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Results of Fish Snorkeling Surveys on The Tuolumne River

At approximately 4,820 km^2, the watershed of the Tuolumne River in California is one of the largest tributaries to the San Joaquin River and home to a diverse array of both native and non-native fishes (Brown and Ford 2002). Multiple dams, diversions and hydroelectric power plants have altered the natural flow regime of much of the lower reaches of the river while leaving the upper reaches with a relatively unimpaired hydrograph. It has been suggested that unnatural flow regimes can support non-native fish populations (Moyle and Light 1996), whereas flow regimes, that mimic the seasonal patterns of the unimpaired hydrograph, can have the potential to increase the spawning success of native fish, and limit the success of non-natives (Marchetti and Moyle 2001). With this in mind, we expected to find the presence of more native fish species upstream of New Don Pedro Reservoir than below it. For our study, we performed snorkel surveys at different locations along the Tuolumne River, beginning at the headwaters in Tuolumne Meadows and moving down the watershed, all the way to the lower Tuolumne below the La Grange dam. Here we report our findings on the presence of fish species observed in our surveys.

Methods

From June 16, 2015 to June 22, 2015, we visited 9 study sites throughout the Tuolumne River watershed. At most of the sites, various metrics were measured including channel morphology, discharge, sediment size, and BMI. Snorkel surveys for fish were performed as well. The snorkel surveys were performed by at least two people and ran from the top of the study reach to the bottom. Each study reach was defined as the channel section that encompassed 2 repeating hydrologic units. Most fish were identified to species and counted at each site. This method certainly has some bias and is not intended to serve as an approximation of distribution

or abundance, it simply is a record of whether or not a particular species was observed in the study reach or not. Seining was also performed at 2 sites along the river using a 30ft long mesh seine.

Results

The first two snorkel surveys were in Tuolumne Meadows. The reaches both had a total discharge of 3.95 CMS, but the water temperature changed from approximately 8.7˚C at the first study reach and 13.5˚C at the second. A possible explanation for this variation is temperature could be that the first site had more trees on the banks that shaded the channel, or because it was sampled in the morning and the second reach was sampled in the afternoon. The species observed in the two reaches are reported in Table 1. All of the fish observed in Tuolumne meadows are assumed to be non-native because of its elevation and because of the barrier to migration below Hetch Hetchy known as Preston Falls (Moyle, Yoshiyama et al. 1996).

Table 1. Snorkel survey results from two study reaches in Tuolumne Meadows.

Study Reach	Rainbow Trout	Brown Trout	Brook Trout	Unidentified Trout
Reach1	NA	6	36	74
Reach 2	32	4	62	9

The next two surveys were conducted below Preston Falls between Hetch Hetchy and the early intake diversion dam. Discharge for the first site was only calculated for a side channel, because of issues accessing the other channel, and was 0.39 CMS. The total discharge for the second reach was 2.11 CMS. Water temperatures at the sites were 19.5˚C and 22.5˚C, respectively. This historically would have been near the upper limit of fish habitation in the Tuolumne River because of the falls upstream. Therefore, we expected to find more native fish

species here than in the previously sampled sites in Tuolumne Meadows. Results from the snorkel surveys are reported in Table 2. This flow in this section of the river is determined by releases from Hetch Hetchy Reservoir, which are required to be at least 75 CFS (2.1 CMS) for minimum in-stream flows (person communication Adam Mazurkiewicz, Hetch Hetchy Water and Power).

Table 2. Snorkel survey results from two study reaches below Preston Falls and above early intake.

Study Reach	Rainbow Trout	Brook Trout	CA Roach	Sac. Sucker	Riffle Sculpin
1	17	10	161+	75+	1
2	2	1	12	2	3

Below the early intake diversion dam is the main stem Tuolumne, we chose to survey one of the main unregulated tributaries to this stretch, the South Fork Tuolumne, in addition to the main stem. We surveyed two sites on the South Fork, both were within about 200 meters of the confluence with the main stem Tuolumne. The total discharge for the South Fork was 0.72 CMS and the water temperature was 20.9˚C. The main stem was sampled using a seine in Meral's Pool and the total discharge there was 3.63, and the water temperature was 18.1˚C. The results from the snorkel surveys in the South Fork and the seining in Meral's Pool are presented in Table 3.

Table 3. Snorkel survey results from two study reaches on the South Fork Tuolumne upstream of the confluence, and seining data from Meral's Pool.

Study Reach	Rainbow Trout	CA Roach	Sac. Sucker	Pike Minnow
SF Tuolumne: Reach 1	9	19	25	NA
SF Tuolumne: Reach 2	8	Present (not counted)	36	46
Meral's Pool (seine)	NA	NA	1	10

The last section of the river that was sampled was the Lower Tuolumne below La Grange Dam. We surveyed the first site with snorkels and the second site with a seine. The total discharge at the first site was 3.6 CMS and the water temperature was 20.6˚C. Snorkel and seine data are presented in Table 4. We expected to see more non-native species in this section than in the upstream reaches because of the warmer temperatures, and the connectivity to the San Joaquin River and Sacramento-San Joaquin Delta, which have well established introduced populations (Feyrer and Healey 2003). Another potential explanation for why we don't see as many introduced species above this section is the physical barrier to dispersal that La Grange dam and the New Don Pedro reservoir dam provide. Additionally, the lower temperature of the water being released from the bottom of Hetch Hetchy and New Don Pedro reservoirs could discourage non-native dispersal into certain reaches. The effect of water temperature is likely stronger directly below these dams, because as we see with the Lower Tuolumne, temperatures increase further away from the dam.

Table 4. Snorkel survey results from a study reach on the Lower Tuolumne below La Grange dam, and seining data from a site on the Lower Tuolumne near the boat ramp of the Tuolumne River Campgrounds.

Study Reach	Pike Minnow	Spotted Bass	Largemouth Bass	Blue Gill	Sac. Sucker	Hardhead	Red-eared Sunfish	Sculpin
1	143	27	1	100	1	50	100	NA
2 (seine)	6	1	1	2	NA	4	5	3

Discussion

The results from our snorkel surveys and seining have indicated that the Lower Tuolumne, below La Grange dam, has the highest percentage of non-native fish species with half of the species observed being non-natives. Tuolumne meadows is assumed to be fishless

historically, and therefore the fish observed there are technically invasive. However, 2 of the three species observed are native to Sierra Nevada streams. The middle sections of the Tuolumne River below Preston Falls, at the South Fork Tuolumne, and at Meral's Pool have the greatest proportion of native fish species observed. Whether the rainbow trout (*Oncorhynchus mykiss)* there are derived from local populations, or are the descendants of hatchery fish, is unclear and would require genetic analysis. Unfortunately, fish data collected for the *UTREP O'Shaughnessy Dam Instream Flow Management Plan* (SFPUC Natural Resources and Lands Management Division, 2014) for the reach below Preston Falls, only includes data on Rainbow and Brown trout, so we cannot compare our results directly with previous data. The proportion of non-native fish species in the Lower Tuolumne was similar to the ones reported by Brown and Ford (2002). They found that out of 28 taxa collected over an 11-year period, only 10 were native fishes. Although our data is less complete in comparison, because of the small sample size, we *did* observe 3 out the 5 species observed most often by Brown and Ford (2002).

Conclusion

Although our fish surveys for the Tuolumne River are by no means comprehensive, they do provide an insight into the species that are present throughout the watershed. Given that different habitats across the watershed can be incredibly diverse and that many have been altered by human activity, it is essential to continue monitoring ecological and hydrological parameters in the future. These data can be used to inform management decisions across agencies and authorities in order to reconcile human needs with the health of organisms living in the watershed.

Brown, L. R. and T. Ford (2002). "Effects of flow on the fish communities of a regulated California river: implications for managing native fishes." River Research and Applications **18**(4): 331-342.
Feyrer, F. and M. P. Healey (2003). "Fish community structure and environmental correlates in the highly altered southern Sacramento-San Joaquin Delta." Environmental Biology of Fishes **66**(2): 123-132.
Marchetti, M. P. and P. B. Moyle (2001). "Effects of flow regime on fish assemblages in a regulated California stream." Ecological Applications **11**(2): 530-539.
Moyle, P. B. and T. Light (1996). "Fish invasions in California: do abiotic factors determine success?" Ecology: 1666-1670.
Moyle, P. B., R. M. Yoshiyama and R. A. Knapp (1996). Status of fish and fisheries. Sierra Nevada ecosystem project: Final report to Congress.