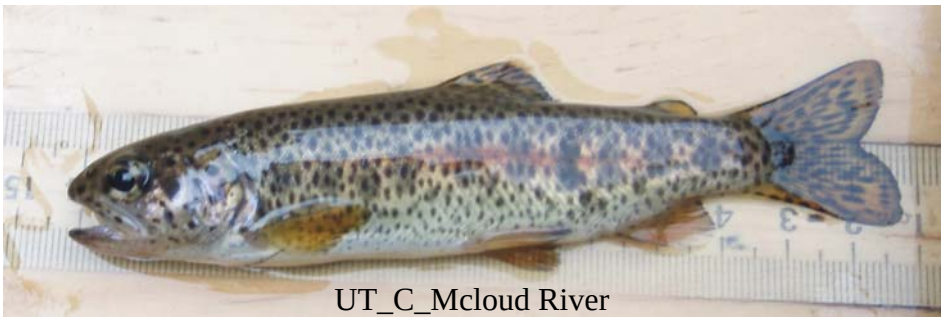
Dry Creek South

Four stations on Dry Creek South were surveyed on July 10th and 11th. Discharge ranged from zero to two cfs; flow along Dry Creek South was intermittent. At one station (located the farthest downstream and closest to the McCloud River), brook trout were observed in isolated pools. We did not electroshock these pools. Farther upstream, at another station, 16 rainbow trout were captured and tissue samples were collected from 15 of these fish (one fish had deformed fins and was not sampled) (Figure 3). Habitat sampled consisted of a pool and short riffle section. Fork lengths ranged from 54 to 173 mm. Water temperature at this station was 10º C.

Figure 4. Comparison of rainbow trout captured from various Upper McCloud River tributaries. Photographs provided by Bill Jong, DFG Northern Region

Sheepheaven Creek

Blue Heron Creek



UT_C_Mcloud River

UT_A_Tate Creek

Discussion:

In total, eight HWTP personnel spent four days surveying 48 tributaries, 20 of which had water present in at least one of the survey station locations. The HWTP captured 29 rainbow trout and 14 brook trout throughout the survey effort. These trout were collected from five different streams: Dry Creek South, Blue Heron Creek, an unnamed tributary to Tate Creek, and two unnamed tributaries to McCloud River (Figure 3). Tissue samples were collected on all but one of the rainbow trout. It was hot and dry in July when sampling occurred and, at this time, most of the streams were intermittent due to either evapotranspiration, subterranean flow, or both. It was difficult to assess whether there are barriers to fish migration on all these tributaries during higher flow stages; however, at many of the road crossings, culverts were poorly installed and showed evidence of scour with plunge pools on the downstream side. Some of these culverts may be barriers to fish migration. A more comprehensive habitat assessment at all of these sites to determine locations of effective barriers and delineate areas of habitat degradation (principally due to ongoing logging and grazing practices) should be pursued. In the event that one or more of these populations are determined to be redbands, stressors and other factors that might negatively influence their persistence need to be better understood and addressed in order to protect redband genetic diversity in the McCloud River drainage. All genetic tissue samples were sent to the University of California at Davis Genomic Variation Laboratory and are undergoing analysis.

Conclusion:

This effort is part of a much larger endeavor being conducted by DFG Northern Region biologists to better understand the phylogenetic relationships of presumed redband trout populations in the upper McCloud River system (as well as other redbands in different geographic areas of California). Results are currently pending genetic analyses of tissue samples and summary reporting by DFG Northern Regional biologists.

References:

Behnke, Robert. 2002. Trout and Salmon of North America. Chanticleer Press, Inc. NY.

Simmons, Rachel and B. May. 2008. Redband Trout Genetics Report. Genomic Variation Laboratory, University of California, Davis.