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GUALALA RIVER STEELHEAD PROJECT

JUVENILE STEELHEAD INVENTORY REPORT

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INTRODUCTION

The Gualala River Steelhead Project (GRSP) has engaged in rescue activities of wild, naturally spawned juvenile steelhead in the North Fork Gualala River tributaries of Dry Creek, Robinson Creek, and McGann Gulch for several years. Steelhead have typically been captured in June and July when their natal streams begin drying up and mortalities would result if no action were taken. The fish are brought to the Doty Creek rearing facility for "grow out" during the summer and early fall. The facility-reared fish have traditionally been released at several locations in the North Fork Gualala River where they continued rearing and/or imprint prior to smoking and migration to the estuary.

An issue has been raised by the California Department of Fish and Game (DFG) regarding potential impacts the release of these fish would have on juvenile steelhead that may already be inhabiting the receiving waters. Their concern is that the released fish would overwhelm the carrying capacity of the stream and have an adverse effect on the naturally reared fish. To help address this concern, the DFG would like all the artificially-reared fish be released downstream of the confluence of the North Fork and mainstem Gualala River where adverse effects may be minimized. There is little information regarding the optimal densities for salmonids in northern California. However, a number of studies have looked at the effects of fish density on growth, survival, and behavior.

Carrying capacity is defined as the greatest weight of fish that a stream can naturally support during the period of least available habitat (Burns 1971). Burns (1971) found that biomass per unit of surface area was the best method of expressing carrying capacity. Of the seven water quality and physical factors considered by Burns, only living space variables correlated significantly with biomass. In his study of NF Caspar Creek, Burns (1971) found decreasing availability of living space caused the greatest mortality, with total mortality highest in the summer of lowest streamflow. The density (fish/m^2) of fish also appears to have an influence on growth and survival of juvenile salmonids in streams.

Slaney and Northcote (1974) found prey abundance affects underyearling rainbow trout density in simulated field conditions. Territory size was found to be larger and aggressive behavior more frequent, at lower prey abundance levels. Slaney and Northcote (1974) considered territorial behavior an important mechanism for limiting the density of stream dwelling salmonids. Hearn (1987) reported coho salmon use one of three distinct feeding strategies: territoriality, nonterritorial schooling, and an intermediate floater strategy. Hearn (1987) also reported that territorial fish appeared to have a net energy intake advantage over the other fish as the result of reduced costs associated with searching and pursuit of prey. Factors influencing the size of a territory include visual isolation, fish size, initial density, and abundance of prey organisms. At high densities, competition may lead to dispersal, downstream displacement, or mortality (Hearn 1987). Harvey and Nakamoto (1996) reported juvenile steelhead survival was lower at an experimental density of 3 fish/m^2 than in the natural density (1.5 fish/m^2) in the South Fork Caspar Creek.

Densities of steelhead in the Gualala River drainage increase and decrease depending on the season of year. The spring outmigration of smolts results in density decreases. The emergence of fry from the gravel in the spring and early summer increase densities. The relatively low survival rates of young-of-the-year steelhead (10-15%) during the first year reduce densities. Densities can increase as more fish become crowded in a smaller area as water levels decrease in summer and early fall. In addition to these seasonal changes, there may be a fall outmigration of steelhead smolts in the Gualala Basin. Members of the GRSP have reported seeing an influx of steelhead smolts in the estuary in the fall (Bill Ackerman, pers. comm.). Steelhead smolting during the fall has also been observed during long-term underwater surveys from 1996 to 1999 in the Mad, Eel, Van Duzen, and Trinity Rivers (Halligan 1997, 1998, 1999; Jensen 2000).

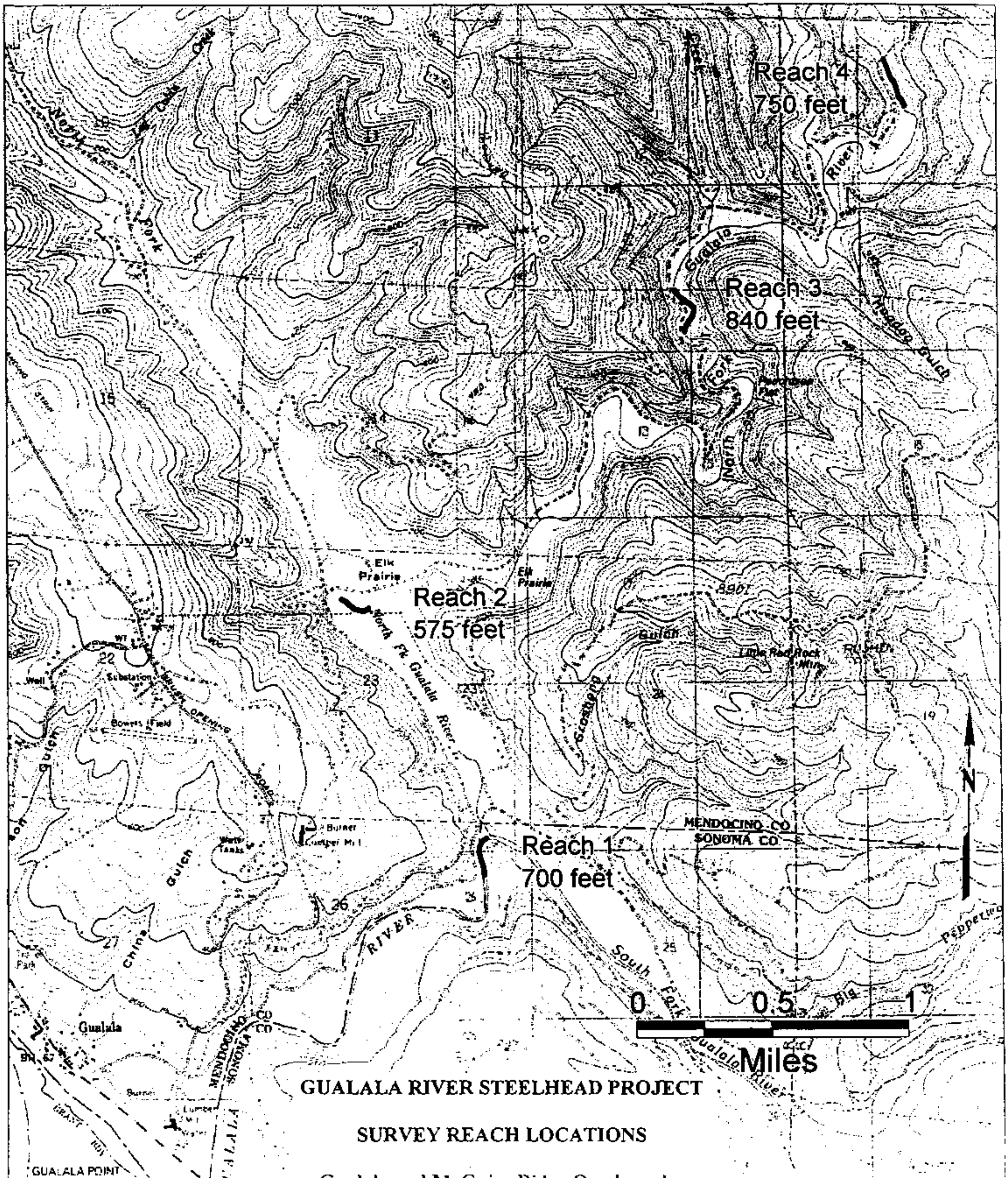
As stated above, there is little information regarding the optimal densities for salmonids in northern California. The only report that comes close to suggesting an optimal upper limit is Harvey and Nakamoto (1996) when they observed a significant decline in juvenile steelhead survival rates when densities rose from 1.5 fish/m^2 to 3 fish/m^2 in the South Fork Caspar Creek. Due to the scarcity of numerical data relating to density dependent behavioral and survival changes, this report will compare juvenile steelhead densities in the North Fork Gualala River and mainstem Gualala River to other streams in Mendocino, Sonoma, and Humboldt counties. This approach is correlative rather than experimental.

METHODS

Underwater observations were conducted on September 16 and October 13, 2000 in four survey reaches within the mainstem Gualala River and the North Fork Gualala River to obtain estimates of salmonid abundance and densities (See Table 1 and Figure 1). The survey reaches were established with one to two and a half miles of separation to get a better representation of fish numbers in a variety of habitats. Each of the three survey reaches in the North Fork Gualala River contained several pool/riffle sequences to capture inter-reach habitat variability. The mainstem Gualala River reach was contained entirely within a corner pool. The October survey was planned to occur either after the first rain or when smolts were reportedly observed in the estuary.

The surveyor entered each reach from the downstream end and proceeded slowly upstream while counting individuals of different age classes. Fish counts were periodically recorded on a dive slate carried by the observer. To avoid double-counting individuals, any fish that entered the diver's view from a downstream direction were not enumerated. The juvenile salmonids tended to move downstream once they observed the surveyor and were aided in this endeavor by the diver allowing room for passage. In a minority of cases, some fish would move upstream. That number of fish was subsequently subtracted from the final result. Fish that fell into the Age 3+ category were assumed to be juvenile steelhead, although they might have been resident rainbow trout.

Estimates of fish density were determined by dividing the number of fish observed by square meters of survey area. Upon completion of each dive, the surveyor recorded reach length and width dimensions, species, number of fish within each age class, and location information on



GUALALA RIVER STEELHEAD PROJECT

SURVEY REACH LOCATIONS

Gualala and McGuire Ridge Quadrangles

T 11 N, R 14 W, Sec. 7
T11N, R15W, Sec. 13, 23, & 26

standard underwater observation field forms as described by Flosi et al. (1998). The surveyor also recorded general habitat information including pool:riffle ratios, instream cover types, and dominant substrate.

Table 1: GRSP survey reach locations and dimensions

Reach	Location	Length (m)	Width (m)	Area (m^2)
1	Mainstem - 100' downstream North Fork	213.3	18.3	3,903
2	NFG - 100' upstream of Little North Fork	175	6.1	1,068
3	NFG - 2,500' downstream of Robinson Ck.	256	5.5	1,408
4	NFG - 3,500' upstream of Dry Ck.	228.6	4.6	1,052

RESULTS

Reach 1, downstream of the mouth of the North Fork, was 213 meters long and contained relatively simplified habitat. The entire reach was a corner pool with rock slope protection along much of the right bank with mean and maximum depths of two and five feet respectively. The reach contained no large woody debris (LWD) with cover provided almost entirely by riprap. There was no overhanging canopy. The dominant substrate was sand. Winter rearing habitat quality appeared to be poor and restricted to interstitial spaces between riprap boulders, which are located along the outside of the meander where water velocities are highest. Water velocity was low and juvenile steelhead were absent during September survey with only 12 observed in October (Table 2)

Reach 2 was located 30 meters upstream of the confluence of the Little North Fork and North Fork Gualala rivers. The survey reach was 175 meters long and contained very complex habitats with a pool to riffle ratio of approximately 1:2. Instream cover was supplied by LWD, small woody debris (SWD), undercut banks, and overhanging terrestrial vegetation. The reach contained primarily gravel substrate with sand in the pools. Winter rearing habitat appeared to be of moderate quality and supplied by LWD, floodplain vegetation, backwater areas, and access to the Little North Fork. Fish may be able to find some high flow refugia upstream in the North Fork. There were 109 and 117 juvenile steelhead observed in September and October respectively. Several habitat units suitable for rearing contained low numbers of steelhead. The densities of fish for those surveys were basically the same at 0.1 fish/m^2

Reach 3 was located at Mile 4 on the North Fork haul road approximately 760 meters downstream of Robinson Creek. The survey reach was 256 meters long and contained moderately complex habitats with a pool to riffle ratio of approximately 1:2. Instream cover was supplied by SWD, undercut banks, overhanging terrestrial vegetation, some riprap, and bubble curtains. The reach contained primarily cobble/gravel substrate with some sand in the pools. Winter rearing habitat appeared to be of moderate quality and supplied by undercut banks, large substrate, access to floodplains, and edgewaters. There were 180 and 210 juvenile steelhead observed in September and October respectively. Several habitat units suitable for rearing contained low numbers of steelhead. The densities of fish were 0.13 and 0.14 fish/m^2 for the respective surveys.

Table 2: September and October, 2000 juvenile steelhead observations by size class, density, and stream length.

Reach	Age Class	Number by Age Class		Density (fish/m^2)		Fish per meter of stream length	
		Sept.	Oct.	Sept.	Oct.	Sept.	Oct.
1	YOY	0	0	0	0	0	0
	1+	0	3	0	0.0008	0	0.014
	2+	0	7	0	0.002	0	0.033
	3+	0	2	0	0.0005	0	0.01
Total		0	12	0	0.003	0	0.047
2	YOY	33	22	0.03	0.02	0.19	0.13
	1+	64	83	0.06	0.08	0.37	0.47
	2+	9	12	0.008	0.01	0.05	0.07
	3+	3	0	0.003	0	0.02	0
Total		109	117	0.101	0.11	0.63	0.67
3	YOY	99	60	0.07	0.04	0.39	0.23
	1+	73	133	0.05	0.09	0.29	0.52
	2+	8	16	0.006	0.01	0.03	0.06
	3+	0	1	0	0.001	0	0.004
Total		180	210	0.126	0.14	0.71	0.81
4	YOY	18	37	0.017	0.035	0.08	0.16
	1+	34	65	0.03	0.062	0.15	0.28
	2+	10	18	0.009	0.017	0.04	0.08
	3+	7	2	0.007	0.002	0.03	0.009
Total		69	122	0.063	0.12	0.3	0.53

Reach 4 was located approximately 0.5 miles up the North Fork haul road from Dry Creek. The survey reach was 229 meters long and contained moderately complex habitats with a pool to riffle ratio of approximately 1:2. Instream cover was supplied by SWD, undercut banks, overhanging terrestrial vegetation, and a small amount of LWD. The reach contained primarily cobble/gravel substrate with some sand in the pools. Winter rearing habitat appeared to be of moderate quality and supplied by undercut banks, large substrate, edgewaters, and access to floodplains and October respectively. Several habitat units suitable for rearing contained low numbers of steelhead. The densities of fish were 0.06 and 0.12 fish/m^2

DISCUSSION

The use of underwater observation, instead of electrofishing, to determine fish densities introduces a level of uncertainty in the results. This uncertainty arises from the potential for measurement error due to double counting, not observing fish that were present, and underwater recording inaccuracies. However, the use of an experienced surveyor can reduce the amount of potential error, maintain observation and methodological consistency, and enable the collection of reasonably accurate data. In addition, underwater observation eliminates the potential for the types of injury or mortality that has been associated with electrofishing. Therefore, while I believe the methodology utilized for this project does not generate information as precise as depletion electrofishing, the data are sufficiently accurate to draw some conclusions regarding the numbers and densities of juvenile steelhead in the project area. The data are also useful for making general comparisons with results of studies from other areas.

Fish densities in the North Fork and mainstem Gualala River survey reaches appear to be relatively low when compared to other watersheds in the region (Table 3). In some cases, there is an order of magnitude difference. This information, when combined with the observations that some GRSP habitat units contained low numbers of fish, may indicate that there is suitable habitat available for additional individuals.

Table 3: Juvenile steelhead density information from the Gualala River basin and other watersheds in northern California.

Year	Location	Juvenile Steelhead Density (fish/m^2)	Source
1952	Lower Gualala River	0.39	Kimsey (1952)
1967-1969	N. F. Caspar Creek	0.5-1.39	Burns (1971)
1988-1991	Little N.F. Gualala R.	0.22-1. 48 (0.52 ave.)	CDFG (1991)
1993	N. F. Caspar Creek	1.5	Harvey and Nakamoto (1996)
1994-1995	Little River and Tribs. Humboldt County	0.3-0.58	Louisiana-Pacific unpublished data
1998	Freshwater Creek, Humboldt County	0.32	Pacific Lumber Co. unpublished data
1999	Freshwater Creek, Humboldt County	2.01	Pacific Lumber Co. unpublished data

Entrix (1992) conducted fish population sampling in the South Fork Gualala River between the Wheatfield Fork and Buckeye Creek from October 7 to 10, 1991. The juvenile steelhead abundance averaged 80 fish per 100m for all habitat types combined (Entrix 1992). The South Fork estimates are comparable to those found during the GRSP survey in the North Fork that averaged 30-71 fish per 100m in September for all habitat types and 53-81 fish per 100m in October, 2000. The South Fork generally contains habitats of lower complexity and higher water temperatures than the North Fork. In addition, Entrix conducted their study during the latter part of the 1986-1993 drought, which may have resulted in reduced numbers. It is reasonable to suspect that the North Fork in the year 2000, with its better spawning and rearing habitat quality and cooler water temperatures, should have significantly greater numbers of fish per 100m than the drought stricken South Fork in 1991. This may indicate that the North Fork is currently not at carrying capacity for rearing steelhead.

As stated above, Burns (1971) found decreasing availability of living space caused the greatest mortality, with total mortality highest in the summer of lowest streamflow. The GRSP generally releases their fish after the fall rains have started. Therefore, the release timing corresponds with reduced potential for density-dependent mortality and increasing availability of living space and streamflow. In addition, the facility-reared fish are typically released at several locations along a five-mile reach of the North Fork, which further reduces the potential for adverse impacts to naturally reared steelhead.

As reported in the Introduction, there have been repeated observations of downstream migrations of steelhead smolts during the fall in several northern California rivers. These migrations generally occurred with the onset of rains, cooling water temperatures, and decreasing daylight hours. The fall arrival of steelhead smolts has been observed in this and previous years in the lower mainstem Gualala River and estuary (Bill Ackerman, pers. comm.). These downstream migrations reduced fish densities in upstream areas.

I had an opportunity to inspect the holding tanks at the Doty Creek rearing facility on October 13, 2000. It appeared that many of the steelhead in the tank containing the larger individuals were losing their parr marks and beginning their transformation to smolts. These fish would likely remain in the proposed release areas for only a short period, prior to migrating to the estuary. Therefore, the potential for these fish to exacerbate density-dependent impacts would be minimized due to their short residence time.

Winter rearing habitat quality should be a concern when selecting release sites for fish. This is especially true with the onset of the rainy season and high flows. Bustard and Narver (1975) found that winter cover used most frequently by coho and age 1+ steelhead was logs and upturned tree roots, although debris accumulations and overhanging banks were also used. Habitat observations conducted during the dive survey showed the reach downstream of the mouth of the North Fork contained poor winter rearing habitat. The entire reach from the North Fork to the estuary is subject to high flows generated by the entire 180,000-acre watershed. Other than edgewaters and riprap there are few places where juvenile salmonids can find refuge. By contrast, the North Fork contains moderate quality winter rearing habitat in the form of undercut banks, backwaters, LWD, large substrate, floodplains, and access to tributary streams. Winter survival would likely be much higher for released fish in the North Fork than in the lower mainstem.

There is potential for artificially reared steelhead not to return to the North Fork Gualala River and its tributaries (their natal locations) if they are released in the lower mainstem Gualala River. Quinn (1997) reported when planted from a hatchery to a river, salmon tend to return to the point of release. Quinn (1997) also reported steelhead released in the lower portion of a river tend to be caught only in the lower portion of that river, and fish released in the middle or upper portion tend to be caught in all parts of the river downstream from the release site. Studies indicate that maturing salmon tend to reverse the sequence of their outward migration as juveniles. This will lead them to the river or hatchery where they began life. Displaced salmon return first to the odors of their release site and will continue to the rearing site if its odors can be detected. If not, they seem to seek the nearest river or hatchery (Quinn 1997).

The rescued fish are native to the North Fork tributaries. As such it would be desirable to release them in the North Fork and have the smolts imprint on waters in the vicinity of their natal stream, if not in the tributaries themselves. This way if the returning adults do not find adequate spawning habitat in the North Fork they may have a high likelihood of straying into their natal streams and help perpetuate those runs.

CONCLUSION

Based on the low density of juvenile steelhead and presence of underutilized habitat units, it appears that the North Fork Gualala River may not be at carrying capacity for salmonids. The arrival of the fall rains and increased runoff regimes should increase the usable area available for salmonids and reduce the potential for density dependent mortalities of steelhead. The fall downstream migration of naturally and artificially reared smolts and multiple release locations would also likely reduce potential for density dependent impacts from the release of the rescued steelhead. The winter survivability of steelhead parr may be greater in the North Fork than the lower mainstem. Straying of returning adults into non-native streams may be reduced if the smolts are allowed to imprint in the North Fork.

It is my opinion that release of the artificially reared native steelhead into the North Fork would have minimal impact on the naturally reared fish currently present. In addition, greater survivability may result from release into the North Fork than in the lower mainstem.

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