Salinas Index Reach Monitoring Surveys

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Executive Summary

Index reach monitoring has been conducted intermittently since 2010 to document the distribution and abundance of rainbow trout/steelhead (*Oncorhynchus mykiss*) in the Arroyo Seco, Nacimiento, and San Antonio Rivers. These surveys were included in the draft Biological Opinion for the Salinas River Diversion Facility (NMFS 2007) as a means of assessing the over-summer population abundance and distribution of *O. mykiss* as well as the overall fish community. These surveys now represent one of the longest active monitoring programs for *O. mykiss* in the Salinas Basin.

On October 29 and 30, 2024, FISHBIO staff conducted index reach monitoring using backpack electrofishing at 11 sites across three rivers. These included two sites in the San Antonio River, four sites in the Nacimiento River, and five sites in the Arroyo Seco River (Figure 1). Fish were captured in all sample locations, and 13 different species were captured across all sites. A total of five invasive species – smallmouth bass (*Micropterus dolomieu*), spotted bass (*Micropterus punctulatus*), brown bullhead (*Ameiurus nebulosus*), pumpkinseed sunfish (*Lepomis gibbosus*), and western mosquitofish (*Gambusia affinis*) – were among the captured fish. Invasive species were observed in all streams, but were most abundant in the San Antonio, where we observed the most diverse fish community overall. In the Nacimiento River, we observed extremely low abundance and diversity of fish across all sampling sites. Only 40 fish were observed overall across 4 sampling sites, which was far fewer than the total abundance observed last year at one fewer sampling location (n=245). In the Arroyo Seco River, black bass (spotted and smallmouth bass) were larger in size, more abundant, and more widely distributed than they have been in prior years.

A total of three *O. mykiss* were observed, all of them in the Arroyo Seco River, where they were observed at two of the five sampling locations. This represents a notable decrease in the population from the prior year when 15 *O. mykiss* were observed at the same monitoring locations. Additionally, all *O. mykiss* captured this year were found in more upstream locations compared to previous years. The observation of only three *O. mykiss* in the Arroyo Seco River was somewhat unexpected given past survey results and the consecutive wet years that occurred in 2023 and 2024. The distribution of *O. mykiss* being centered further upstream than in years past suggests that poor temperature conditions in the river throughout the summer and early fall may have resulted in *O. mykiss* remaining in the upstream portions of the watershed. No young-of-year individuals were observed this year as they have been in past years, and therefore we are unable to speculate whether there were suitable habitat conditions for successful spawning in 2024. However, the inability to sample in in the upstream reaches of the watershed, for the second consecutive year, precludes the ability to further investigate these hypotheses.

Changes in survey methodology over the years limit the ability to make direct comparisons with surveys in prior years, especially prior to 2023 when survey locations were modified. However, 2024 surveys generally confirm patterns of population abundance and distribution previously observed in the Salinas basin. Namely, the quality habitat and presence of a population of *O. mykiss* in the Arroyo Seco River, the scarce population of O. mykiss below the dam in the Nacimiento River, and the absence of an *O. mykiss* population below the dam in the San Antonio River.

Introduction

Index reach monitoring has been conducted annually since 2010 during the late summer and early fall to document the distribution and abundance of *O. mykiss* at several sites in the Arroyo Seco, San Antonio, and Nacimiento Rivers. Despite missing some survey years due to drought or budget considerations, this is one of the longest-running fisheries datasets for the Salinas Basin. Index reach monitoring attempts to achieve an understanding of juvenile *O. mykiss* distribution and abundance in response to varying environmental conditions. In addition, the monitoring provides an opportunity to implant captured *O. mykiss* with PIT tags in preparation for future monitoring efforts.

Surveys have primarily been conducted with backpack electrofishing, which allows for sampling in a variety of habitats. However, permit constraints and habitat conditions have prevented electrofishing in some years, and multi-pass dive counts have been used as an alternative. Due to unknown detection probabilities and differences in methodology, it is difficult to assess absolute abundance through time. However, both methods have been crafted to allow for relative comparisons of population trends, especially between years when electrofishing was used as the primary method for index reach monitoring. Most recently, index reach monitoring was conducted in October 2022 using electrofishing. Prior to that, surveys were conducted in 2021 (dive counts), 2018 (electrofishing), 2017 (dive counts), 2014 (dive counts), and 2010-2013 (electrofishing). In 2023 modifications were made to survey methodology to improve efficiency, increase sampled habitat, and maximize the capture and PIT tagging of *O. mykiss*. Instead of multiple-pass depletion electrofishing, field crews conducted extended transects, thereby increasing total sampling effort at each site. Further, they focused on sampling in likely *O. mykiss* habitat only (i.e., riffles and runs, heads of pools). This was intended to increase the likelihood of encountering *O. mykiss* at all surveyed locations.

Electrofishing and snorkel surveys at index reach sites have revealed that *O. mykiss* can persist in the mainstems of the Nacimiento and Arroyo Seco Rivers throughout the summer in most years. Previous findings suggest a low density or absence of *O. mykiss* in the Nacimiento River and a higher but variable abundance of *O. mykiss* in the Arroyo Seco from year to year, which generally decreases in a downstream direction. Of note is the presence of *O. mykiss* of various sizes (young-of-year up to > 300 mm FL) in the Arroyo Seco in 2017 following several very dry years, suggesting that conditions permitted successful reproduction of *O. mykiss* even during years of severe drought.

These index reach monitoring surveys are especially useful in light of the Habitat Conservation Plan (HCP) that is being developed for water operations in the basin. As part of the HCP, fish passage analyses are being conducted for the Nacimiento and San Antonio rivers to evaluate the feasibility of facilitating fish passage around the dams on both rivers. Index reach monitoring can provide baseline estimates of *O. mykiss* habitat use downstream of the dams in each river. In addition, surveys provide an opportunity for tagging and recapturing individuals with PIT tags, which may be an important component of the monitoring for the HCP. Surveys this year were designed in part to evaluate the potential for tagging large numbers of juvenile *O. mykiss* in the Arroyo Seco, which would likely be a critical component of any future PIT-tag monitoring

program. As such, the relative densities of captured *O. mykiss* in 2024 will serve as a useful data point for the design of future monitoring programs.

This summary report is intended to provide an overview of the sampling methodology and survey results. Details of previous surveys can be found in the relevant annual fisheries reports produced by the Monterey County Water Resources Agency and are referenced as appropriate.

Methods

Field Surveys

Surveys were conducted at a total of 11 sites: two sites in the San Antonio River, four sites in the Nacimiento River, and five sites in the Arroyo Seco River (Figure 1). Some of these sites have been surveyed repeatedly since 2010, allowing for comparisons of fish community composition, fish community size structure, and relative densities of various species. Although sampling reaches were extended in 2023, care was taken to ensure that previously sampled index reach monitoring sites were included within these larger reaches. In addition, many sites were added in 2023 or shifted in location to maximize potential catch of *O. mykiss*. All the same sites were sampled again in each river in 2024, with the addition of one site near the previous rotary screw trap monitoring location. This site was added to expand the sampling distribution downstream due to observations of extremely low fish abundance at the upstream sampling locations. Notably, sampling in the Arroyo Seco was hindered again this year by the inability to access the historical upstream sampling locations. As such, sampling began at the Arroyo Seco Road bridge and continued in an upstream direction throughout all suitable *O. mykiss* habitat for approximately 1 mile, until upstream travel became impossible due to a deep pool with steep bedrock sides (Figure 1).

At each site, sampling was concentrated on potential *O. mykiss* habitat (primarily riffles and some runs). Where possible, sites coincided with natural barriers such as cascades to limit fish movement out of the sampled reaches. In 2023, these sites were subject to a visual assessment of the instream and riparian habitat that consisted of measuring the wetted width and length of the index reach using a digital rangefinder to allow for estimation of relative fish density within the reach. Any changes in stream configuration (and corresponding sampling area) were noted this year and measurements were taken for the one site in the Nacimiento that was added this year. Due to survey modifications in 2023, calculation of absolute abundance and density are no longer possible as the reaches are not closed with block nets during sampling and fish were free to move in and out of the sampled area. However, total catch by area may still be used as a coarse comparison of fish abundance among the sampled reaches and between years. More details on survey modifications in 2023 can be found in the annual report for that year.

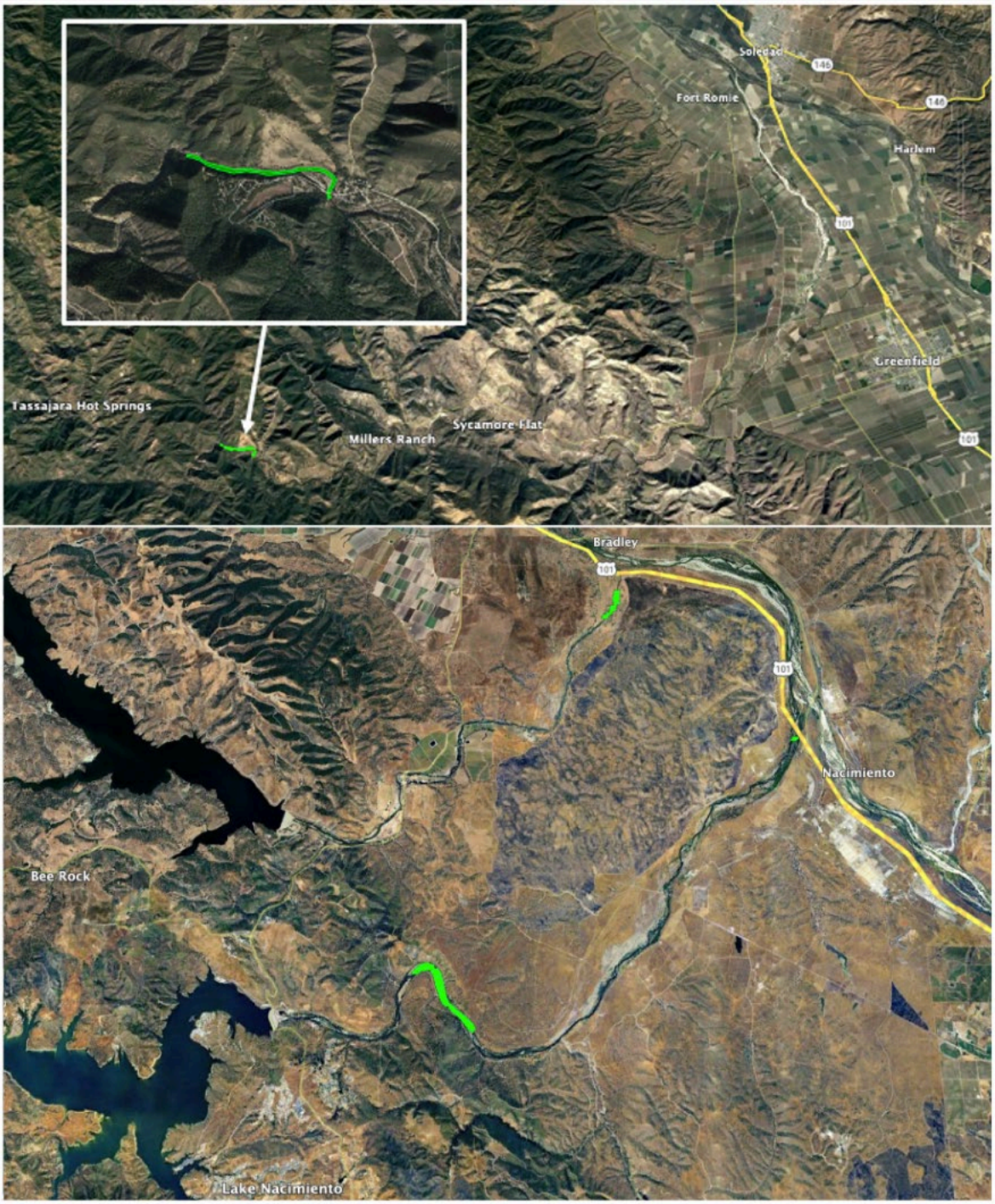

Figure 1. Map of survey reaches in the Arroyo Seco River (top) and Nacimiento and San Antonio Rivers (bottom). Note the short sampling reach added near the downstream end of the Nacimiento River in 2024.

Two Smith-Root LR24 Backpack Electrofishing Units were used at all sampling sites, using the quick set option to establish the initial power and waveform settings, which were verified with conductivity readings and cross referenced with the National Marine Fisheries Service (NMFS) Guidelines for Electrofishing Waters Containing Salmonids Listed under the Endangered Species Act (NMFS 2000). Electrofishing proceeded in an upstream direction, and each operator was

flanked by a netter. Captured fish were held in aerated live buckets and processed following the survey. During processing, fish were measured to total length, and fork length was also measured for all species possessing forked tails. The first 20 individuals of all captured species in each stream were measured, and any additional individuals belonging to those species were plus counted. All captured *O. mykiss* and individuals of other rare species were also weighed using a digital scale. In addition, field crews measured conductivity, temperature, and dissolved oxygen using a YSI water quality meter at each site.

All captured *O. mykiss* were scanned for existing PIT tags using a handheld PIT tag reader (Oregon RFID), and once it was verified that they did not possess a tag they were anesthetized using Alka-Seltzer tablets dissolved in river water and implanted with a half-duplex PIT tag (Oregon RFID). Tissue glue was applied to the injection site, and the fish was allowed to recover in an aerated bucket prior to being released back into the river at the approximate location of its capture. PIT tags and the implantation syringe were cleaned with chlorhexidine solution between tagging of individuals.

Data Analyses

Analyses were conducted in R statistical software (R Core Team 2024) and began with the calculation of Shannon-Weiner Diversity Index (H') values for each of the sample sites. This diversity index is a quantitative measurement that takes both species richness and abundance into account and serves as a statistical representation of biodiversity. Rarefied species richness values for each river were also calculated to account for differences in sample size among the various sites. Rarefaction randomly subsamples the total catch diversity at each site based on the minimum catch size and helps to correct for the fact that the diversity represented in catch tends to increase with increased sampling, thereby allowing for a more balanced comparison of species richness among the sample sites. Jaccard similarity values were then calculated for fish catch among each river, and these values were used to create a hierarchical cluster. This process was performed to evaluate the similarity of fish communities in each river.

Catch-per-unit-effort was also evaluated at each site, which allows for an assessment of relative fish abundance within each site despite differences in sampling effort. Because the sampling protocol only involved single pass electrofishing in each location, it was not possible to estimate absolute abundance of the species present in each site (meaning the true number of individuals), but CPUE provides a means of evaluating relative abundance in that higher CPUE values in a location would suggest a greater abundance of fish. Values of CPUE were compared across years to visualize variation over time. As methods were not the same in all years (see Field Surveys), only CPUE was compared as it standardized for variable effort. Finally, average, minimum, and maximum total lengths of fish in each location were calculated for each site to allow for comparisons of size composition across sampled locations.

Results

Water Quality

Water quality assessments indicated suitable conditions for *O. mykiss* at all sites, with temperatures ranging from 11.3˚C to 16.3˚C (52.3˚F to 61.3˚F) and dissolved oxygen ranging from 8.89 to 10.62 mg/L (Table 1). Unlike surveys prior to 2023, the San Antonio River was sampled further downstream in the watershed, thus excluding the previously sampled sites immediately below the dam that were characterized by continually poor water quality and intense sulfurous smells. Turbidity was only assessed visually, but water appeared generally more turbid in the Nacimiento River than the San Antonio River, perhaps due to the further downstream sampling location in the San Antonio. The Arroyo Seco was the least turbid of all three tributaries, as expected given the relatively undisturbed habitat in the basin and the absence of a dam. Emergent aquatic vegetation was very widespread in the San Antonio River.

Data on discharge during the surveys were obtained from the Arroyo Seco near Greenfield gauges (USGS gauge numbers 11151870), as well as the daily release schedule for Nacimiento and San Antonio Reservoirs. During surveys, Arroyo Seco discharge averaged approximately 69.2 cubic feet per second (cfs), Nacimiento River discharge was approximately 69 cfs, and San Antonio discharge was approximately 10 cfs.

Table 1. Water quality metrics as measured at each index reach site.

Site	Survey Time	Temperature (˚C)	Dissolved Oxygen (mg/L)	TDS (mg/L)	SPC (uS/cm)	Discharge (CFS)*
Arroyo Seco 1	9:15	12.1	9.51	247	286.3	69.2
Arroyo Seco 2	10:25	13.8	10.12	249	301.5	69.2
Arroyo Seco 3	11:40	12	9.56	251	290.4	69.2
Arroyo Seco 4	14:00	13	10.42	245	289.7	69.2
Arroyo Seco 5	15:00	12.8	10.39	248	382.2	69.2
Nacimiento 1	9:10	11.3	8.89	188	213.6	69
Nacimiento 2	10:10	11.3	8.89	188	213.6	69
Nacimiento 3	11:00	11.3	8.89	188	213.6	69
Nacimiento 4	12:30	11.3	8.89	188	213.6	69
San Antonio 1	14:15	16.3	10.62	318	407.4	10
San Antonio 2	15:30	15.9	10.18	318	489.5	10

*Discharge during the surveys was measured at the Arroyo Seco NR Greenfield (USGS 11151870) gauge as well as the Nacimiento and San Antonio Reservoir daily release schedule (available at: https://www.countyofmonterey.gov/home/showdocument?id=24234).

Fish Community

2024

Species diversity was relatively similar across all sites, with a total of 13 species captured overall (n=10 in San Antonio, n=5 in Nacimiento, and n=7 in Arroyo Seco; Tables 2 and 3). Most fish captured were native, with nonnative species present this year including western mosquitofish, black bass (spotted and smallmouth), brown catfish, and pumpkinseed sunfish. The Nacimiento and San Antonio rivers had species that were not captured or observed in the Arroyo Seco. Nacimiento exhibited lower diversity compared to the Arroyo Seco and San Antonio, which had a more similar fish community to one another than to the Nacimiento (Figure 2). Overall, both species richness and species diversity metrics were relatively low and reflect the minimal number of fish species present in each stream (Figures 3 and 4). CPUE was low overall but was higher in the Arroyo Seco and San Antonio rivers (Figure 5). On average, total length was similar among the different rivers, but Arroyo Seco and San Antonio had the largest fish, which were Sacramento suckers in both rivers (Figure 6).

Table 2. Total counts of each species captured in each sample site and associated length ranges.

River	Site	Species	Count	Minimum Total Length (mm)	Maximum Total Length (mm)
Arroyo Seco	1	California Roach	10	44	88
		Sacramento Pikeminnow	9	70	143
		Sacramento Sucker	7	61	207
		Spotted Bass	3	117	136
		Speckled Dace	30	39	83
	2	California Roach	1	55	55
		Sacramento Pikeminnow	9	70	303
		Sacramento Sucker	10	87	372
		Spotted Bass	2	138	145
		Speckled Dace	37	43	81
		Smallmouth Bass	1	201	201
	3	California Roach	1	50	50
		Sacramento Pikeminnow	33	45	167
		Sacramento Sucker	8	66	248
		Speckled Dace	23	37	88
		Smallmouth Bass	1	233	233
		Rainbow Trout	2	267	267
	4	Sacramento Pikeminnow	14	56	188
		Sacramento Sucker	2	115	210
		Spotted Bass	1	126	126
		Speckled Dace	7	41	72
	5	California Roach	3	48	73
		Sacramento Pikeminnow	4	72	102
		Speckled Dace	23	51	71
		Smallmouth Bass	1	119	119
		Rainbow Trout	2	133	337

Table 2. Continued.

River	Site	Species	Count	Minimum Total Length (mm)	Maximum Total Length (mm)
Nacimiento	1	Sacramento Sucker	2	80	221
		Prickly Sculpin	4	56	140
		Threespine Stickleback	5	43	55
	2	Sacramento Pikeminnow	2	79	93
		Prickly Sculpin	3	53	78
		Threespine Stickleback	2	41	41
	3	Threespine Stickleback	2	NA	NA
	4	Speckled Dace	7	48	79
		Prickly Sculpin	12	61	140
		Threespine Stickleback	1	55	55
San Antonio	1	California Roach	1	110	110
		Sacramento Pikeminnow	14	56	173
		Sacramento Sucker	47	68	245
		Speckled Dace	11	46	61
		Prickly Sculpin	1	137	137
		Threespine Stickleback	9	34	57
		Brown Bullhead	2	57	70
		Hitch	31	42	247
		Western Mosquitofish*	TNTC	22	23
		Pumpkinseed	1	91	91
	2	Sacramento Sucker	29	62	360
		Speckled Dace	25	50	76
		Threespine Stickleback	10	37	58
		Hitch	1	74	74
		Western Mosquitofish*	TNTC	NA	NA

*Western mosquitofish (*Gambusia affinis*) were abundant in the San Antonio River but were too small to effectively catch with the dipnet for measurement and too numerous to count.

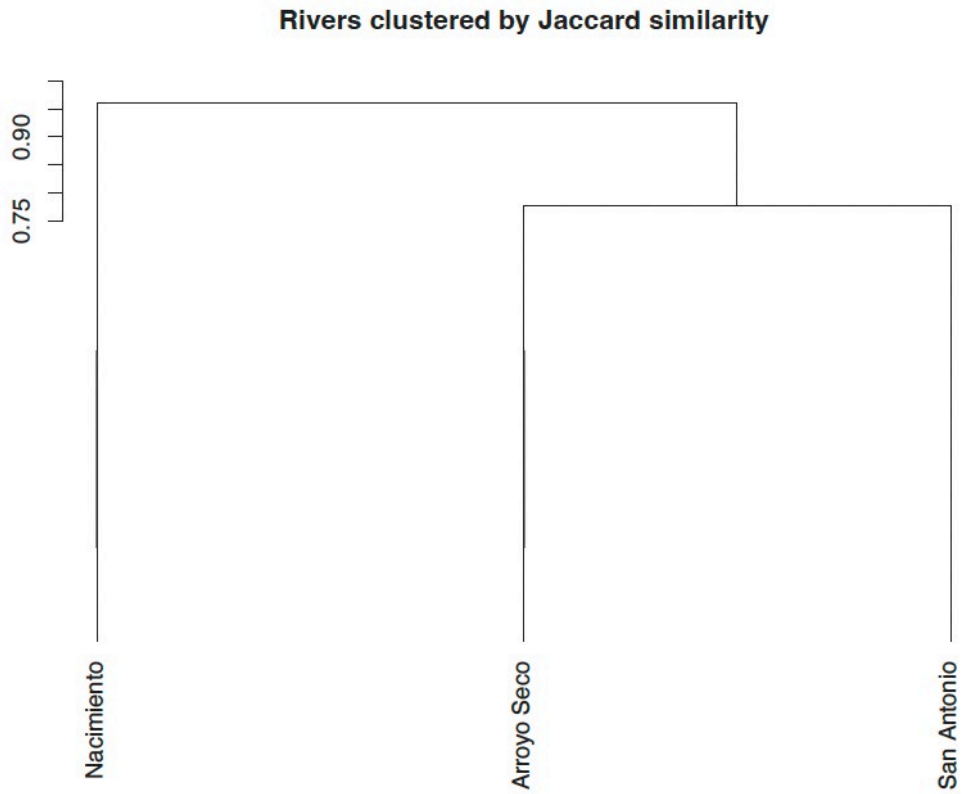

Figure 2. Fish catch across the sites in each of the three rivers clustered by Jaccard similarity.

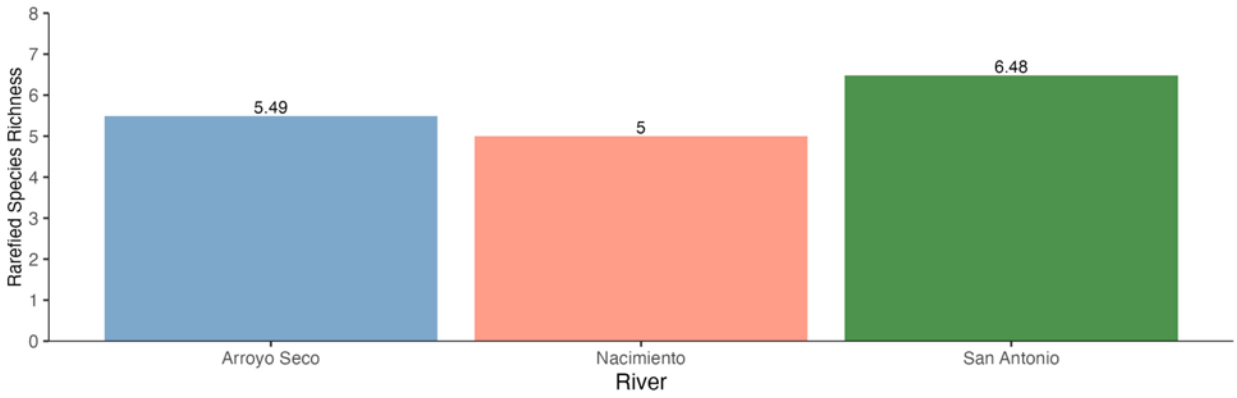

Figure 3. Rarefied species richness of combined sample sites in each river.

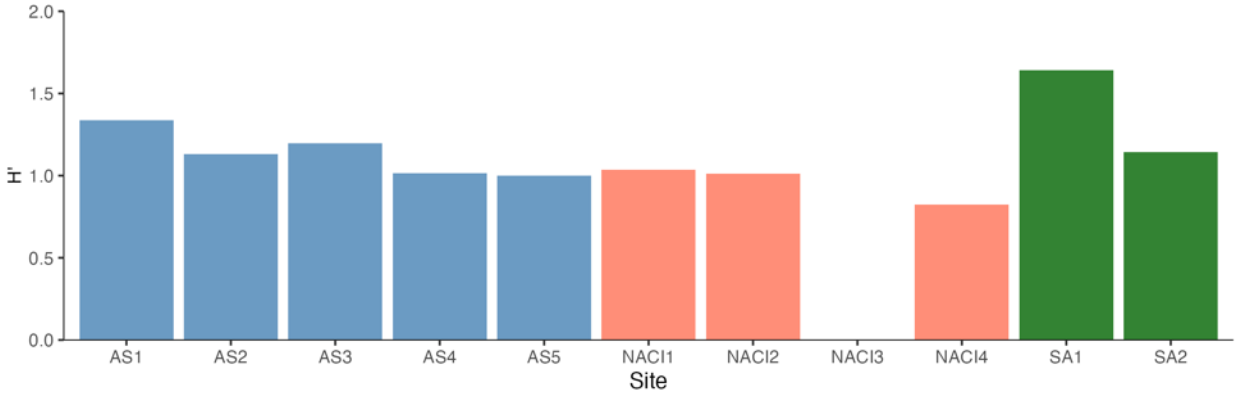

Figure 4. Shannon-Wiener Diversity Index (H') values of each sample site in 2024.

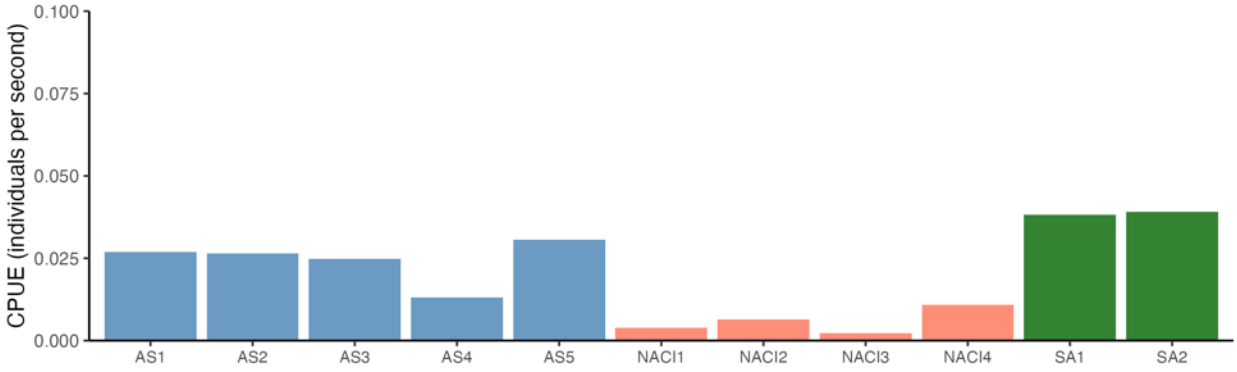

Figure 5. Catch-per-unit-effort (CPUE) in terms of individuals captured per second of electrofishing effort for sites sampled in 2024.

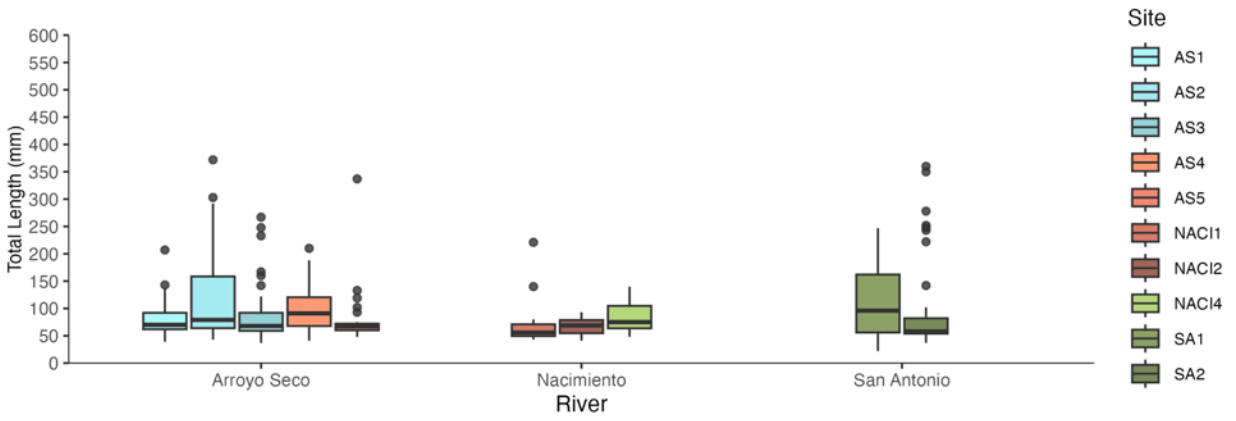

Figure 6. Length composition of fish captured in each of the sample sites

2022-2024

Compared to previous years, all three tributaries generally exhibited similar levels of fish community diversity (Figure 7); however, relationships among sites varied within each year. Shannon-Wiener Diversity Index (H') varied the most in the San Antonio River compared to the Arroyo Seco and Nacimiento Rivers (Figure 7). When all electrofishing data were pooled across years (2022 to 2024), Nacimiento had the highest rarefied species richness compared to Arroyo Seco and San Antonio which were similar (Figure 8). While community diversity was similar in Arroyo Seco among years, Nacimiento and San Antonio experienced variation. Nacimiento community diversity was similar in 2022 and 2024 and was highest in 2023. San Antonio community diversity was substantially lower in 2022 than 2023 and 2024. Catch-per-unit-effort varied within and among sites among years (Figure 9), though each site followed similar changes in CPUE over time. Nacimiento generally had lower CPUE compared to Arroyo Seco and San Antonio. The highest CPUE for each site was in 2023.

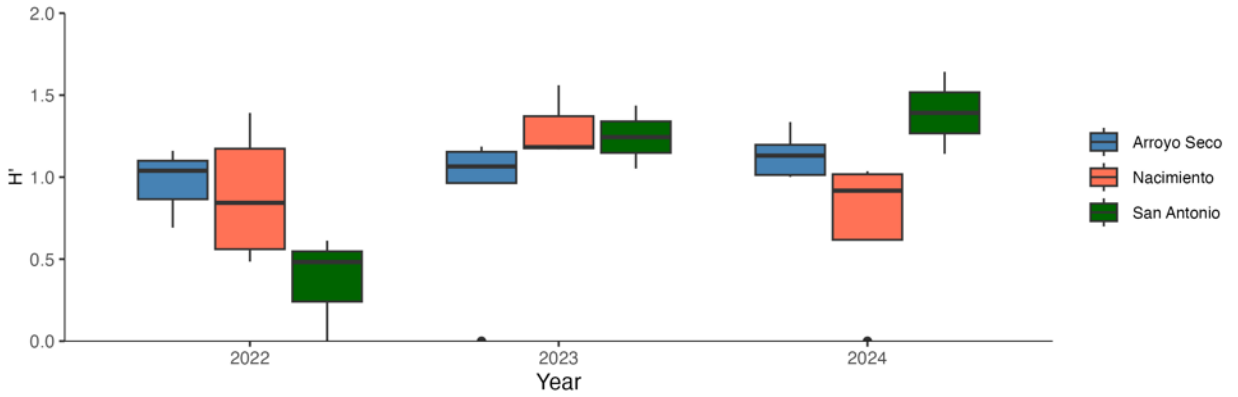

Figure 7. Shannon-Wiener Diversity Index (H') values of each river from 2022 to 2024.

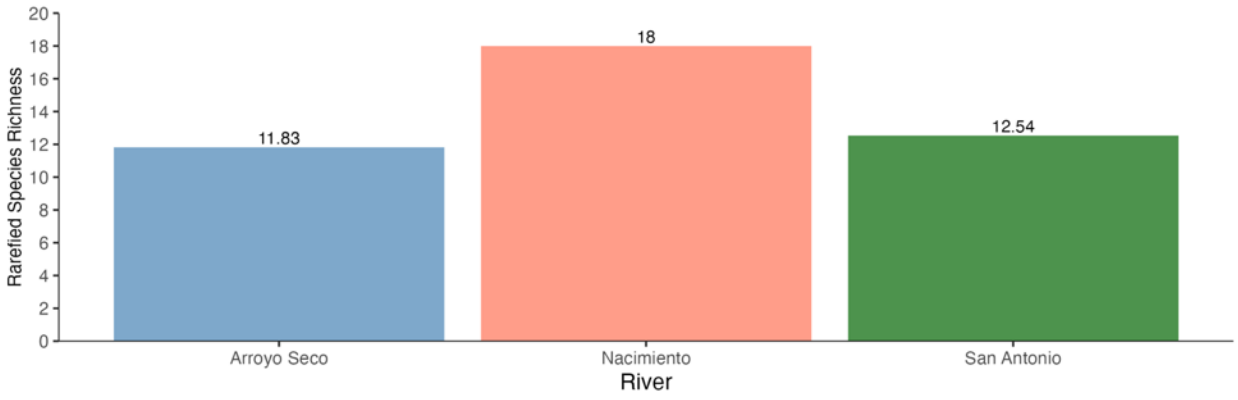

Figure 8. Rarefied species richness of each river where sample sites and years were combined.

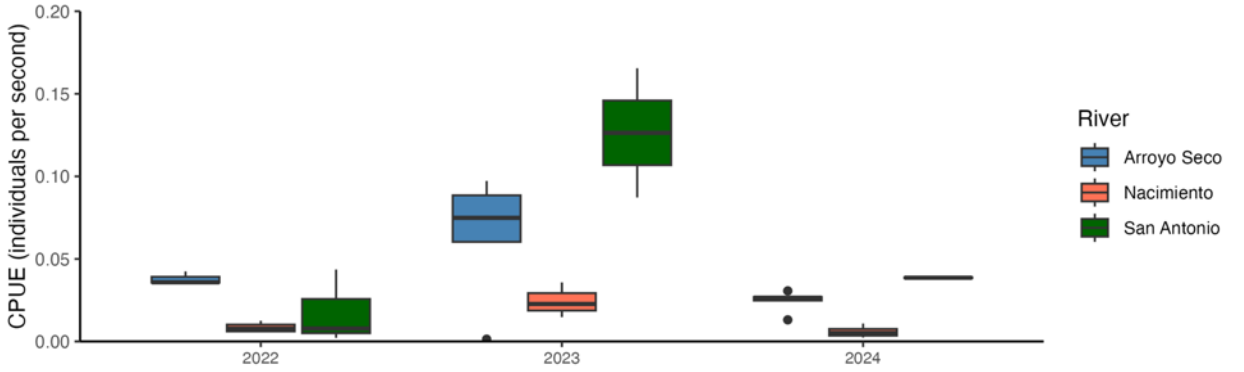

Figure 9. Catch-per-unit-effort (CPUE) in terms of individuals captured per second of electrofishing effort for rivers sampled from 2022 to 2024.

O. mykiss

A total of three *O. mykiss* were captured in 2024 in the Arroyo Seco River, which was the lowest count on record for the Arroyo Seco (Table 3). However, sites did not directly overlap with previously sampled locations, and upstream sites that have historically harbored more *O. mykiss* were not accessible during this year's sampling effort. Catch patterns in each tributary were similar to previous surveys, with no *O. mykiss* captured in the San Antonio, zero or few *O. mykiss* captured in the Nacimiento, and the most *O. mykiss* observed in the Arroyo Seco. Abundance and distribution of *O. mykiss* in the Arroyo Seco River deviated from patterns observed in previous years. While *O. mykiss* were present as far downstream as the Arroyo Seco Road bridge and generally increased in an upstream direction, *O. mykiss* were not observed until halfway upstream of the reach and only in two sites. The absence of *O. mykiss* in the Nacimiento confirms insights gained through previous rotary screw trap and index reach monitoring, namely that the abundance and/or production of *O. mykiss* in the Nacimiento is exceedingly low.

Table 3. Capture history of *O. mykiss* during all index reach monitoring surveys that used electrofishing as a primary sampling method.

Year	San Antonio	Nacimiento	Arroyo Seco Sites 1-3	Arroyo Seco Sites 4-5	Annual Total
2010	-	-	20	14	34
2011	-	0	27	35	62
2012	-	1	21	0	22
2013	-	0	13	0	13
2018	0	2	4	0	6
2022	0	1	7	1	9
2023	0	0	15	-	15
2024	0	0	3	-	3

- Indicates no electrofishing sampling occurred

Sizes of captured *O. mykiss* ranged from 133 to 337 mm in total length, corresponding to ages ranging from age 1 to age 2+, based on analyses of scales collected during surveys (Figure 7). As expected for this time of year, none of the captured *O. mykiss* showed physical signs of preparing for migration.

Figure 7. An age 1 *O. mykiss* captured in the Arroyo Seco River.

Discussion

The results from the 2024 surveys generally confirm patterns of population abundance and distribution previously observed in the Salinas basin. Namely, the quality habitat and presence of a population of *O. mykiss* in the Arroyo Seco River, the scarce population of *O. mykiss* below the dam in the Nacimiento River, and the absence of an *O. mykiss* population below the dam in the San Antonio River. Although *O. mykiss* densities in the Arroyo Seco were the lowest, they have been compared to previous surveys, sampled sites occurred only in the lower portions of the watershed, and patterns from previous surveys suggest that occupancy and density is lower in the downstream sites. Patterns of occupancy are dependent on environmental conditions, and surveys during years with below-average discharge (e.g., 2013, 2022) have revealed either zero or very few *O. mykiss* in downstream index reaches. In 2024, no *O. mykiss* were observed in the most downstream reaches, suggesting that despite above average precipitation in 2024, conditions for *O. mykiss* in the lower watershed were unfavorable or there may be a legacy effect of the three consecutive dry water years from 2020 to 2022 that were not apparent in 2023. It is possible that poor temperature conditions throughout the summer and early fall resulted in dispersal of *O. mykiss* to upstream portions of the watershed. However, the inability to sample in in the upstream reaches of the watershed, for the second consecutive year, precludes the ability to further investigate these hypotheses.

Of note, the largest and *oldest O. mykiss* captured in this survey appeared to be in relatively poor condition (Figure 8). In addition, no young-of-year individuals were observed this year as they have been in past years, and therefore we are unable to speculate whether there were suitable habitat conditions for successful spawning in 2024. Of note, there is a persistent population of non-native black bass in the vicinity of the Arroyo Seco campground. Black bass are known predators of salmonids and although they were not exceedingly abundant in the sampling sites, they were distributed among all sampling locations and may pose a threat to rearing and migrating *O. mykiss* in the watershed.

Figure 8. An age 2+ O. mykiss captured on the Arroyo Seco in relatively poor condition.

Historically, index reach monitoring data consistently revealed a resilient population of *O. mykiss* in the basin despite changing environmental conditions, including multiple consecutive dry years (Figure 9). For example, during previous dry year sampling in 2014, *O. mykiss* were not observed in the Arroyo Seco, and the survey reaches consisted of isolated pools with poor water conditions (i.e., water temperatures >20°C and dissolved oxygen levels <6.0 mg/L). Although no sampling was conducted in 2015 and 2016 due to low-flow conditions, surveys in 2017 revealed multiple *O. mykiss* ranging in size from less than 100 mm (visually estimated) to larger than 300 mm at four of the five sites surveyed. The presence of various age classes during the 2017 survey provides evidence of juvenile production during dry years from 2014 to 2016 and indicates that *O. mykiss* likely sought refuge further upstream in the watershed where conditions were seemingly better for spawning and rearing. Similarly, although conditions were poor in 2022 and followed another three consecutive years of drought, *O. mykiss* were still captured at nearly all sampling locations in the Arroyo Seco and at one site in the Nacimiento, confirming the persistence of the population despite challenging conditions. Notably, recent low capture of *O. mykiss* in 2024 suggests that the population has not fully recovered from previous dry years or faces other challenges that were not accounted for in this study.

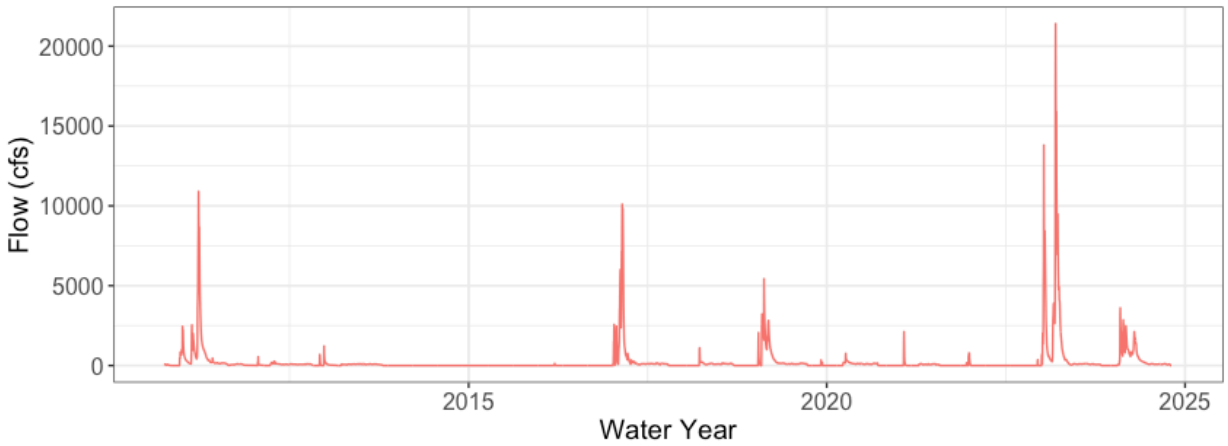

Figure 9. Annual discharge in the Salinas River at Chualar from Nov. 2010 to Oct. 2024.

Analysis of electrofishing data in the Arroyo Seco, Nacimiento, and San Antonio Rivers across three years (2022 to 2024) suggests that the Arroyo Seco River may be more stable than the Nacimiento or San Antonio Rivers. On average, species diversity was least variable among years in the Arroyo Seco River compared to the Nacimiento and San Antonio where the San Antonio varied the most among years. Additionally, CPUE was relatively stable among years in the Arroyo Seco and Nacimiento Rivers compared to the San Antonio among years. This suggests that populations or habitat in the Arroyo Seco River may be more resilient or may experience less temporal variation than the Nacimiento and San Antonio Rivers.

In the Nacimiento River, the absence of *O. mykiss* matches findings from previous surveys, where only four individual *O. mykiss* have been captured in over six years of electrofishing sampling effort (one in 2012, two in 2018, one in 2022). Visual surveys have documented additional *O. mykiss* in the Nacimiento but always at very low densities. These patterns mirror what was observed with rotary screw trap monitoring and confirm that steelhead production in the Nacimiento remains poor despite it possessing some characteristics associated with productive

trout habitat. The Nacimiento provides relatively complex habitat, including a variety of substrates (e.g., gravel, cobble, bedrock), riparian vegetation, large woody debris, and varying river reaches from riffles to pools.

Given this habitat potential, there are currently efforts underway to improve understanding of the relationships between habitat availability and flow for various *O. mykiss* life stages. It was hypothesized that the high flows in 2023 and 2024 may have resulted in more favorable conditions for the *O. mykiss* population in the river; however, the fish community overall in 2024 looked to be highly impacted, with extremely low abundance and diversity compared to previous years. Visual surveys at numerous locations throughout the river revealed an absence of fish along the stream margins or in locations where they were previously found (i.e., deeper pools). The diminished state of the fish community following two consecutive wet years, as well as the poor condition of fish captured in the Nacimiento over the last few years (e.g., emaciated or suffering from wounds or parasites), suggests that there remain serious ecological issues within the stream that may not be able to be improved with a revised flow schedule.

Due to the absence of an approved Biological Opinion for the Salinas Basin, surveys are no longer required as a regulatory action. As such, there is an opportunity to develop new methods for fisheries monitoring in the basin. As noted above, methods were altered in 2023 to increase efficiency, provide additional opportunities to capture juvenile *O. mykiss* in rivers with low abundance and increase understanding of *O. mykiss* occupancy over a greater range. In addition, this year's surveys were designed to provide information on the potential for capturing greater numbers of juvenile *O. mykiss* for tagging in the Arroyo Seco, which would likely be a component of any future monitoring program. However, sampling was somewhat hindered again in 2024 by the inability to access the upper watershed where fish densities are presumably higher, and there is still some uncertainty as to whether it is possible to tag enough *O. mykiss* in the Arroyo Seco watershed to facilitate a PIT tag mark-recapture program through index reach sampling paired with outmigration monitoring (i.e., rotary screw traps, incline plane traps). Given likely monitoring changes in the basin with the implementation of the HCP, we recommend an expanded index reach monitoring program throughout the summer months to provide expanded tagging opportunities for *O. mykiss* and improve understanding of their distribution throughout the watershed. Sampling sites could be chosen with a spatially stratified sampling scheme such as Generalized Random Tessellation Stratified (GRTS) sampling that covers both mainstem and tributary habitats in the Arroyo Seco Basin. This is especially important as understanding of steelhead habitat use in the various Arroyo Seco tributaries remains largely unknown. These expanded surveys could also be used to understand juvenile production on an annual basis, and the increase in tagged fish over time would provide information on growth, survival, migratory patterns, rate of anadromy, and production among the various tributaries.

Several findings from the index reach monitoring conducted to date are applicable to the development of the HCP in the Salinas Basin. One of the key considerations for maintaining steelhead populations in the basin is the ability to support populations in the Nacimiento and San Antonio Rivers. Historically, these streams provided relatively abundant habitat for *O. mykiss* in their upper reaches, with steelhead migration to and from the ocean occurring opportunistically depending on annual flow conditions (NMFS 2007; Stillwater Sciences 2020). Following the construction of dams on both streams, this habitat has been cut off from the rest of the basin, and

steelhead populations are now confined to the tailwaters below the dams. Given that passage around the dams seems potentially infeasible or impractical and may be detrimental to the population (Lusardi and Moyle 2017; Ohms et al. 2022), efforts should be made to improve habitats in the tailwaters to support spawning and rearing conditions for *O. mykiss* and potentially to increase the prevalence of the migratory phenotype (Eschenroeder et al. 2022). In the San Antonio River, a self-sustaining population of steelhead appears highly unlikely given current habitat conditions. However, in the Nacimiento River, habitat improvements could be made through targeted restoration and revised flow schedules. Such improvements may offer comparable or superior population benefits compared to the labor-intensive approach of manually moving fish around the dams and are likely much more feasible to sustain in the long term.

The Arroyo Seco River clearly provides the vast majority of steelhead habitat in the basin and attempting to maintain connectivity of this tributary to the ocean during the main migratory periods should remain a focus. Overall, the monitoring and research that has taken place to date in the Arroyo Seco does not appear commensurate with the importance of the basin. Further understanding of barriers to migration, potential habitat, and *O. mykiss* distribution and patterns of habitat use among the upper mainstem and tributaries of the Arroyo Seco remains a data gap and should also be prioritized. A recent review of available data on the Arroyo Seco watershed found that estimates of potential steelhead habitat in the Arroyo Seco vary substantially, in large part due to the paucity of surveys that have been conducted in the watershed and the lack of empirical evidence about barriers, fish occupancy, and habitat quality (Lee et al., 2021). Many of the Arroyo Seco tributaries have not been surveyed, and targeted flow-passage thresholds have never been determined for known barriers in the mainstem, despite passage barriers being identified as one of the top stressors in the Arroyo Seco (NMFS 2007). Data on existing barriers and passage potential is needed to refine estimates of available habitat in the watershed. In particular, an examination of the bedrock chute at river mile 31 is a necessary first step to determine if steelhead passage is possible into the upper tributaries, or if upstream populations are comprised of resident populations of *O. mykiss* that may contribute anadromous offspring. Strategic monitoring of *O. mykiss* and their habitats in the Arroyo Seco and its tributaries is arguably the most immediately critical activity for ensuring the long-term persistence of Salinas steelhead, and for facilitating future population recovery efforts.

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Appendix A – Data Management Plan

This data management plan is designed to ensure that project data are collected using peer–approved methods, undergo a quality control and accuracy assessment process, include metadata that meet CDFW's minimum standards.

The following documentation provides evidence of the methods and quality control procedures that were used to meet Grant Agreement requirements.

1. **Who collected the data:** Dana Lee, Andrea Fuller, Garth Jaehnig, Matea Djokic
2. **When the data was collected:** October 2023
3. **Where the data was collected:** Arroyo Seco, Nacimiento, and San Antonio Rivers
4. **How the data was collected (description of methods and protocols):** Surveys conducted by FISHBIO used a two backpack electrofishers and a four person crew to net fish. Potential trout habitat was preferentially targeted or favored for sampling across multiple several hundred meter long reaches in each river. Sampling locations were chosen to coincide with previously sampled locations and were designed to obtain an adequate overview of the spatial distribution of *O. mykiss* within each watershed. At each sampling location electrofishing proceeded in an upstream direction. All fish captured during each survey were identified to species and enumerated, and a subset of each species were measured. All *O. mykiss* were measured and weighed and scanned for the presences of a PIT tag, and if none was found, implanted with a PIT tag. All data sheets collected in the field were scanned (with electronic copies stored on a server) before the data was entered into a database. Prior to data analyses, the database underwent QA/QC procedures including being checked against field datasheets by two separate individuals. All datasheets were also stored as hard copies at the FISHBIO office.
5. **The purposes for which the data was collected:** Salinas index reach monitoring is intended to assist in determining the presence and spatial distribution of *O. mykiss* in tributaries of the Salinas River. The purpose of these sampling efforts is to assess the over-summer condition of the potential steelhead population in the basin. Objectives include evaluating presence or absence, condition, relative abundance (i.e., catch per unit effort; CPUE), and distribution of *O. mykiss* in the watershed.
6. **Definitions of variables, fields, codes, and abbreviations used in the data, including units of measure:** All species field codes are included below.
7. **The terms of any landowner access agreement(s), if applicable:** Not Applicable
8. **References to any related Department permits or regulatory actions:** Not Applicable
9. **Peer review or statistical consultation documentation:** All reports were reviewed by multiple parties, including the Grant recipient, and will also be published online and therefore subject to external peer review.
10. **Data licensing and disclaimer language:** All data is the property of Monterey County Water Resources Agency and is subject to their data licensing and disclaimer requirements.

Abbreviation Codes

Common Name	Species Code
American Shad	AMS
Bass Unknown	BAS
Bigscale Logperch	LP
Black Bullhead	BKB
Black Crappie	BKS
Blue Catfish	BLC
Bluegill	BGS
Brook Trout	BKT
Brown Bullhead	BRB
Brown Trout	BT
California Roach	CAR
Catfish Unknown	CAT
Channel Catfish	CHC
Chinook Salmon	CHN
Common Carp	C
Delta Smelt	DSM
Fathead Minnow	FHM
Golden Shiner	GSN
Goldfish	GF
Green Sturgeon	GST
Green Sunfish	GSF
Hardhead	HH
Hitch	HCH
Inland Silverside	MSS
Kern Brook Lamprey	KBL
Kokanee Salmon	KOS
Lamprey Unknown	LAM
Largemouth Bass	LMB
No Catch	NONE
Pacific Lamprey	PL
Pacific Brook Lamprey	BL
Pacific Staghorn Sculpin	PSS
Prickly Sculpin	PRS
Pumpkinseed	PKS
Rainbow / Steelhead Trout	RBT
Red Shiner	RSN
Redear Sunfish	RES
Redeye Bass	REB
Riffle Sculpin	RFS
River Lamprey	RL
Sacramento Blackfish	SCB
Sacramento Perch	SP
Sacramento Squawfish	SASQ
Sacramento Sucker	SASU
Sculpin Unknown	SCP
Shimofuri Goby	SHM
Smallmouth Bass	SMB
Speckled Dace	SPD
Splittail	SPLT
Spotted Bass	SPTB
Striped Bass	STB
Sturgeon Unknown	STG
Sunfish Unknown	SNF
Threadfin Shad	TFS
Threespine Stickleback	TSS
Tule Perch	TP
Unknown (Unid Juvenile Fish)	UNID
Unknown Centrarchid	CENT
Wakasagi	WAG
Warmouth	W
Western Mosquitofish	MQK
White Catfish	WHC
White Sturgeon	WST
Yellow Bullhead	YEB
Yellowfin Goby	YFG

Stanislaus River Station	Station Code
Caswell State Park	ST004X

Tuolumne River Station	Station Code
Grayson	TU005X
Grayson – North Trap	TU005N
Grayson – South Trap	TU005S
Waterford	TU030X

Caswell State Park – North Trap	ST004N
Caswell State Park – South Trap	ST004S
Oakdale Recreation Area	ST040X
Stanislaus Weir	ST031X
Calaveras River Station	**Station Code**
Shelton Rd.	CR028X
Merced River Station	**Station Code**
Gallo Ranch	ME041X
Hatfield Park – North Trap	ME002N
Hatfield Park – South Trap	ME002S

Condition Code	**Description**
1	Good
2	Fair (partial cell block)
3	Poor (total cell block)
4	No sample taken

Debris Code	**Description**
LIT	Light
MED	Medium
HVY	Heavy

Weather Code	**Description**
CLD	Cloudy
RAN	Rainy
CLR	Clear
NIT	Night

Tuolumne Weir	TU024X
Arroyo Seco River	**Station Code**
Arroyo Seco River	AS012X
Nacimiento River	**Station Code**
Nacimiento River	NR001X
Salinas River	**Station Code**
Upper Salinas	SR109X
Salinas Weir	SR003X

Mark Codes	**Description**
CFG**N**	Natural Origin
CFG**H**	Hatchery Origin
CFG*	Caudal Fin Green
CFR*	Caudal Fin Red
CFO*	Caudal Fin Orange
CFP*	Caudal Fin Pink
CFB*	Caudal Fin Blue
AFG*	Anal Fin Green
AFB*	Anal Fin Blue
TCR**	Top Caudal Fin Red
BCR**	Bottom Caudal Fin Red
DCB**	Double Caudal Fin Red
(*) Always indicate stock origin (H or N)	
(**) Indicate if mark is specific to location on fish (T or B or D)	

Gear Status	**Description**
0	Set trap
3	Check and raise trap

Appendix B – Invasive Species Prevention Plan

All field gear used in the Salians Lagoon was properly disinfected following California Department of Fish and Wildlife Aquatic Invasive Species Disinfection/Decontamination Protocols prior to the start of fieldwork.

A detailed list of the relevant disinfection procedures and preventative measures that were used to prevent the spread of aquatic invasive species in the Salinas Watershed is listed below.

If equipment is used on the project that was previously working in another stream, river, lake, pond, or wetland within 10 days of initiating work, we implement one of the following procedures to prevent the spread of New Zealand Mud Snails and other aquatic hitchhikers:

1) Remove all mud and debris from equipment (waders, nets, watercraft, etc.) and keep the equipment dry for 10 days. OR
2) Remove all mud and debris from Equipment (waders, nets, watercraft, etc.) and spray/soak equipment with either a 1:1 solution of Formula 409 Household Cleaner and water, or a solution of Sparquat 256 (5 ounces Sparquat per gallon of water). Treated equipment must be kept moist for at least 10 minutes. OR
3) Remove all mud and debris from equipment (waders, nets, watercraft, etc.) and spray/soak equipment with water greater than 120 degrees F for at least 10 minutes. OR (4) Remove all mud and debris from equipment (waders, nets, watercraft, etc.) and freeze equipment below 0 degrees F for at least 48 hours.