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) and were intended to document the abundance and distribution of *O. mykiss* as well as provide a snapshot of the overall fish community.

On October 26–28, 2022, FISHBIO staff conducted index reach monitoring surveys in the Salinas River Basin. Backpack electrofishing was conducted at three sites in the San Antonio River, four sites in the Nacimiento River, and 5 sites in the Arroyo Seco River (Figure 1). Fish were captured in all sample locations, and a total of 11 different species were captured across all sites. Nine *O. mykiss* were captured in total, including seven in Arroyo Seco Site 1, one in Arroyo Seco Site 4, and one in Nacimiento Site 2. All *O. mykiss* except the single individual captured in the Nacimiento were implanted with PIT tags. eDNA samples collected from the two downstream Nacimiento sites did not detect any *O. mykiss*, confirming their extremely low densities in the Nacimiento River.

A total of three invasive species – goldfish (*Carassius auratus*), spotted bass (*Micropterus punctulatus*), and western mosquitofish (*Gambusia affinis*) – were among the captured fish. Goldfish were captured in San Antonio Sites 1 and 3, spotted bass were only captured in Arroyo Seco Site 4, and western mosquitofish were captured in all San Antonio sites and Nacimiento Site 3. As in past surveys, the San Antonio sites exhibited poor water quality and the field crew noted an intense sulfurous smell to the water.

The observation of a relatively abundant *O. mykiss* population in the Arroyo Seco River is encouraging given several consecutive dry years in the basin. Monitoring during a previous dry year in 2014, revealed isolated pools even at the upper Arroyo Seco sites and an absence of *O. mykiss* at all surveyed locations. Although the number of captured *O. mykiss* in 2022 was slightly lower than previous electrofishing surveys in 2012 and 2013, their capture in downstream reaches indicates that river conditions have remained favorable throughout most of the wetted stream. In addition, the presence of small-sized individuals confirms successful spawning in recent years.

During this sampling effort, the protocol of multiple-pass depletion sampling using block nets that was established by the former Biological Opinion (BO) was modified in an effort to improve efficiency and increase sampled habitat. Instead of deploying block nets (which takes extensive amounts of field time and likely leads to flushing fish out of the sample reach) and sampling until depletion is achieved, the field crew conducted extended transects and increased total sampling effort in each site. This was intended to increase the possibility of encountering *O. mykiss* in habitats where they are not abundant and increase our understanding of the fish community over a greater range of habitats.

Introduction

Index reach monitoring has been conducted annually since 2010 during the late summer and early fall to document the distribution and abundance of steelhead 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 tag *O. mykiss* with Passive Integrated Transponder (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 and extrapolation of abundance estimates. 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, no valid comparisons regarding densities or density trends through time can be made. However, both methods have been crafted to create anecdotal comparisons between previous years' index reach monitoring using electrofishing. Most recently, index reach monitoring was conducted in June of 2021 using multi-pass dive counts. Prior to that, surveys were conducted in 2017 and 2018 (dive counts), 2014 (dive counts), and 2010-2013 (electrofishing).

Electrofishing and snorkel surveys at index reach sites have revealed that steelhead can persist in the mainstems of the Nacimiento and Arroyo Seco rivers throughout the summer in most years. Previous findings include the low density of *O. mykiss* in the Nacimiento River and higher but variable abundances of *O. mykiss* in the Arroyo Seco from year to year generally decreasing in a downstream direction. Of note is the presence of *O. mykiss* of various sizes (YOY to > 300 mm FL) in the Arroyo Seco in 2017, suggesting that conditions permitted successful reproduction of *O. mykiss* even during years of severe drought.

These surveys are especially useful in light of the upcoming Habitat Conservation Plan (HCP) being planned for river 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 provided an opportunity for tagging and recapturing individuals with PIT tags, which will be an important component of the monitoring for the HCP.

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 12 sites: 3 sites in the San Antonio River, 4 sites in the Nacimiento River, and 5 sites in the Arroyo Seco River (Figure 1). The majority of these sites have been surveyed repeatedly since 2010, allowing for comparisons of densities and distribution. At each site, sampling reaches were selected to correspond with previously sampled locations. Whereas previous surveys employed multiple-pass depletion sampling using block nets, surveys were modified in 2022 by eliminating the block nets and extending the transects to increase the total sampling effort at each site. Sites were chosen to incorporate a variety of habitats (i.e., riffles, runs, and pools). Where possible, sites coincided with natural barriers such as cascades to limit fish movement out of the sampled reaches. More details on survey modifications are included below.

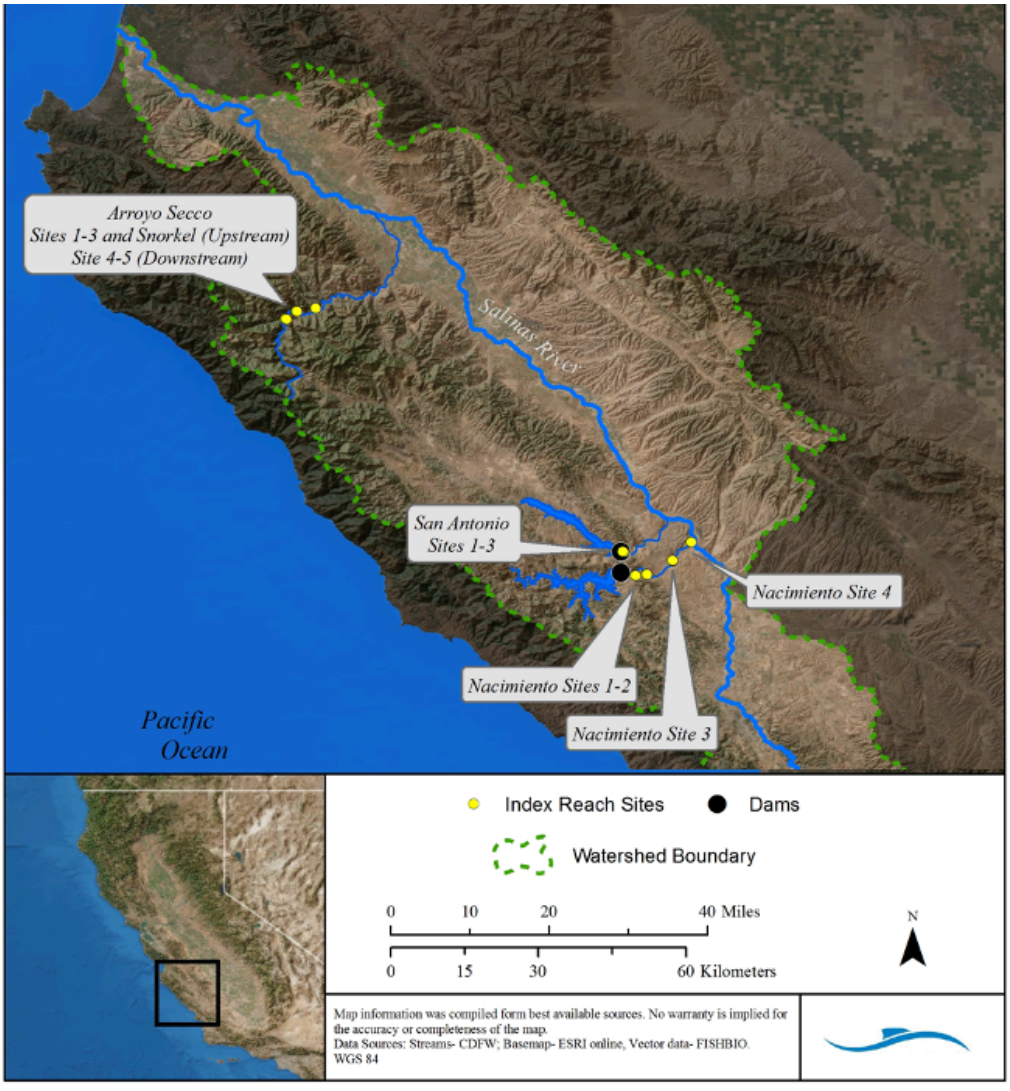

Figure 1. Map of survey locations in the Nacimiento, San Antonio, and Arroyo Seco rivers.

A visual assessment of the instream and riparian habitat was conducted prior to beginning surveys at each site. This consisted of measuring the wetted width and length of the index reach using a digital rangefinder and assessing the average depth of the reach using a stadia rod. Field crews also noted the occurrence of habitat features including algae, boulders, undercut banks, root wads, macrophytes, woody debris, overhanging vegetation, and artificial structures, and noted the primary substrates in the stream channel. In addition, field crews measured conductivity, temperature, and dissolved oxygen using a YSI water quality meter. A water sample was also collected to assess turbidity using a portable turbidimeter.

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, verified with conductivity readings and referenced with the NMFS Guidelines for Electrofishing Waters Containing Salmonids Listed under the Endangered Species Act (NMFS, 2000). Electrofishing commenced 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, fork length was measured for all species possessing forked tails, and total length was measured for the first 20 individuals of all captured species (additional individuals were plus counted). All captured *O. mykiss* and notable individuals of other species were also weighed using a digital scale.

Captured *O. mykiss* were also scanned 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 PIT tag (half duplex 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. Only a single *O. mykiss* (captured at Nacimiento Site 2) was not subjected to this tagging procedure, as field crews were worried about tagging stress due to the small size of the species. An additional individual captured at Arroyo Seco Site 4 was tagged with a PIT tag, but the PIT number was unable to be recorded due to equipment malfunction.

At Site 1 in the Arroyo Seco River, visual observations were made in the pool immediately upstream of the electrofishing site as this pool had been snorkeled during previous surveys. During the survey, snorkeling was conducted by a single diver swimming upstream from the bottom of the pool. Water clarity was very high during the time of surveys, allowing for complete visual coverage of the entire pool. All species and their approximate sizes were recorded immediately following the survey.

During this sampling effort, the protocol of multiple-pass depletion sampling using block nets that was established by the former Biological Opinion (BO) was modified in an effort to improve efficiency and increase sampled habitat. The previous method of deploying block nets (which consumes extensive amounts of field time and likely leads to flushing fish out of the sample

reach) and sampling until depletion is achieved, is time-consuming and offers robust data for only a limited sampling area. The purpose of these surveys is to compare indices of abundance over time and examine the longitudinal distribution of *O. mykiss* in each tributary. As such, extended transects increased the opportunity to capture juvenile *O. mykiss* in rivers where abundance is very low overall (e.g., Nacimiento) and provided more information on species distribution throughout the river. In addition, longer transects can increase our understanding of the fish community over a greater range of habitats. While depletion electrofishing offers the ability to develop estimates of abundance in each site, the estimator often did not work if low numbers of *O. mykiss* were captured (which occurred frequently), and indices of abundance can still be compared by comparing the Catch Per Unit Effort (CPUE) within and between sites.

Data Analyses

Analyses were conducted in R statistical software (R Core Team 2017) and began with the calculation of Shannon-Wiener 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 calculated as well 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 how fish communities in each river compared to each other.

Catch-per-unit-effort (CPUE) was 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 sampling events in each location (with the exception of Arroyo Seco Sites 1-3), it was not possible to evaluate 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 given location would suggest a greater abundance of fish. Finally, average, minimum, and maximum total lengths of fish in each location was calculated for each site.

To supplement sampling of the fish community with traditional gear (electrofishing), a total of two eDNA samples were collected from the lower Nacimiento River. All samples were collected using eDNA filtration kits provided by Jonah Ventures (Boulder, Colorado). These kits include a 60mL syringe and 1-µm filter cartridge. At each sample location, one full syringe of water (60mL) was drawn up from just below the surface and pushed through the filter. The kits also contained a 1-mL syringe of preservative solution, which was used to stabilize collected DNA and prevent degradation during storage and transport. Samples were shipped to Jonah Ventures (Boulder, Colorado) for PCR analysis using primers specifically developed for *O. mykiss*.

Results

Water Quality

Water quality assessments indicated suitable conditions for *O. mykiss* in the majority of sites, with temperatures ranging from 9.4 to 19.4˚C (49 to 67 ˚F) and dissolved oxygen ranging from 8.71 to 11.23 mg/L (Table 1). As in past surveys, the San Antonio sites exhibited poor water quality overall and the field crew noted the intense sulfurous smell of the water. Turbidity was also within the range of suitable conditions but varied widely between rivers. Although measurements were not collected in the San Antonio River, visual observation indicated very high turbidity in the river (similar to previous surveys). Turbidity varied at sites in the Nacimiento River but generally decreased in a downstream direction (i.e., water clarity was higher at the downstream sites). 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. Similarly, aquatic vegetation was very widespread in the San Antonio River and relatively common in the Nacimiento, especially at the most upstream sites.

Discharge during the surveys was measured at the Nacimiento near Bradley, and Arroyo Seco near Greenfield gauges. During surveys, Nacimiento River discharge was approximately 62 cubic feet per second (CFS), San Antonio discharge was approximately 10 CFS, and Arroyo Seco discharge ranged from approximately 0.47 CFS to 1.11 CFS at the gauges.

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

Site	Temperature (˚C)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Discharge (CFS)*
Arroyo Seco 1-3	9.4	11.22	0.89	1.08
Arroyo Seco 4	13.2	9.80	2.80	1.11
Arroyo Seco 5	14.2	10.58	1.17	0.47
Nacimiento 1	15.8	8.96	6.21	62.1
Nacimiento 2	13.0	9.06	7.64	61.9
Nacimiento 3	13.6	11.23	4.02	61.9
Nacimiento 4	15.6	10.64	2.12	61.9
San Antonio 1	17.8	9.26	–	–
San Antonio 2	19.4	8.71	–	–
San Antonio 3	19.2	9.67	–	–

*Discharge during the surveys was measured at the Nacimiento near Bradley, and Arroyo Seco near Greenfield gauges

Fish Community

Species diversity was relatively similar across all sites with a total of 11 species captured overall (n=4 in San Antonio, n=7 in Nacimiento, and n=7 in Arroyo Seco; Table 2). The majority of fish captured were native, with only mosquitofish and goldfish being non-native. Unique species were captured in the Arroyo Seco (n=2) and San Antonio (n=1) rivers, with all fish captured in the Nacimiento being observed in the other rivers. Overall, both species richness and species diversity metrics were relatively low and indicative of the minimal number of species in each stream (Figures 2-6). The fish communities in the San Antonio and Nacimiento were more similar to each other than they were to the fish community in the Arroyo Seco, which is to be expected given the proximity and similarities between the two rivers (Figure 4). Catch per unit effort (CPUE) was low overall but generally higher in the Arroyo Seco. CPUE was also high in one of the San Antonio sites due to extremely abundant populations of threespine stickleback and mosquitofish (Figure 5).

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	1-3	*O. mykiss*	7	93	248
		Sacramento Pikeminnow	77	50	170
		Sacramento Sucker	17	71	201
	4	Lamprey spp.	1	110	110
		O. mykiss	1	137	137
		Sacramento Pikeminnow	20	45	207
		Sacramento Sucker	11	87	328
		Speckled Dace	76	47	83
		Spotted Bass	6	141	179
	5	Lamprey spp.	1	120	120
		Sacramento Pikeminnow	17	62	94
		Sacramento Sucker	21	54	102
		Speckled Dace	21	43	65
Nacimiento	1	Prickly Sculpin	8	60	138
		Threespine Stickleback	3	24	31
	2	Prickly Sculpin	25	60	132
		O. mykiss	1	81	81
		Sacramento Pikeminnow	5	83	193
		Sacramento Sucker	7	81	495
		Threespine Stickleback	2	39	50
	3	Lamprey spp.	1	120	120
		Western Mosquitofish	5	27	56
		Prickly Sculpin	3	68	110
		Sacramento Pikeminnow	1	593	593

	4	Sacramento Sucker	6	80	207
		Prickly Sculpin	1	86	86
		Sacramento Pikeminnow	1	197	197
		Sacramento Sucker	13	119	448
San Antonio	1	Goldfish	3	161	170
		Western Mosquitofish	3	23	32
		Prickly Sculpin	26	55	142
	2	Western Mosquitofish*	TNTC*	–	–
		Prickly Sculpin	3	83	108
	3	Goldfish	3	100	142
		Western Mosquitofish	3	18	25
		Prickly Sculpin	5	58	105
		Threespine Stickleback	84**	34	57

* Western Mosquitofish observed at San Antonio Site 2 were too numerous to count, but due to their very small size the field crew was not able to capture them with the dip nets, and therefore they are not considered in diversity calculations.
**Abundant Threespine Stickleback of smaller size classes were also observed but could not be effectively captured with the dip nets.

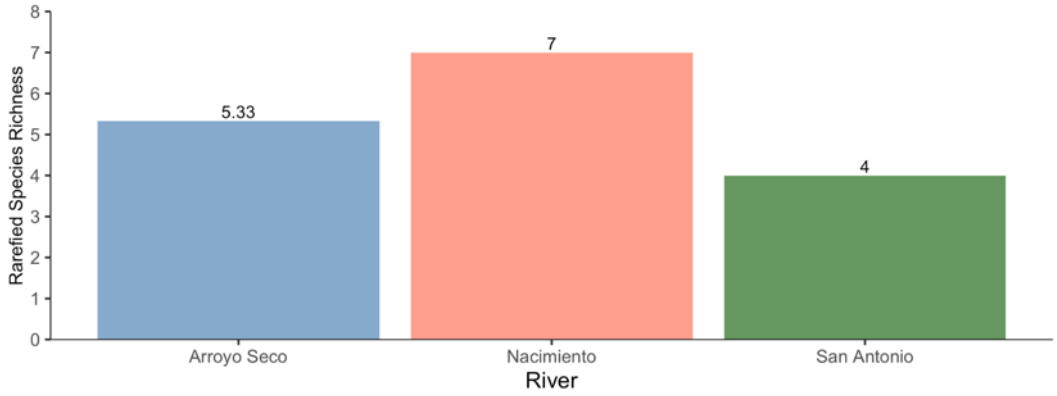

Figure 2. Rarefied species richness of combined sample sites in each river.

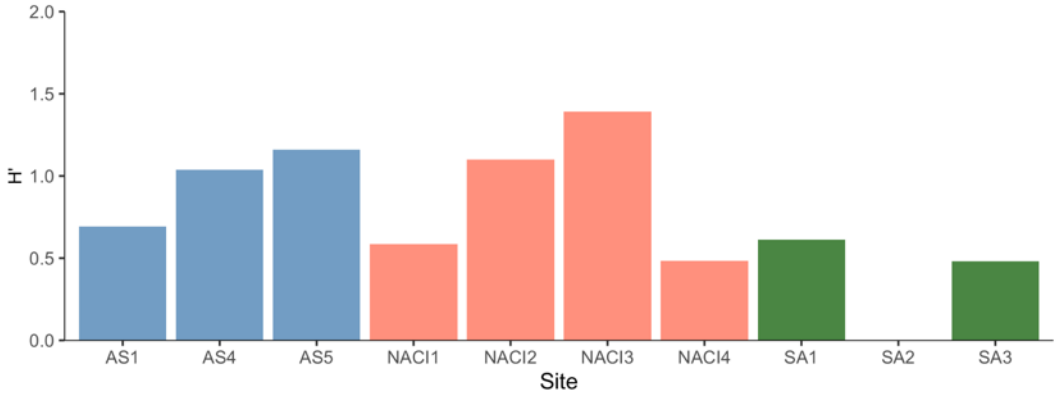

Figure 3. Shannon-Wiener Diversity Index (H') values of each sample site.

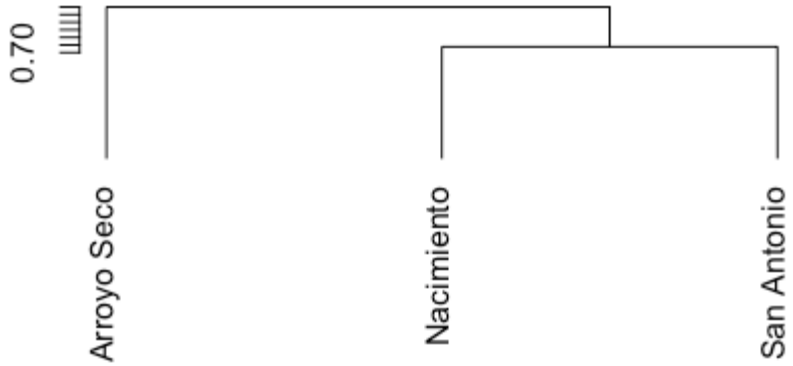

Figure 4. Fish catch across the sites in each of the three rivers clustered by Jaccard similarity.

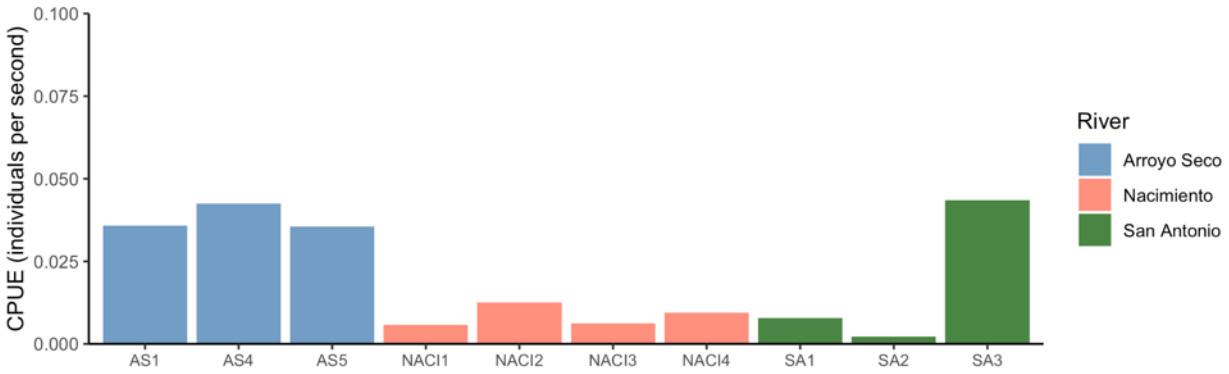

Figure 5. CPUE in terms of individuals captured per second of electrofishing effort.

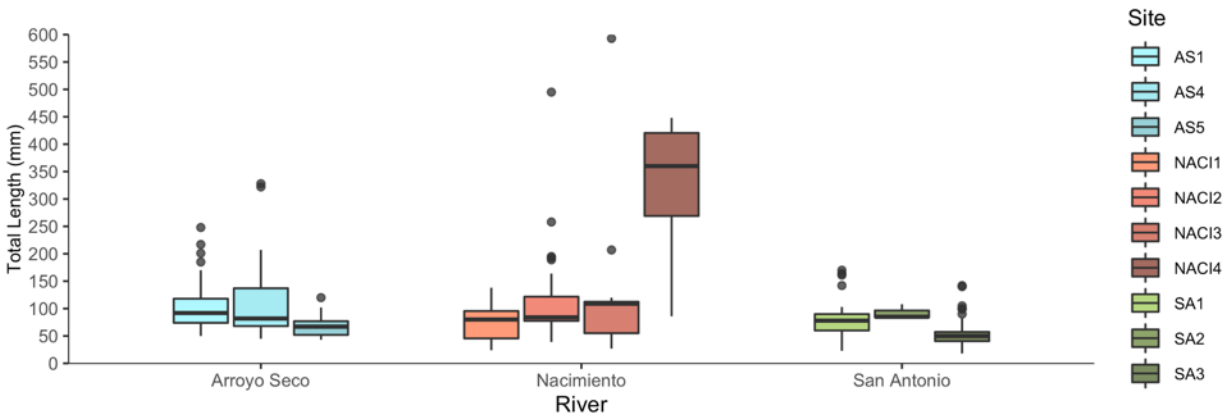

Figure 6. Length composition of fish captured in each of the sample sites.

O. mykiss

A total of eight *O. mykiss* were collected overall with all but one of those being captured in the Arroyo Seco River. Catch patterns in each tributary were similar to previous surveys, with no *O. mykiss* captured in the San Antonio, few *O. mykiss* captured in the Nacimiento, and numerous *O. mykiss* observed in the Arroyo Seco. The capture of a single *O. mykiss* in the Nacimiento (Figure 7) confirms insights gained through previous rotary screw trap and index reach monitoring, namely that the abundance and/or production of steelhead in the Nacimiento is exceedingly low. *O. mykiss* abundance and distribution in the Arroyo Seco River matched previously observed patterns, with higher catch at the upstream sites. The capture of seven *O. mykiss* in the Arroyo Seco river is lower than previous electrofishing surveys from 2010-2013, but were higher than visual observations that occurred during previous dry years (Table 2).

Table 2. Capture history of *O. mykiss* during all index reach monitoring surveys that used electrofishing as a primary sampling method.

Year	Nacimiento	Arroyo Seco Sites 1-3	Arroyo Seco Sites 4-5	Annual Total
2010	-	20	13	33*
2011	0	27	35	62
2012	1	21	0	22
2013	0	13	0	13
2022	1	7	1	9

*An additional O. mykiss was captured at a downstream sampling site in the Arroyo Seco River
- Indicates no electrofishing sampling occurred in this region

Sizes of captured *O. mykiss* ranged from 81 to 248 mm corresponding to ages ranging from zero (young of the year) to two, based on analyses of scales collected during surveys. As expected for this time of year, none of the captured *O. mykiss* showed physical signs of preparing for migration.

Figure 7. Juvenile *O. mykiss* captured in the Nacimiento River.

eDNA

There were no detections of O. mykiss from eDNA samples collected at the two downstream sites (sites 3 and 4) on the Nacimiento River. The absence of O. mykiss DNA in water samples does not conclusively prove the species absence in the downstream reaches of the river but provides strong evidence that their densities in the river are extremely low and they are likely only present in upstream reaches near the dam.

Discussion

Index reach monitoring has been conducted since 2010 in the Arroyo Seco, San Antonio, and Nacimiento rivers to assess relative *O. mykiss* abundance, fish community structure, and habitat use in the fall of each year. Sampling has been conducted using both electrofishing and snorkel surveys, depending on river conditions, but unknown detection probabilities and differences in methodologies complicate comparisons of densities and temporal trends. Despite missing several years due to poor conditions and regulatory complications, this monitoring currently constitutes the longest-running and most robust dataset on *O. mykiss* populations in the Salinas Basin. As the Monterey County Water Resources Agency pursues long-term operations permitting through a Habitat Conservation Plan, this data constitutes a valuable resource to inform species protection efforts for *O. mykiss*.

The results from the 2022 surveys confirm the general patterns of population abundance and distribution in the basin. Namely, the quality habitat and relatively abundant population of *O. mykiss* in the Arroyo Seco River, the scarce but persistent population of *O. mykiss* below the dam in the Nacimiento River, and the absence of a *O. mykiss* population below the dam in the San Antonio River. Although *O. mykiss* densities in the Arroyo Seco were less abundant compared to previous surveys, patterns of occupancy declined from upstream sites to those further downstream, similar to previous years. However, during previous surveys in years with below-average discharge (i.e., 2013), no *O. mykiss* were observed in downstream index reaches like they were in 2022. Of note 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 still may pose a threat to rearing and migrating *O. mykiss* in the watershed.

In the Nacimiento River, the observation of a single *O. mykiss* matches findings from previous surveys, where only one individual steelhead was captured during the 4 years of electrofishing sampling effort (in 2012). 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 the several stream characteristics associated with productive habitat. Compared to rivers like the San Antonio and other small tributaries of the Salinas, 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 (Figure 8). Given this habitat potential and the enormous efforts to provide steelhead passage opportunities to the river, efforts should be made to improve understanding of steelhead production in the tailwater to see if habitat restoration or altering flow schedules, for example, could improve spawning and rearing conditions for *O. mykiss* in the river. It should be noted, however, that several fish captured in the Nacimiento appeared to be of low weight, and wounds and/or parasites were noticed on numerous fish indicating poor conditions and potentially high rates of predation in the stream (Figure 8).

Figure 8. Clockwise from top left: A skinny pikeminnow with numerous parasites; a Sacramento sucker with a large wound; woody debris and spawning gravel in the Nacimiento River (Site 3); woody debris, gravel, and riparian forest cover in the Nacimiento River (Site 4).

Encouragingly, data collected in 2022 has revealed a resilient population of *O. mykiss* in the basin despite three consecutive dry years (Figure 9). 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: water temperatures exceeded 20°C with dissolved oxygen levels less than 6.0 mg/L. Although no sampling was conducted in 2015–2016 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 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.

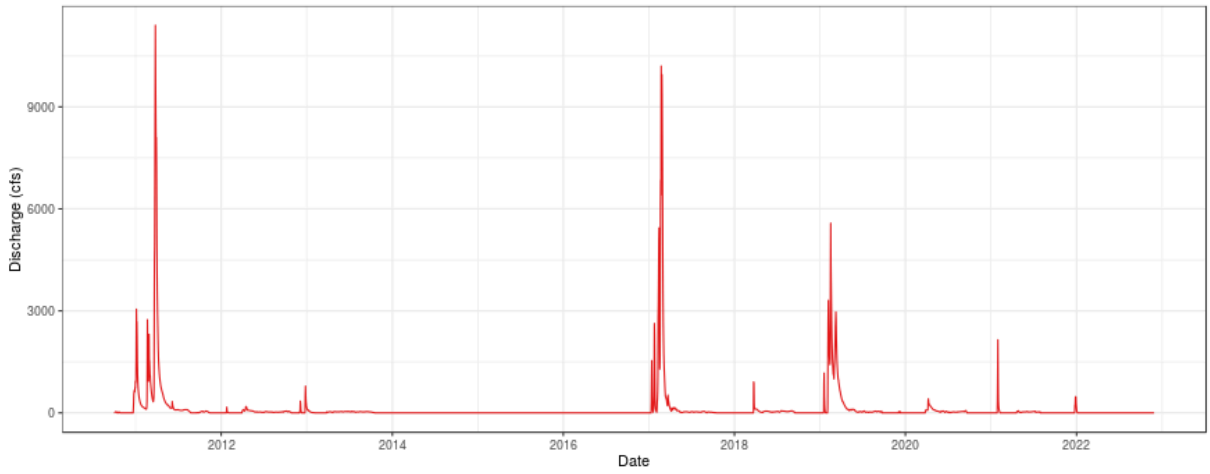

Figure 9. Annual discharge patterns in the Salinas River at Spreckels from Oct. 2010 - Oct. 2022.

Due to the absence of an approved BO 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 discussed previously, methods were altered in 2022 to increase efficiency, provide additional opportunities to capture juvenile *O. mykiss* in rivers with low abundance (e.g., Nacimiento), and increase understanding of *O. mykiss* occupancy over a greater range of habitats. 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 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 (e.g., GRTS) that covers both mainstem and tributary habitats (in the Arroyo Seco). This is especially important as understanding of steelhead habitat use in the various Arroyo Seco tributaries remains largely unknown. These expanded surveys can also be used to understand juvenile production on an annual basis, and the increase in tagged fish over time can provide information on migratory patterns, residency rate, movement patterns, and production among the various tributaries.

Several findings from these surveys are applicable to the development of an 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 (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 long-term population of steelhead seems unlikely given current habitat conditions. However, in the Nacimiento River, habitat improvements could be made through targeted restoration and revised flow schedules. These sorts of improvements may offer comparable population benefits compared to manually moving fish around the dams and may be much more feasible 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 the basin 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 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 assessments 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 (FISHBIO 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 RM 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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