Trinity River Restoration Program Performance Measure:

# Distribution of Natural-Origin Chinook Salmon Spawners

**Hypothesis:** Re-initiation of channel-forming processes in the Trinity River will change the distribution of salmon habitat. The distribution of natural origin spawners will respond to (a) physical changes in the river that influence the distribution of suitable spawning habitat, and (b) changes in rearing habitat that spatially influence the distribution of "successful" redds (those that produce fish that survive to adulthood).

**Importance:** The mainstem spawning distribution of natural-origin Trinity River Chinook salmon upstream of the Burnt Ranch Gorge is currently skewed toward Lewiston Dam; the distribution of hatchery origin fish much more so (Sinnen 2004, Knechtle and Sinnen 2006, Hill 2009, Hill 2010, Chamberlain et al. (In review). We postulate that the spatial distribution of returning natural-origin spawners (hatchery fish excluded) is influenced not only by the spatial distribution of spawning habitat, but by the distribution of deposited eggs that successfully produce fry that survive to adulthood. In the Salmon River Basin of Idaho, Neville et al. (2006) detected spatial autocorrelation in individual genotypes of female Chinook salmon at scales down to 1 km, suggesting a strong homing tendency to natal habitats among females at that spatial scale. As the success of eggs deposited in mainstem redds (nests) increases in response to improved rearing habitat conditions, we expect spawning distribution to be driven increasingly by distribution of habitat (and successful rearing) rather than proximity to the hatchery (and high density of hatchery strays).

**Objective:** The objective of this assessment is to provide the Program a measure of the influence its management has on the magnitude and distribution of mainstem Trinity River natural origin salmon production.

This assessment feeds evaluation of *multiple* objectives from the Integrated Assessment Plan (Trinity River Restoration Program and ESSA Technologies 2009), perhaps the primary being:

Sub-objective 3.1: Increase spawning success of anadromous spawners

3.1.1 Optimize adult utilization of suitable spawning habitat areas in the mainstem within 3-4 brood cycles following rehabilitation of fluvial river processes

**Targets, Predicted or Desired Response:** The primary desired response of natural origin Chinook salmon spawners to rehabilitation is increased production. We expect that, in order to accomplish this, the distribution of spawners will need to be less skewed toward mainstem habitats near Lewiston Dam/Trinity River Hatchery, to disperse juvenile salmon production across a larger spatial area.

**Technical Approach:** The locations of Trinity River mainstem salmon redds are mapped annually from Lewiston Dam to Weitchpec (the Burnt Ranch Gorge excluded). Proportions attributable to construction by natural- and hatchery-origin Chinook salmon females are estimated by modeling the distribution of hatchery-marked fish among recovered carcasses (data collected concurrent with redd mapping efforts). Chamberlain et al. (In review) evaluated the mean distance from Lewiston Dam across the years 2002 to 2010 to assess response of redd distribution to rehabilitation efforts (using linear regression). These data are also provided to rehabilitation design teams for evaluation of project-specific response of spawning salmon to newly constructed surfaces (constructed side channels, bars, etc.).

**Results:** Constructed rehabilitation sites have had only a few years to evolve and respond to flow, sediment, and riparian processes, and the response to these by the distribution of Chinook salmon spawning will take time. There is considerable "noise" in the figure for mean distance downstream from Lewiston Dam that natural origin Chinook salmon redds are constructed, but it does appear to be increasing over time since 2002 (Figure 1).

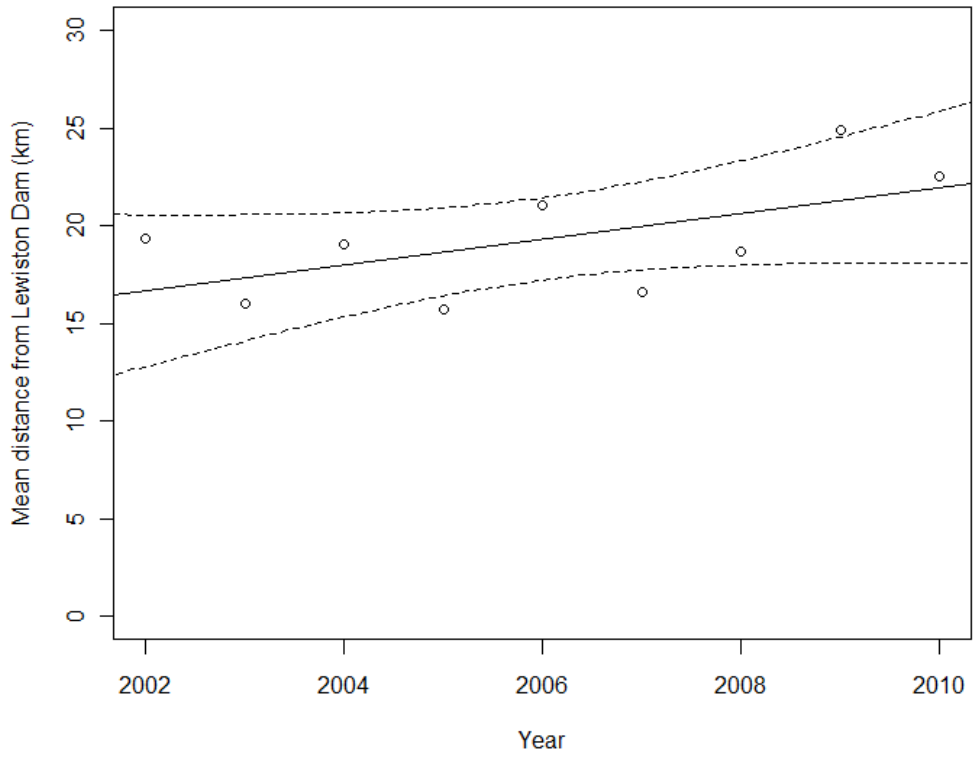


**Figure 1. Yearly mean distance from Lewiston Dam of natural-origin Chinook salmon redds constructed by year appears to be increasing (adjusted $r^2 = 0.25$; $p = 0.096$). Solid line represents the trend over time and dashed lines are 95-percent confidence limits (from Chamberlain et al. In review).**

Due to the high rate of use of in-river spawning habitats near the Trinity River Hatchery by hatchery-origin Chinook salmon (as high as 70 percent of the females in some years), many of the "natural-origin" fish returning to spawn there are likely offspring of hatchery-produced fish homing to their "natal" spawning area. Figure 2 below in no way fully characterizes hatchery influence on in-river spawning grounds, as offspring of hatchery fish that spawn in the river are unmarked and cannot be differentiated from fish with natural-origin parentage. Maximizing the production and return of Trinity River natural-origin Chinook salmon will likely be achieved by a combination of strategies that maximizes the success of natural-origin redds (river restoration) and minimizes the occurrence of hatchery-origin strays on in-river spawning grounds (hatchery management).

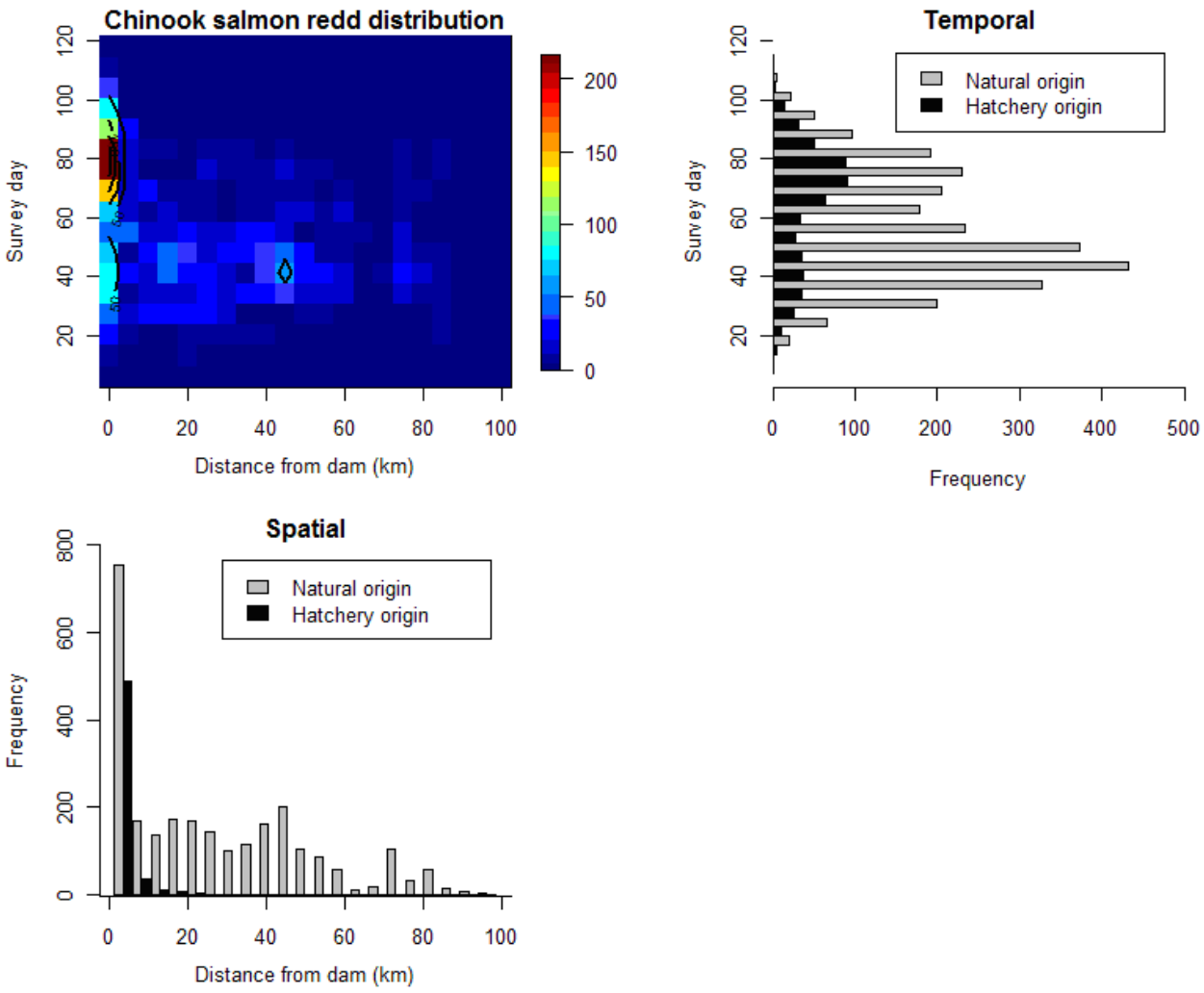


**Figure 2. Fall 2010 distribution of Chinook salmon redds in the mainstem Trinity River from Lewiston Dam to Cedar Flat. The Trinity River Restoration Program reach encompasses river kilometers 0 to 64 (Lewiston Dam to North Fork Trinity River). Survey day 1 to 120 = September 1 to December 29. Distributions of hatchery and natural origin fish differ both spatially and temporally.**

**Recommendations:** In the future, investigators plan to look for correlation in the distribution of rearing habitat and natural origin Chinook salmon spawning. Correlation between the two might help prioritize and target rehabilitation in critical areas that are currently underutilized due to rearing habitat limitations.

Channel responses to rehabilitation require time to evolve though channel-forming influences such as multiple years of variable flow, riparian development, and gravel routing (Larson et al. 2004). Subsequent response of Chinook salmon populations to channel change will likewise require time, full expression may not be realized for multiple Chinook salmon generations.

**Sources of Information:** This assessment is based on annual surveys conducted by the U.S. Fish and Wildlife Service's Arcata Office, California Department of Fish and Game, Yurok Tribe, Hoopa Valley Tribe, and Shasta-Trinity National Forest and reported in Chamberlain et al. (In review).

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