2019 Coyote Creek Watershed Fisheries Monitoring

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Reports included:

2019 Juvenile *Oncorhynchus mykiss* Rearing Monitoring in the Coyote Creek Watershed

Coyote Creek 2018-2019 Adult Salmonid Migration Monitoring Using the Vaki Riverwatcher Passive Monitoring System at the Coyote Percolations Facility
2019 Juvenile *Oncorhynchus mykiss* Rearing Monitoring in the Coyote Creek Watershed

Prepared by:
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January 30, 2020
Executive Summary

To better understand juvenile steelhead (*Oncorhynchus mykiss, O. mykiss*) populations within Coyote Creek Watershed, Valley Water performed index reach monitoring for juvenile *O. mykiss* on Coyote Creek and Upper Penitencia Creek. The goal of the monitoring was to document the abundance, distribution, and densities of all fish in the watershed as well as, collect *O. mykiss* genetic information, and implement a tracking study using Passive Integrated Transponders (PIT). In 2018 the National Marine Fisheries Service and California Department of Fish and Wildlife authorized the monitoring to the Coyote Creek Watershed under Section 10(a)1(A) Recovery Permit # 16417-2R and California Department of Fish and Wildlife Scientific Collecting Permit # 11325.

In fall 2019, monitoring was conducted at 10 stations in the Coyote Creek Watershed, with 6 monitoring stations on Coyote Creek and 4 monitoring stations on Upper Penitencia Creek. Multi-pass depletion backpack electrofishing was conducted at each station. Appropriately sized *O. mykiss* received PIT tags to study their movement within the Coyote Creek Watershed.

Juvenile *O. mykiss* were present in Coyote Creek and Upper Penitencia Creek during fall 2019, with three (<0.01 *O. mykiss*/m) and 63 (0.39 *O. mykiss*/m) individuals captured in each creek respectively. An additional 37 *O. mykiss* were collected in Upper Penitencia Creek specifically to increase the sample size of fish fitted with PIT tags. Based on the size range of *O. mykiss* collected, it can be deduced that production and successful summer rearing occurred, and multiple age classes were present in Upper Penitencia Creek. Though juvenile *O. mykiss* were detected in Coyote Creek, the numbers were low and distribution through the system was limited.

Four species of non-native fish were observed on Coyote Creek and no non-native fish were observed on Upper Penitencia Creek at the monitoring stations. Six percent of the total number of fish observed on Coyote Creek in 2019 were non-native. A single non-native fish (golden shiner (*Notemigonus crysoleucas*)) was observed on Upper Penitencia Creek while conducting additional sampling.

This juvenile rearing monitoring is part of a continuing effort to better understand *O. mykiss* distribution and abundance in the Coyote Creek Watershed. Since this is the first year of complete surveys it is difficult to assess any trends at this time, but as more data becomes available a better understanding of the Coyote Creek Watershed will develop.
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1. Introduction

The Coyote Creek Watershed is the largest watershed in Santa Clara County, encompassing over 829 square kilometers. The eastern and southern portions of the watershed drain most of the western face of the Diablo Mountain Range where the creek originates at elevations up to 1,110 meters. These upper watershed areas remain undeveloped with little anthropogenic disturbance. The northern and western portions of the watershed are comprised of the Santa Clara County valley floor. Portions of the valley floor are extensively urbanized with patches of undeveloped parks and open agricultural lands. Coyote Creek has 29 tributaries and flows northwest through the valley, approximately 68 kilometers from the headwaters, where it enters the southern extent of the San Francisco Bay. The Coyote Creek Watershed supports Central California Coast steelhead (*Oncorhynchus mykiss*; *O. mykiss* for the remainder of this document) distinct population segment which is a federally threatened species. Two systems in the Coyote Creek Watershed are defined as critical habitat for *O. mykiss*: Coyote Creek and Upper Penitencia Creek. Critical Habitat for Coyote Creek extends from the creek’s confluence with the San Francisco Bay to the base of the Leroy Anderson Dam. Critical Habitat for Upper Penitencia Creek extends from the creek’s confluence with Coyote Creek to the base of the dam at Cherry Flat Reservoir.

In an attempt to better understand *O. mykiss* populations within these systems, Valley Water (formerly the Santa Clara Valley Water District) performed index reach monitoring for juvenile *O. mykiss* on Coyote Creek and Upper Penitencia Creek. The goal of the monitoring was to document the abundance, distribution, and densities of all fish in the watershed as well as, collect *O. mykiss* genetic information, and implement a tracking study using Passive Integrated Transponders (PIT).

2. Methods

2.1 Station Selection

A total of 10 stations within the Coyote Creek Watershed were sampled, six on Coyote Creek and four on Upper Penitencia Creek. Stations were designated using stratified random selection and by selecting targeted areas of interest. Site selection was limited
to locations Valley Water has ownership or easement, or to locations owned by other
government agencies. Specifics for site selection for each waterway can be seen in the
two sections below.

_Coyote Creek_

The area of study for Coyote Creek was defined as the extent between the overcrossing of Metcalf Road to the base of Leroy Anderson Dam. This area was broken into 17, 1.0 km reaches. Four of the 17 reaches were randomly selected using a random number generator. Each 1.0 km reach was then broken into 25, 40.0 m reaches, and a station was randomly selected using a random number generator (stations COY001, COY002, COY005, and COY006). If randomly selected stations fell into areas that were too deep to facilitate sampling, a new random number was generated. Two stations were not randomly selected, with one station being chosen as an area of interest (COY003) and one having been previously sampled in 2018 (COY004). All stations were field fit for access and feasibility of sampling. The results of the Coyote Creek station selection can be seen in Figure 1.

_Upper Penitencia Creek_

The area of study for Upper Penitencia Creek was defined as the section between the Piedmont Road overcrossing to the upper extent of the City of San Jose’s property upstream of Alum Rock Park. This area was selected as it had the highest likelihood of being wetted throughout the sampling period. This area was broken into four, 1.0 km reaches with a single station being placed within each of the four reaches. Each 1.0 km reach was then broken into 25, 40.0 m reaches, and a site was randomly selected using a random number generator. The most downstream site was field fit to account for the areas of dry back that naturally occur in this system. The results of the station selection can be seen in Figure 2.
Figure 1: Coyote Creek juvenile rearing monitoring stations.
Figure 2: Upper Penitencia Creek juvenile rearing monitoring stations.
2.2 Sampling Methods
Each monitoring station was between 30.0 and 40.0 m in length. The target length was
40.0 m, but deviations in length occurred based on the ability to install and secure block
nets. At least two distinct habitat types (described below) were included in each station
with the exception of COY003. Multi-pass depletion backpack electrofishing was
deployed at every station (Johnson et al. 2007). This method allowed for: consistency
with previous juvenile rearing monitoring methods, the extrapolation of population
estimates, and the sampling of a variety of habitat types.

Habitat Typing
Each monitoring station was habitat typed using the classifications described in Table 1.
Habitat typing followed Ode (2007) for habitat type descriptions (Table 1). Average
wetted width and depth were estimated and the presence of any anthropogenic
influences (bridge, dam, etc.) was noted. Prior to the start of sampling, ambient
conditions (weather) were noted and water quality (dissolved oxygen, conductivity,
turbidity, and temperature) was collected at the downstream end of the monitoring
stations. Ocular estimates of percent cover of macrophytes/emergent vegetation,
boulders, woody debris, undercut banks, overhanging vegetation, submerged roots (live
and dead), and artificial structures were recorded for each monitoring station (Table 2).
Each habitat feature was ranked on a 0-4 point scale described in Table 2, with 0 being
absent and 4 being a very heavy presence. Primary and secondary substrate types
were determined based upon ocular estimates (Table 3; Ode 2007).

Table 1: Habitat type classifications (Ode 2007).

<table>
<thead>
<tr>
<th>Habitat Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cascades</td>
<td>Short, high gradient drop in streambed elevation often accompanied by boulders and considerable turbulence.</td>
</tr>
<tr>
<td>Falls</td>
<td>High gradient drop in elevation of the streambed associated with an abrupt change in the bedrock.</td>
</tr>
<tr>
<td>Rapids</td>
<td>Sections of stream with swiftly flowing water and considerable surface turbulence. Rapids tend to have larger substrate sizes than riffles.</td>
</tr>
<tr>
<td><strong>Riffles</strong></td>
<td>Shallow sections where the water flows over coarse streambed particles that create mild to moderate surface turbulence.</td>
</tr>
<tr>
<td><strong>Step-Run</strong></td>
<td>A series of runs that are separated by short riffles or flow obstructions that cause discontinuous breaks in slope.</td>
</tr>
<tr>
<td><strong>Runs</strong></td>
<td>Sections without flow obstructions. The streambed is typically even and the water flows faster than it does in a pool.</td>
</tr>
<tr>
<td><strong>Glides</strong></td>
<td>A section of stream with little or no turbulence, but faster velocity than pools.</td>
</tr>
<tr>
<td><strong>Pool</strong></td>
<td>A reach of stream that is characterized by deep, low-velocity water and a smooth surface.</td>
</tr>
</tbody>
</table>

**Table 2: Ocular estimate scale (Ode 2007).**

<table>
<thead>
<tr>
<th>Scale</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent</td>
<td>0%</td>
<td>&lt;10%</td>
<td>10-40%</td>
<td>40-75%</td>
<td>&gt;75%</td>
</tr>
<tr>
<td>Coverage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Descriptor</td>
<td>Absent</td>
<td>Sparse</td>
<td>Moderate</td>
<td>Heavy</td>
<td>Very Heavy</td>
</tr>
</tbody>
</table>

**Table 3: Substrate classes**

<table>
<thead>
<tr>
<th>Particle Size</th>
<th>Size Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boulder</td>
<td>&gt; 250 mm</td>
</tr>
<tr>
<td>Cobble</td>
<td>65-250 mm</td>
</tr>
<tr>
<td>Gravel</td>
<td>2.0-65 mm</td>
</tr>
<tr>
<td>Sand</td>
<td>&lt;2.0 mm (gritty texture)</td>
</tr>
<tr>
<td>Silt/Clay</td>
<td>Not gritty</td>
</tr>
<tr>
<td>Bedrock</td>
<td>No individual particles</td>
</tr>
</tbody>
</table>

**Electrofishing**

Block nets were installed at both the upstream and downstream ends of sampling reaches to block immigration into and emigration out of sampling reaches. Electrofishing commenced from down to upstream and worked laterally across the stream to ensure all portions of the wetted width were sampled. Smith-Root LR24 Backpack
Electrofishing Units were used at all monitoring stations. As recommended in Johnson et al. 2007, in portions of the creeks that exceeded 7.0 m in width, two electrofishers were deployed, to provide adequate coverage of the channel. The LR24 quick set option was used to establish the initial power and waveform settings. The quick set output was verified with conductivity readings. Electrofishers were run using direct current, at a frequency of 30 Hz, duty cycle of 12%, and voltage that ranged between 125 and 200 volts (depending on conductivity). Each electrofisher operator(s) was flanked by two netters. Verbal communication and spatial awareness were used to ensure the entire width of the stream was covered. Triple-pass depletion electrofishing methods were deployed at all stations.

Fish Processing
Fish were held in aerated dark-colored containers during processing. Length measurements were recorded to the nearest millimeter at the fork of the tail (fork-length). For each pass, up to 30 individuals of each species were measured, and all other individuals of that species were counted for a total number.

Carbon dioxide (CO₂) was administered to *O. mykiss* using Alka-Seltzer Gold, in doses to induce light narcosis (1 tablet per 2.5 liters of stream water). *O. mykiss* were exposed to the anesthesia for no more than 5 minutes. *O. mykiss* were observed for listing, and upon listing were removed from the anesthetizing solution, weighed, measured, tail-clipped for a genetic sample, and PIT tagged if large enough (≥65 mm fork-length).

Fin clips were taken for genetic analysis of all *O. mykiss* from the caudal fin. Clips were a 1-2 mm square. Medical grade scissors used to collect the clips were sterilized with an alcohol dilution with a final concentration of 60-80% isopropyl. Tissue samples were placed in sterile chromatography paper and placed in a labeled envelope denoting the field specimen number, species, stream, stream location, date, and fork-length. Tissues collected will be sent to the National Marine Fisheries Service Southwest Fisheries Science Center for analysis.
All PIT tagging was conducted in accordance with the PIT Tag Marking Procedures Manual (CBFWA 1999) by staff trained in the procedure. All *O. mykiss* 65 mm in fork-length or greater received a PIT tag. Biomark single-use preloaded needles were used in the tagging process. Prior to inserting PIT tags all *O. mykiss* were scanned to ensure they were not previously tagged. *O. mykiss* greater than or equal to 65 mm fork-length received 12 mm half-duplex PIT tags. *O. mykiss* larger than 150 mm fork-length received 23 mm tags. The permits allow for fish greater than 100 mm to be tagged with 23 mm tags, but to be conservative with the fishes’ welfare, the minimum size was increased to 150 mm. PIT tags were scanned prior to insertion to verify they were viable. PIT tag numbers and associated biological data for each fish is included in Appendix A.

After exposure to the anesthesia and all procedures, fish were placed in an aerated dark-colored receptacle, then transferred to an in-channel live car for recovery, and then released.

2.3 Data Analysis

MicroFish 3.0 was used to calculate population estimates for each station using a maximum-likelihood iterative process (MLIP); the associated standard errors and 95% confidence intervals (95% CI) are reported. This method uses the number of fish captured (n) and the difference in capture between electrofishing passes (i.e., depletion rate) to calculate an estimate of fish likely to have been present but not captured, thus generating a population estimate (N) for each station. Population estimates are restricted to the sampled areas and are only an index of the overall population. If the number of a particular species was too low (i.e., only one fish was captured) or all fish of a particular species were captured on the first pass, then maximum-likelihood population estimate could not be produced. If the lower confidence interval was less than the total catch it was set equal to total catch, as it is certain at least that many fish were present in the sampling reach. These calculations assume emigration and immigration were prevented by the erection of upstream and downstream block nets. It is assumed that shocking efficiency did not change between passes and that staff did
not become more efficient using the equipment, nor did fish learn to avoid the electrical field between passes.

3. Results and Discussion

3.1 Coyote Creek
Sampling occurred at six stations on Coyote Creek on November 6 and 7, 2019. The weather was sunny and clear with no precipitation. Flows at the ALERT 5082 Coyote Creek at Madrone stream flow gage, were approximately 40.0 cubic feet per second (cfs; flow measurements will be reported using the standard unit system) during all sampling days.

**COY001**
This was the most downstream station sampled on Coyote Creek. This station is low gradient and located directly upstream of the Metcalf Pond Facility. A dense riparian corridor is present but lacks in stature (Figure 3). The channel is situated between two levees with industrial land use and urban development on each side. The monitoring station was 40.0 m in length with an average wetted width of 9.0 m and an average depth of 0.25 m. Two habitat types were present within the station: riffle and run. The riffle habitat made up 75% of the habitat sampled, with the run habitat contributing to 25%. The primary substrate was cobble with a secondary substrate of gravel. Water quality and habitat complexity at the time of sampling are summarized in Table 4.
Figure 3: Photos of station COY001, looking upstream (left) and looking downstream (right).

Table 4: Coyote Creek station COY001 water quality data and ocular estimates of habitat complexity.

<table>
<thead>
<tr>
<th>Water Quality</th>
<th>Conductivity (μS/cm)</th>
<th>Temperature (°C)</th>
<th>Dissolved Oxygen (mg/l)</th>
<th>Turbidity (NTU)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>495.00</td>
<td>16.36</td>
<td>8.90</td>
<td>6.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Habitat Complexity Scoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macrophytes/Emergent Vegetation</td>
</tr>
<tr>
<td>-----------------------------</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Tandem electrofishers were used at this site. Fish captured and associated population estimates are summarized in Table 5. Five species of fish were captured: prickly sculpin (*Cottus asper*), mosquitofish (*Gambusia affinis*), inland silverside (*Menidia beryllina*), bluegill (*Lepomis macrochirus*), and largemouth bass (*Micropterus salmoides*). The most abundant and only native species was prickly sculpin (n=120). No *O. mykiss* were captured. The MLIP indicates that the number of bluegill, mosquitofish, and prickly sculpin were likely higher than what was observed.
Table 5: Number captured and population estimates at station COY001 on Coyote Creek.

<table>
<thead>
<tr>
<th>Species</th>
<th>Native</th>
<th>n</th>
<th>N</th>
<th>SE</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bluegill</td>
<td>No</td>
<td>11</td>
<td>16</td>
<td>9.80</td>
<td>11-37</td>
</tr>
<tr>
<td>Inland silverside</td>
<td>No</td>
<td>1</td>
<td>1</td>
<td>0.73</td>
<td>1-1</td>
</tr>
<tr>
<td>Largemouth bass</td>
<td>No</td>
<td>1</td>
<td>1</td>
<td>2.03</td>
<td>1-1</td>
</tr>
<tr>
<td>Mosquitofish</td>
<td>No</td>
<td>3</td>
<td>4</td>
<td>0.00</td>
<td>4-4</td>
</tr>
<tr>
<td>Prickly sculpin</td>
<td>Yes</td>
<td>120</td>
<td>247</td>
<td>90.66</td>
<td>120-426</td>
</tr>
</tbody>
</table>

n = total number captured, N = calculated population estimate, SE = standard error, CI = confidence interval

**COY002**

This station is downstream of the Ogier Ponds complex bordered by a golf course and fallow fields. A dense riparian corridor is present and the channel braids at high flows. The monitoring station was 35.0 m in length due to depths at the upstream and downstream ends of the reach. The average wetted width was 5.5 m and the average depth was 0.6 m. Four habitat types were present within the station: riffle, run, glide, and pool (Figure 4). The riffle habitat was 14% of the reach, glide habitat was 43%, run habitat was 37%, and pool habitat was the remaining 6%. The primary substrate was gravel, with a secondary substrate of cobble. Water quality and habitat complexity at the time of sampling is summarized in Table 6.

![Figure 4: Photos of station COY002, looking upstream (left) and looking downstream (right).](image-url)
Table 6: Coyote Creek station COY002 water quality data and ocular estimates of habitat complexity.

<table>
<thead>
<tr>
<th>Water Quality</th>
<th>Conductivity (μS/cm)</th>
<th>Temperature (°C)</th>
<th>Dissolved Oxygen (mg/l)</th>
<th>Turbidity (NTU)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>410.00</td>
<td>14.75</td>
<td>10.14</td>
<td>7.70</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Habitat Complexity Scoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macrophytes/Emergent Vegetation</td>
</tr>
<tr>
<td>3</td>
</tr>
</tbody>
</table>

Prickly sculpin were the only native species collected. Fish captured and associated population estimates are summarized in Table 7. No *O. mykiss* were captured at this monitoring station. The MLIP estimates equaled the number of fish captured.

Table 7: Number captured and population estimates at station COY002 on Coyote Creek.

<table>
<thead>
<tr>
<th>Species</th>
<th>Native</th>
<th>n</th>
<th>N</th>
<th>SE</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Largemouth bass</td>
<td>No</td>
<td>3</td>
<td>3</td>
<td>0.00</td>
<td>3-3</td>
</tr>
<tr>
<td>Prickly sculpin</td>
<td>Yes</td>
<td>8</td>
<td>8</td>
<td>0.51</td>
<td>8-9</td>
</tr>
</tbody>
</table>

*n = total number captured, N = calculated population estimate, SE = standard error, CI = confidence interval*

**COY003**

This station is upstream of Ogier Ponds on Santa Clara County Parks Property. The surrounding land use is rural park with orchards to the west. The monitoring station was 38.0 m in length with an average wetted width of 7.0 m and an average depth of 0.25 m. Riffle habitat was the only habitat present within the station (Figure 5). The primary substrate was cobble with a secondary substrate of boulders. Results of the water quality monitoring and the ocular assessment of habitat complexity can be seen in Table 8.
Figure 5: Photos of station COY003, looking upstream (left) and looking downstream (right).

Table 8: Coyote Creek station COY003 water quality data and ocular estimates of habitat complexity.

<table>
<thead>
<tr>
<th>Water Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conductivity (μS/cm)</td>
</tr>
<tr>
<td>402.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Habitat Complexity Scoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macrophytes/Emergent</td>
</tr>
<tr>
<td>Vegetation</td>
</tr>
<tr>
<td>3</td>
</tr>
</tbody>
</table>

*Artificial structures in this reach include the design riffle and installed large woody debris.

Tandem electrofishers were used at this site due to the 7.0 m wetted width. The five species of fish captured were: hitch (*Lavinia exilicauda*), largemouth bass, prickly sculpin, Sacramento sucker (*Catostomus occidentalis*), and three-spined stickleback (*Gasterosteus aculeatus*). The most abundant species encountered was prickly sculpin (n=124). Fish captured and associated population estimates are summarized in Table 9. The MLIP indicates that prickly sculpin and three-spined stickleback numbers were likely higher than what was observed.
Table 9: Number captured and population estimates at station COY003 on Coyote Creek.

<table>
<thead>
<tr>
<th>Species</th>
<th>Native</th>
<th>n</th>
<th>N</th>
<th>SE</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hitch</td>
<td>Yes</td>
<td>3</td>
<td>3</td>
<td>0.00</td>
<td>3-3</td>
</tr>
<tr>
<td>Largemouth bass</td>
<td>No</td>
<td>1</td>
<td>1</td>
<td>0.73</td>
<td>1-1</td>
</tr>
<tr>
<td>Prickly sculpin</td>
<td>Yes</td>
<td>124</td>
<td>131</td>
<td>4.31</td>
<td>124-140</td>
</tr>
<tr>
<td>Sacramento sucker</td>
<td>Yes</td>
<td>5</td>
<td>5</td>
<td>0.79</td>
<td>5-7</td>
</tr>
<tr>
<td>Three-spined stickleback</td>
<td>Yes</td>
<td>3</td>
<td>5</td>
<td>9.68</td>
<td>3-32</td>
</tr>
</tbody>
</table>

n = total number captured, N = calculated population estimate, SE = standard error, CI = confidence interval

COY004
This station was a continued sampling location from the 2018 exploratory sampling. This upstream extent of the monitoring station was located under HWY 101. The site is bordered by the Coyote Creek Trail, with rural parks and orchards. The monitoring station was 40.0 m in length with an average wetted width of 10.0 m and an average depth of 0.35 m. Habitat at the station was 55% riffle and 45% run (Figure 6). The primary substrate was cobble, with a secondary substrate of gravel. Results of the water quality monitoring and the ocular assessment of habitat complexity can be seen in Table 10. Issues with the water quality instrumentation calibration lead to dissolved oxygen not being collected.

Figure 6: Photos of station COY004, looking upstream (left) and looking downstream (right).
Table 10: Coyote Creek station COY004 water quality data and ocular estimates of habitat complexity.

<table>
<thead>
<tr>
<th>Water Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conductivity (μS/cm)</td>
</tr>
<tr>
<td>----------------------</td>
</tr>
<tr>
<td>401.00</td>
</tr>
</tbody>
</table>

Habitat Complexity Scoring

<table>
<thead>
<tr>
<th>Macrophytes/Emergent Vegetation</th>
<th>Boulders</th>
<th>Woody Debris</th>
<th>Undercut Banks</th>
<th>Overhanging Vegetation</th>
<th>Roots</th>
<th>Artificial Structures</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>

Four species of fish captured were: *O. mykiss*, prickly sculpin, Sacramento sucker, and largemouth bass. The most abundant species encountered was prickly sculpin (n=13). Fish captured and associated population estimates are summarized in Table 11. *O. mykiss* (n=3; Figure 7) were encountered at this site with the MLIP providing an estimated abundance higher than what was observed (N=5). The density of *O. mykiss* in this reach was observed at 0.08 *O. mykiss* per meter (*O. mykiss*/m) and an estimated density of 0.13 *O. mykiss*/m. The *O. mykiss* captured measured 112 mm, 122 mm, and 133 mm fork-length.

Table 11: Number captured and population estimates at station COY004 on Coyote Creek.

<table>
<thead>
<tr>
<th>Species</th>
<th>Native</th>
<th>n</th>
<th>N</th>
<th>SE</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Largemouth bass</td>
<td>No</td>
<td>1</td>
<td>1</td>
<td>0.00</td>
<td>1-1</td>
</tr>
<tr>
<td>Prickly sculpin</td>
<td>Yes</td>
<td>13</td>
<td>13</td>
<td>0.88</td>
<td>13-15</td>
</tr>
<tr>
<td><em>O. mykiss</em></td>
<td>Yes</td>
<td>3</td>
<td>5</td>
<td>9.68</td>
<td>3-32</td>
</tr>
<tr>
<td>Sacramento sucker</td>
<td>Yes</td>
<td>5</td>
<td>5</td>
<td>1.19</td>
<td>5-8</td>
</tr>
</tbody>
</table>

*n* = total number captured, *N* = calculated population estimate, *SE* = standard error, *CI* = confidence interval
This station is within Santa Clara County Parks property surrounded by rural park lands. A dense riparian corridor is present. The monitoring station was 40.0 m in length with an average wetted width of 9.5 m and an average depth of 0.8 m. Two habitat types were present within the station: riffle and run (Figure 8). The riffle made up 63% of the habitat with the run making up the remaining 37% of the habitat. The primary substrate was cobble, with a secondary substrate of gravel. Results of the water quality monitoring and the ocular assessment of habitat complexity can be seen in Table 12. Issues with the water quality instrumentation calibration lead to dissolved oxygen not being collected.
Figure 8: Photos of station COY005, looking upstream (left) and looking downstream (right).

Table 12: Coyote Creek station COY005 water quality data and ocular estimates of habitat complexity.

<table>
<thead>
<tr>
<th>Water Quality</th>
<th>Conductivity (μS/cm)</th>
<th>Temperature (°C)</th>
<th>Dissolved Oxygen (mg/l)</th>
<th>Turbidity (NTU)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>410.00</td>
<td>15.50</td>
<td>-</td>
<td>2.70</td>
</tr>
</tbody>
</table>

Habitat Complexity Scoring

<table>
<thead>
<tr>
<th>Macrophytes/Emergent Vegetation</th>
<th>Boulders</th>
<th>Woody Debris</th>
<th>Undercut Banks</th>
<th>Overhanging Vegetation</th>
<th>Roots</th>
<th>Artificial Structures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

Tandem electrofishers were used at this station. Two species of fish were captured: prickly sculpin and Sacramento sucker. Fish capture at this site was very low. Fish captured and associated population estimates are summarized in Table 13. The MLIP provided population estimates higher than what was observed for prickly sculpin. No *O. mykiss* were captured at this monitoring station.
Table 13: Number captured and population estimates at station COY005 on Coyote Creek.

<table>
<thead>
<tr>
<th>Species</th>
<th>Native</th>
<th>n</th>
<th>N</th>
<th>SE</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prickly sculpin</td>
<td>Yes</td>
<td>2</td>
<td>3</td>
<td>0.00</td>
<td>3-3</td>
</tr>
<tr>
<td>Sacramento sucker</td>
<td>Yes</td>
<td>1</td>
<td>1</td>
<td>0.00</td>
<td>1-1</td>
</tr>
</tbody>
</table>

n = total number captured, N = calculated population estimate, SE = standard error, CI = confidence interval

**COY006**

This station is the most upstream station sampled on Coyote Creek and was 600.0 m downstream of the outlet of Leroy Anderson Dam. The surrounding land use consists of rural park lands with a small picnic area. The monitoring station was 30.0 m in length with an average wetted width of 11.0 m and an average depth of 0.5 m. Habitat at the station was 73% run and 27% riffle (Figure 9). The primary substrate was boulders, with a secondary substrate of cobbles. Results of the water quality monitoring and the ocular assessment of habitat complexity can be seen in Table 14.

**Figure 9**: Photos of station COY006, looking upstream (left) and looking downstream (right).
Table 14: Coyote Creek station COY006 water quality data and ocular estimates of habitat complexity.

<table>
<thead>
<tr>
<th>Water Quality</th>
<th>Conductivity (μS/cm)</th>
<th>Temperature (°C)</th>
<th>Dissolved Oxygen (mg/l)</th>
<th>Turbidity (NTU)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>394.00</td>
<td>15.33</td>
<td>-</td>
<td>4.90</td>
</tr>
</tbody>
</table>

Habitat Complexity Scoring

<table>
<thead>
<tr>
<th>Macrophytes/Emergent Vegetation</th>
<th>Boulders</th>
<th>Woody Debris</th>
<th>Undercut Banks</th>
<th>Overhanging Vegetation</th>
<th>Roots</th>
<th>Artificial Structures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>

Tandem electrofishers were used at this station. Three species of fish were captured: Sacramento sucker, hitch, and prickly sculpin. Fish captured and associated population estimates are summarized in Table 15. All species observed were native. The MLIP analysis indicates the number of prickly sculpin is likely higher than what was observed. No *O. mykiss* were observed.

Table 15: Number captured and population estimates at station COY006 on Coyote Creek.

<table>
<thead>
<tr>
<th>Species</th>
<th>Native</th>
<th>n</th>
<th>N</th>
<th>SE</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hitch</td>
<td>Yes</td>
<td>6</td>
<td>6</td>
<td>1.38</td>
<td>6-10</td>
</tr>
<tr>
<td>Prickly sculpin</td>
<td>Yes</td>
<td>36</td>
<td>48</td>
<td>11.53</td>
<td>36-71</td>
</tr>
<tr>
<td>Sacramento sucker</td>
<td>Yes</td>
<td>1</td>
<td>1</td>
<td>2.03</td>
<td>1-1</td>
</tr>
</tbody>
</table>

\( n = \text{total number captured, } N = \text{calculated population estimate, } SE = \text{standard error, } CI = \text{confidence interval} \)

*Coyote Creek Discussion*

Three *O. mykiss* were collected on Coyote Creek in 2019. Five of the six stations did not yield detection of *O. mykiss*. COY003 was the only stations with *O. mykiss* detections. This station was also the only station in 2018 that yielded *O. mykiss* detections. Though juvenile *O. mykiss* were detected in Coyote Creek, the numbers are still low and distribution through the system is limited. All stations sampled had some sort of habitat complexity (i.e., undercut banks, large woody debris, or submerged roots)
that could be used as *O. mykiss* refugia, and had riffle habitat that should support fast-water feeding requirements.

According to Moyle (2002), in small streams with low summer flows, such as Coyote Creek, young-of-the-year steelhead measure 50–90 mm, and fish at the end of their second year measure 100–160 mm. Within the Coyote Watershed, Smith (2018) aged fish from Upper Penitencia Creek between 2011 and 2018 and found that young-of-the-year *O. mykiss* ranged from 80–144 mm, fish in their second year ranged from 85–229 mm and fish in their third year 205-359 mm. This is a faster growth rate than predicted by Moyle (2002), but this is expected in warmer, more productive systems. Though Coyote Creek is a much larger system than Upper Penitencia Creek, the data on growth could be similar and is the best regional dataset. Based on Moyle (2002) and Smith (2018) growth rates, *O. mykiss* captured in Coyote Creek in WY 2019 were either young of the year or in their second year. In a high productivity system such as Coyote Creek, faster growth rates are expected so the *O. mykiss* captured were likely young-of-the-year.

Five native species were detected during this effort: Hitch, prickly sculpin, Sacramento sucker, three-spined stickleback, and *O. mykiss*. An additional four non-native species were observed: Inland silverside, mosquitofish, largemouth bass, and bluegill. The non-native species made up 6% of the total capture, but only largemouth bass are a major predator to *O. mykiss*.

Based on the sampling effort, it can be concluded that *O. mykiss* are present in the system but are in low abundance. This low capture rate is indicative of the current populations within the Creek, but environmental conditions also limit the effectiveness of electrofishing. Coyote Creek habitat consists of deep mid-channel pools, as well as riffle and run habitat with high velocities that were not wadeable during the sampling period. It is likely that the number of *O. mykiss* is higher than perceived as they could be using habitat that was too deep or too high velocity to install block nets for successful sampling. Through continued standardized monitoring, trends in abundance will be obtained, but overall abundance will remain difficult to ascertain.
3.2 Upper Penitencia Creek
Sampling occurred at four stations on Upper Penitencia Creek on November 4 and 5, 2019. All sampling days were sunny and clear. Flows during the sampling events were low. In some instances, flow limited up and downstream movement of fish. The nearest gage for accurately describing flow conditions is the ALERT Gage 5083 Upper Penitencia Creek at Dorel Drive. This gage is downstream of three of the four sampling locations. Flows at the time of the sampling were recorded at 0.2 cfs.

UP001
This was the most downstream station sampled and was near the end of flow for the system. This monitoring station is surrounded by urban residential housing but has a dense riparian canopy. The monitoring station was 40.0 m in length with an average wetted width of 4.0 m and an average depth of 0.3 m. Three habitat types were present within the station: riffle, glide, and pool (Figure 10). Riffle habitat made up 63% of the sampled area, followed by pool habitat at 25%, with glide habitat making up the remaining 12%. The primary substrate was boulders with a secondary substrate of gravel. Results of the water quality monitoring and the ocular assessment of habitat complexity can be seen in Table 16.

Figure 10: Photos of station UP001, looking upstream (left) and looking downstream (right).
Table 16: Station UP001 water quality data and ocular estimates of habitat complexity.

<table>
<thead>
<tr>
<th>Water Quality</th>
<th>Conductivity (μS/cm)</th>
<th>Temperature (°C)</th>
<th>Dissolved Oxygen (mg/l)</th>
<th>Turbidity (NTU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,520.00</td>
<td>10.25</td>
<td>5.12</td>
<td></td>
<td>1.10</td>
</tr>
</tbody>
</table>

Habitat Complexity Scoring

<table>
<thead>
<tr>
<th>Macrophytes/Emergent Vegetation</th>
<th>Boulders</th>
<th>Woody Debris</th>
<th>Undercut Banks</th>
<th>Overhanging Vegetation</th>
<th>Roots</th>
<th>Artificial Structures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Three species of fish were captured during the survey: riffle sculpin (*Cottus gulosus*), California roach (*Hesperoleucus symmetricus*), and Sacramento sucker. The most abundant species encountered was riffle sculpin (n=89). Fish captured and associated population estimates are summarized in Table 17. The MLIP indicates that the number of California roach and riffle sculpin is likely higher than what was captured. No *O. mykiss* were detected at this station.

Table 17: Number captured and population estimates at station UP001 on Upper Penitencia Creek.

<table>
<thead>
<tr>
<th>Species</th>
<th>Native</th>
<th>n</th>
<th>N</th>
<th>SE</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>California roach</td>
<td>Yes</td>
<td>74</td>
<td>92</td>
<td>11.56</td>
<td>74-115</td>
</tr>
<tr>
<td>Riffle sculpin</td>
<td>Yes</td>
<td>89</td>
<td>116</td>
<td>15.97</td>
<td>89-148</td>
</tr>
<tr>
<td>Sacramento sucker</td>
<td>Yes</td>
<td>4</td>
<td>4</td>
<td>0.54</td>
<td>4-6</td>
</tr>
</tbody>
</table>

*n = total number captured, N = calculated population estimate, SE = standard error, CI = confidence interval*

**UP002**

This station is located in the downstream extent of the City of San Jose’s Alum Rock Park. The surrounding land use is rural park lands with a two-lane road parallel to the creek channel. The monitoring station was 40.0 m in length with an average wetted width of 2.0 m and an average depth of 0.2 m. Four habitat types were present within the station: riffle, step-run, glide, and pool (Figure 11). The pool habitat made up 50% of the sampled reach, the step-run 35%, and the riffle and glide the remaining 7.5% each.
The primary substrate was boulder with a secondary substrate of cobble. Results of the water quality monitoring and the ocular assessment of habitat complexity can be seen in Table 18. The artificial structure observed was a historical concrete structure on the edge of the channel. These features are common within Alum Rock Park.

![Figure 11: Photos of station UP002, looking upstream (left) and looking downstream (right).](image)

Table 18: Upper Penitencia Creek station UP002 water quality data and ocular estimates of habitat complexity.

<table>
<thead>
<tr>
<th>Water Quality</th>
<th>Conductivity (μS/cm)</th>
<th>Temperature (°C)</th>
<th>Dissolved Oxygen (mg/l)</th>
<th>Turbidity (NTU)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1,610.00</td>
<td>9.17</td>
<td>6.27</td>
<td>8.10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Habitat Complexity Scoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macrophytes/Emergent Vegetation</td>
</tr>
<tr>
<td>-------------------------------</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Three species of fish were captured during the survey: riffle sculpin, Sacramento sucker, and California roach. Fish captured and associated population estimates are summarized in Table 19. The most abundant species encountered was California roach (n=72). The MLIP indicates the number of California roach and riffle sculpin were likely higher than what was captured. No *O. mykiss* were detected.
Table 19: Number captured and population estimates at station UP002 on Upper Penitencia Creek.

<table>
<thead>
<tr>
<th>Species</th>
<th>Native</th>
<th>n</th>
<th>N</th>
<th>SE</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>California roach</td>
<td>Yes</td>
<td>72</td>
<td>106</td>
<td>23.94</td>
<td>72-153</td>
</tr>
<tr>
<td>Riffle sculpin</td>
<td>Yes</td>
<td>60</td>
<td>67</td>
<td>5.44</td>
<td>60-78</td>
</tr>
<tr>
<td>Sacramento sucker</td>
<td>Yes</td>
<td>24</td>
<td>24</td>
<td>0.50</td>
<td>24-25</td>
</tr>
</tbody>
</table>

n = total number captured, N = calculated population estimate, SE = standard error, CI = confidence interval

UP003
This station is located within Alum Rock Park. The surrounding land use consists of a manicured park setting with parking lots, picnic areas, and lawns. The monitoring station was 40.0 m in length with an average wetted width of 3.0 m and an average depth of 0.1 m. Two habitat types were present within the station: step-run and pool (Figure 12). Habitat at the station was 75% step-run and 25% pool. The primary substrate was boulders with a secondary substrate of cobbles. Results of the water quality monitoring and the ocular assessment of habitat complexity can be seen in Table 20.

Figure 12: Photos of station UP003, looking upstream (left) and looking downstream (right).
Table 20: Upper Penitencia Creek station UP003 water quality data and ocular estimates of habitat complexity.

<table>
<thead>
<tr>
<th>Water Quality</th>
<th>Conductivity (μS/cm)</th>
<th>Temperature (°C)</th>
<th>Dissolved Oxygen (mg/l)</th>
<th>Turbidity (NTU)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1,670.00</td>
<td>13.02</td>
<td>6.26</td>
<td>0.80</td>
</tr>
</tbody>
</table>

Habitat Complexity Scoring

<table>
<thead>
<tr>
<th>Macrophytes/Emergent Vegetation</th>
<th>Boulders</th>
<th>Woody Debris</th>
<th>Undercut Banks</th>
<th>Overhanging Vegetation</th>
<th>Roots</th>
<th>Artificial Structures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Three species of fish were captured during the survey: *O. mykiss*, California roach, and riffle sculpin. Fish captured and associated population estimates are summarized in Table 21. The most abundant species encountered was riffle sculpin (n=72). Five *O. mykiss* were captured and PIT tagged prior to being released.

In station UP003 the MLIP indicate that the number of California roach and riffle sculpin are likely higher than what was captured. A more detailed analysis of the *O. mykiss* capture results will occur in the discussion section.

Table 21: Number captured and population estimates at station UP003 on Upper Penitencia Creek.

<table>
<thead>
<tr>
<th>Species</th>
<th>Native</th>
<th>n</th>
<th>N</th>
<th>SE</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>California roach</td>
<td>Yes</td>
<td>36</td>
<td>71</td>
<td>44.43</td>
<td>36-160</td>
</tr>
<tr>
<td><em>O. mykiss</em></td>
<td>Yes</td>
<td>5</td>
<td>5</td>
<td>0.79</td>
<td>5-7</td>
</tr>
<tr>
<td>Riffle sculpin</td>
<td>Yes</td>
<td>72</td>
<td>82</td>
<td>6.78</td>
<td>72-95</td>
</tr>
</tbody>
</table>

\( n = \) total number captured, \( N = \) calculated population estimate, \( SE = \) standard error, \( CI = \) confidence interval

UP004

This station was the most upstream station sampled on Upper Penitencia Creek. The station is situated amongst rural park lands. Hiking and walking trails border the creek in this area. The monitoring station was 40.0 m in length with an average wetted width of 2.0 m and an average depth of 0.2 m. Two habitat types were present within the station: pool and step-run (Figure 13). Habitat at the station was 40% pool and 60% step-run.
The primary substrate was cobble with a secondary substrate of boulder. Results of the water quality monitoring and the ocular assessment of habitat complexity can be seen in Table 22.

![Figure 13: Photos of station UP004, looking upstream (left) and looking downstream (right).](image)

Table 22: Station UP004 water quality data and ocular estimates of habitat complexity.

<table>
<thead>
<tr>
<th>Water Quality</th>
<th>Conductivity (μS/cm)</th>
<th>Temperature (°C)</th>
<th>Dissolved Oxygen (mg/l)</th>
<th>Turbidity (NTU)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>665.00</td>
<td>11.33</td>
<td>9.91</td>
<td>4.10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Habitat Complexity Scoring</th>
<th>Macrophytes/Emergent Vegetation</th>
<th>Boulders</th>
<th>Woody Debris</th>
<th>Undercut Banks</th>
<th>Overhanging Vegetation</th>
<th>Roots</th>
<th>Artificial Structures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
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<td>1</td>
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Three species of fish were captured during the survey: *O. mykiss*, California roach, and riffle sculpin. The most abundant species encountered was riffle sculpin (n=184), followed by *O. mykiss* (n=58). Fifty-seven of the *O. mykiss* were ≥65 mm so they were PIT tagged prior to being released. Fish captured and associated population estimates are summarized in Table 23. For all three species, the MLIP indicates that the number
of individuals captured in the reach is likely higher than what was observed. A more
detailed analysis of the *O. mykiss* capture will occur in the discussion section.

**Table 23: Number captured and population estimates at station UP004 on Upper Penitencia Creek.**

<table>
<thead>
<tr>
<th>Species</th>
<th>Native</th>
<th>n</th>
<th>N</th>
<th>SE</th>
<th>95% CI</th>
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*n = total number captured, N = calculated population estimate, SE = standard error, CI = confidence interval*

**Upper Penitencia Creek Discussion**
Based on the results of the WY 2019 sampling, Upper Penitencia Creek supports
multiple age classes of *O. mykiss* and summer rearing was successful. A total of 63 *O. mykiss* were collected, though only the two most-upstream stations had detections. Fifty-eight of the 63 *O. mykiss* detections occurred at the most upstream station (Figure 14). The MLIP analysis indicates that the number of *O. mykiss* observed could have been as high as 150 individuals within the area sampled. This estimate lacks statistical
rigor, as a high standard error and a wide confidence interval was generated. The reason for the declining trend in *O. mykiss* abundance as monitoring stations moved
downstream is unknown. The physical habitat conditions present at all sites appeared
suitable to support *O. mykiss*. Alum Rock Park and Upper Penitencia Creek contain
unique geological formations. Mineral spring seeps release minerals such as sulfur,
sodium chloride, magnesium, iron, and calcium carbonate into the waters of Upper
Penitencia Creek. Station UP004 (the most upstream station) was located above most
of these seeps. It is possible that the change in water chemistry is altering the
distribution of *O. mykiss*. This could be especially true during the low flow conditions
that were present during the sampling period.
Figure 14: Observed *O. mykiss* densities at the four monitoring stations on Upper Penitencia Creek.

*O. mykiss* fork-lengths ranged from 63 mm to 245 mm (Figure 27). Growth rates of juvenile *O. mykiss* in California are highly variable and are dependent on temperature, food availability, seasonal flow, and population densities/competition (Moyle 2002). Based on Moyle (2002) and Smith (2018) growth rates (discussed in the Coyote Creek section), *O. mykiss* captured in Upper Penitencia Creek in WY 2019 were predominantly young-of-the-year or fish in their first year, ranging to fish that were potentially in their third year. The abundance of young-of-the-year fish captured indicates that Upper Penitencia Creek had successful reproduction and summer rearing in 2019, and the wide range of fork-lengths indicates multiple age classes are present.
Figure 15: Upper Penitencia Creek *O. mykiss* length histogram. All measurements are in fork-length and binned in 10 mm increments.

The average *O. mykiss* density (fish per meter) for all monitoring stations in Upper Penitencia Creek was 0.39 fish per meter (based on the number of fish caught [n]). This density is not an accurate extrapolation of the entire system as two stations had no detections. The MLIP indicates that the density of *O. mykiss* in Upper Penitencia Creek is likely higher than what was observed during our sampling effort (0.94 fish per meter based on N). Additional sampling was conducted in unconfined reaches to capture *O. mykiss* for the PIT tag study. This sampling occurred upstream of station UP004 over a 50.0 m length of stream. This was single pass electrofishing with no block nets, with the intention to increase the sample size of PIT tagged fish. A total of 37 additional *O. mykiss* were captured and 34 of the *O. mykiss* were PIT tagged. Of the 100 *O. mykiss* encountered during the sampling efforts, four had a Neascus-type parasitic infection commonly called “blackspot” disease. The visible black spots associated with fish are the metacercaria stage of the free-swimming parasite that produce a melanin-induced fibrous cyst (Schaaf et al. 2017). A severity scale ranging from level one to three was developed to denote the degree of infection. Level one being low severity, level two
being moderate, and level three being severe. None of the fish observed were classified with a severe or level three infection (raised cysts present on greater than 25% of the body). All infected fish were recorded as having a level one infection with only a few raised cysts. The impacts to *O. mykiss* associated with this infection are not known.

Four species of native fish were observed on Upper Penitencia Creek. No non-native species were captured during the multi-pass depletion electrofishing at the four selected monitoring stations, but a single golden shiner (*Notemigonus crysoleucas*) was collected during the additional sampling. The two most-downstream stations did not detect *O. mykiss*, however they did encounter species that are commonly associated with *O. mykiss* and have similar habitat requirements, indicating that the habitat is suitable. Through continued standardized sampling and monitoring through PIT antenna stations, trends in abundance and migration will begin to develop.

### 4. Conclusion

In 2019, juvenile *O. mykiss* were observed in both Coyote and Upper Penitencia Creek. The average densities and average fork-length of *O. mykiss* detected in these systems can be seen in Table 24. Upper Penitencia Creek had a higher density of *O. mykiss* and a greater distribution in size classes. Figure 16 shows the size distribution of all collected *O. mykiss* in the Coyote Creek Watershed. Coyote Creek produced larger juveniles, but the sample size is much smaller. Based on the size range of fish collected, production and successful summer rearing must have occurred and multiple age classes are present in the watershed, but the vast majority of it is occurring in Upper Penitencia Creek. In 2018, two *O. mykiss* were detected at station COY003. *O. mykiss* were detected in this reach again in 2019. This portion of the systems appears to support rearing and allows for efficient sampling.
Table 24: 2019 average density and length of *O. mykiss* captured within the Coyote Creek Watershed.

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<th><em>O. mykiss</em>/meter</th>
<th>Median fork-length</th>
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Figure 16: Box plot of *O. mykiss* size distribution (fork-length) for Coyote and Upper Penitenica Creek. The box displays the first and third quartiles, the median (line within the box), mean (x symbol), with whiskers indicating the highest and lowest points within 1.5 times the interquartile range, and outlier points that fall outside the 1.5 times the interquartile range.

In addition to *O. mykiss* data, information on the presence of non-native fish species in the Coyote Creek Watershed was obtained. No non-native species were collected in Upper Penitencia Creek during the index reach monitoring, but one non-native fish (golden shiner) was observed during the additional sampling effort for the PIT tag study. Four non-native species were detected in Coyote Creek, including largemouth bass which are considered a major predator of juvenile *O. mykiss*. The other three non-native species are not major predators, but could impact the habitat and natural communities within the system. Coyote Creek had approximately 6.0% non-native fish species.
Juvenile *O. mykiss* are persisting in the Coyote Creek Watershed, with multiple age classes present in Upper Penitencia Creek. Non-native fish are contributing to the assemblage in Coyote Creek, but at a small percentage. Since this is the first year of complete surveys it is difficult to assess any trends at this time, but as more data becomes available a better understanding of the Coyote Creek Watershed will develop.
5. Work Cited


Smith, J. J. 2018. Upper Penitencia Creek Fish Resources Through 2018. Department of Biological Sciences, San Jose State University. Unpublished manuscript. San Jose, California.
Appendix A
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</tr>
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COYOTE CREEK 2018-2019 ADULT SALMONID MIGRATION MONITORING USING THE VAKI RIVERWATCHER PASSIVE MONITORING SYSTEM AT THE COYOTE PERCIFICATIONS FACILITY

Prepared by:

Valley Water

Environmental Mitigation and Monitoring Unit

January 30, 2020
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INTRODUCTION
Steelhead (*Oncorhynchus mykiss, O. mykiss* for the remainder of the document) in the Central California Coast (CCC) Distinct Population Segment were listed as threatened by the National Marine Fisheries Service (NMFS) in 1997. Due to their protected status, Valley Water implemented a noninvasive means of documenting adult steelhead escapement in Coyote Creek. The equipment chosen to accomplish the task was the Vaki Riverwatcher (Vaki), a computer-based fish counter which employs scanner plates and a digital camera to capture videos and silhouette images of fish as they pass between the plates. This monitoring also allows for detections of other anadromous fish such as Chinook salmon (*Oncorhynchus tshawytscha*) and Pacific lamprey (*Entosphenus tridentatus*). The monitoring season selected allows for these species to be detected. The Vaki provides information on the occurrence and timing of adult fish migration both upstream and downstream through the counter. This unit was installed at the Coyote Percolation Facility within the fish ladder that provides passage over the instream diversion dam.

The percolation pond fish ladder is located 51 kilometers upstream of the South San Francisco Bay on Coyote Creek between Metcalf Road and Highway 101, just downstream of Metcalf Pond (Figure 1). The fish ladder was constructed in 1999 to enable upstream and downstream fish passage around the Coyote Diversion Dam. Since 1934 the Coyote Diversion Dam had created an impassable barrier to fish migration. The Vaki at this location was installed for the first year of monitoring in the 2018-2019 migration season. The Vaki provides documentation of anadromous fish passage through Coyote Creek as well as the Coyote Percolation Facility fish ladder and serves as a potential tool for estimating adult escapement into the upper Coyote Creek Watershed. This monitoring will also provide valuable insight into understanding passage conditions at the Singleton Road crossing on Coyote Creek. The in-stream crossing consisting of a road surface and two culverts has been identified as the most crucial barrier for removal in Coyote Creek to help protect and restore anadromous fish populations.
Figure 1: Location of Vaki Riverwatcher in the Coyote Creek Watershed.
OPERATION, INSTALLATION, AND MAINTENANCE

The Vaki was installed on October 4, 2018 and removed on May 30, 2019. The counter itself is a rectangular-shaped unit outfitted with infrared light emitting diodes on the interior and is completely submerged underwater within the fish ladder (Figure 2). Adult fish are directed through the counter opening by use of weirs in the ladder. When a fish swims through the counter and breaks the plane of light beams, the fish is scanned and a resulting silhouette image is sent to the onsite computer. Other information recorded as the fish passes through the counter includes the speed the fish was traveling, the direction the fish was moving (upstream or downstream), the body depth of the passing fish (for length-to-depth ratios), along with the date and time. A fish detection then triggers an underwater digital camera which records a 4.1 second video for fish traveling upstream or a 14.4 second video for fish traveling downstream. However, due to issues in programming the software the camera typically recorded 7.4 second videos for fish traveling upstream or 17.3 second videos for fish traveling downstream. This was not the intended length of time for the videos; however, the only consequence of the longer videos was the additional time it took to review. The videos enable the user to scan through the videos to confirm the presence of a fish and improves confidence in species identification. All the data collected by the Vaki are stored by the attached onsite computer.

Figure 2: Vaki Riverwatcher system being installed in the Coyote Creek Fishway. The red box indicates the fish counter.
The Vaki was maintained and cleaned from installation until its removal on May 30, 2019, twice a week by removing debris and algal build up on the scanner plates and plexiglass in front of the camera with a car wash brush. Data was manually downloaded from the onsite database, which was reset during each of these checks. The files were manually vetted as soon as possible.

The Vaki was attached directly to AC power. After power outages, the onsite computer is unable to automatically reopen the Vaki software which causes gaps in the data until the Vaki is visited in person and the program is manually reopened. A power outage on January 17, 2019 caused a five-day gap in recorded data because the Vaki was not immediately visited after the power outage to reopen the Vaki software on the computer. Additionally, for five and a half days in February, the Vaki was not functioning properly as flow conditions created low light and high turbidity that exceeded the operational range of the unit causing it to be unable to trigger fish detections (Table 1). Directly following the previous outage described in February, the Vaki was temporarily lifted out of the fish ladder for an additional ten days due to debris at the bottom of the fish ladder blocking the Vaki from being lowered flush with the bottom of the fish ladder. Additionally, the Vaki software unexpectedly shut down and data was not recorded for three days in April. These are all the periods that migrating fish could have been missed. These outages add up to a total of 24 days where fish were not being tracked.

<table>
<thead>
<tr>
<th>Duration of outage</th>
<th>Cause of outage</th>
<th>Start of outage</th>
<th>End of outage</th>
</tr>
</thead>
<tbody>
<tr>
<td>127 hours</td>
<td>Power outage</td>
<td>1/17/2019 9:36 am</td>
<td>1/22/2019 4:14 pm</td>
</tr>
<tr>
<td>133 hours</td>
<td>Low visibility of scanner plates</td>
<td>2/13/2019 10:07 pm</td>
<td>2/19/2019 11:15 am</td>
</tr>
<tr>
<td>243 hours</td>
<td>Debris blocking lowering of Vaki</td>
<td>2/19/2019 11:15 am</td>
<td>3/1/2019 2:00 pm</td>
</tr>
<tr>
<td>71 hours</td>
<td>Software failed to record data</td>
<td>4/12/2019 4:23 pm</td>
<td>4/15/2019 3:18 pm</td>
</tr>
</tbody>
</table>

**Total duration of outage: 574 hours (~24 days)**

**DATA ANALYSIS**

The Vaki records silhouettes and videos of all items large enough to break the plane of the diodes. Scanned infrared silhouettes and video images were reviewed by Valley Water staff to ensure that only fish passage events were included in the overall passage counts. Video images were used to identify fish to species when conditions provided clear images. Silhouettes were also used to identify the fish to species if identifying characteristics were depicted. A confidence level rating system analyzing both
silhouette and video quality was used to rate the likelihood of accurate identification for all anadromous fish (Table 2). This rating system was utilized for *O. mykiss*, Chinook salmon, and Pacific lamprey. Detection events without accompanying videos were only sorted into specific species categories if the silhouette was particularly clear and the confidence level of identification was high; otherwise, these detections were sorted into the “unknown fish” category.

**Table 2: Confidence rating system used for identifying fish detections to species for *O. mykiss*, Chinook salmon, and Pacific lamprey.**

<table>
<thead>
<tr>
<th></th>
<th>High quality video</th>
<th>Average quality video</th>
<th>Poor quality video</th>
<th>Video absent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High quality silhouette</strong></td>
<td>High confidence</td>
<td>High confidence</td>
<td>Medium confidence</td>
<td>Medium confidence</td>
</tr>
<tr>
<td><strong>Average quality silhouette</strong></td>
<td>High confidence</td>
<td>High confidence</td>
<td>Medium confidence</td>
<td>Low confidence</td>
</tr>
<tr>
<td><strong>Poor quality silhouette</strong></td>
<td>High confidence</td>
<td>Medium confidence</td>
<td>Low confidence</td>
<td>Can’t be categorized</td>
</tr>
<tr>
<td><strong>Silhouette absent</strong></td>
<td>High confidence</td>
<td>Medium confidence</td>
<td>Low confidence</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Length-to-depth ratios were used to estimate the lengths of specific individuals based upon their body depth as measured by the Vaki. The length-to-depth ratios for *O. mykiss* were 4.1:1 for length up to 400 mm and 4.8:1 for lengths 401 to 1,000 mm (Cuthbert et al. 2012). The length-to-depth ratios for Chinook salmon was 4.1:1 for all fish (Cuthbert et al. 2012). No length-to-depth ratios were available for Pacific lamprey.

*O. mykiss* with a standard length greater than 350 mm were classified as adult steelhead, while anything 350 mm and below were determined to be juveniles (Moyle, 2002). The scanner plates trigger a detection and a video recording only when a body depth of 40 mm or greater is detected. This results in a lack of detection for *O. mykiss* with an estimated standard length of 159 mm or less.

Since one fish may move upstream and downstream through the fish counter multiple times in a given time span, body depths along with proximity in timing were used to differentiate detections of Chinook salmon at the individual level in order to obtain a more accurate count on total number of Chinook salmon passing through the counter. *O. mykiss* detections were not able to be analyzed to determine a specific number of individual fish because all the *O. mykiss* detections were juvenile fish. Their small size allows these juvenile fish to swim between the weir bars thus avoiding detection by the Vaki and reducing the accuracy of determining the number of individual fish.
The Vaki system is designed to track adult migratory fish with a clear migratory path (i.e., anadromous fish). The system does not provide the ability to estimate the number of fish using the habitat that the system is installed in. For Centrarchidae, Cyprinidae, Ictaluridae, and Catostomidae species that are not migrating, detection indicates presence, but cannot develop population numbers. These species were lumped by family for data analysis purposes, but if positive identification was possible the species was noted.

RESULTS

During the 2018-2019 monitoring season, *O. mykiss*, Chinook salmon, Pacific lamprey, Sacramento sucker (*Catostomus occidentalis*), Centrarchids, Cyprinids, and Ictalurids were documented passing through the percolation pond fish ladder. There was a total of 15,847 fish detections throughout the time the Vaki was installed with Ictalurids and Cyprinids being the most commonly identified species, with 6,069 and 2,315 detections, respectively (Figure 3). Unknown fish was the highest category of fish discerned by the Vaki system. This was a result of the high flows and turbid conditions from the precipitation events that occurred in WY 2019.

![Figure 3: Number of detections of each fish species/family throughout the Coyote Creek Vaki deployment period (2018-2019 monitoring period).](image)

The Centrarchidae species positively identified using the Vaki system included largemouth bass (*Micropterus salmoides*) and bluegill (*Lepomis macrochirus*). The
Cyprinidae species positively identified by the system included Sacramento blackfish (*Orthodon microlepidotus*), hitch (*Lavinia exilicauda*), common carp (*Cyprinus carpio*) and goldfish (*Carassius auratus*). The Ictaluridae species positively identified by the Vaki included channel catfish (*Ictalurus punctatus*).

Detections of *O. mykiss*, Chinook salmon, and Pacific lamprey were run through the confidence matrix. The confidence rating in those detections can be seen in Table 3.

**Table 3: Confidence rating system for anadromous fish detections based on Table 2.**

<table>
<thead>
<tr>
<th>Confidence Rating</th>
<th>High</th>
<th>Medium</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>O. mykiss</em></td>
<td>0</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Chinook Salmon</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Pacific Lamprey</td>
<td>7</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

Of the five *O. mykiss* detections, one was recorded moving upstream and four recorded moving downstream. Two of the *O. mykiss* detections recorded moving downstream were triggered by another fish moving downstream, but the *O. mykiss* observed in the videos were moving upstream. This modifies the number to a total of three *O. mykiss* moving upstream and two *O. mykiss* moving downstream. The size range of *O. mykiss* detected ranged from 170 mm to 220 mm standard length. The calculated lengths of the two detections that were triggered by a different fish swimming in the opposite direction of the *O. mykiss* were not included in the size range above because these detections did not record the depth for the *O. mykiss* observed. These detections do not indicate individual fish but are rather instances that fish passed through the Vaki system. There were no Vaki detections of *O. mykiss* in the adult size class (>350 mm). The timing of *O. mykiss* detections can be seen in Figure 4.

The two Chinook salmon detections were both recorded moving upstream. One of the Chinook salmon had an estimated length of 520 mm and the other Chinook salmon had an unknown length due to the Vaki being triggered by debris rather than the actual fish thus creating an inaccurate estimated length. The timing of Chinook salmon detections can be seen in Figure 4.

Of the eight Pacific lamprey detections, three were recorded moving upstream and five were recorded moving downstream. One of the Pacific lamprey detections was low confidence due to an average quality silhouette and a video with no discernable lamprey present. Length estimates were not calculated as no length-to-depth ratio was available for Pacific lamprey. The timing of Pacific lamprey detections can be seen in Figure 4.
Figure 4: *O. mykiss*, Chinook salmon, and Pacific lamprey detections in relation to cubic feet per second (cfs) daily averages on the Coyote Creek stream gage ALERT 5058 at Edenvale. Hydrograph was cut off above 200 cfs, but the daily average cfs peaked at 924 cfs on February 15, 2019. Stream gage ALERT 5089 below percolation pond was not used due to outages in the data collection at the stream gage. On occasion when two detections of the same species were recorded moving in the same direction on the same day, only one of the detections is visible on the figure.
DISCUSSION

No adult steelhead detections occurred during the monitoring period; however, it is possible that adult *O. mykiss* moved through the fish ladder during the periods of time when the Vaki was non-operational or did not provide a clear enough silhouette or video to be identified. Per Moyle (2002), adult winter steelhead typically begin their upstream migration between December and March, peaking in January and February. The known peak of adult *O. mykiss* movement directly overlaps with the longest lapses in Vaki operation for a total outage period of 21 days throughout January and February. It is also possible that adult steelhead could have passed through the Vaki system but detections did not provide adequate videos or silhouettes to be identified to species and were therefore accounted for as “unknown fish”.

As previously mentioned, the Vaki is not designed to track movement of juvenile *O. mykiss*. The small size of the juvenile fish allows them to potentially swim back and forth between the weir bars or swim through the Vaki without triggering the scanners and thus avoid detection by the Vaki. Therefore, seasonal timing of migration and evaluation of numbers of individual *O. mykiss* was not conducted.

Of the two Chinook salmon moving upstream, one had an adipose fin and one could not be determined based on the video and silhouette. Since both detections were recorded moving upstream, and were 32 days apart, both detections were determined to be individual fish. The detection of Chinook salmon provides valuable insight into passage conditions at the Singleton Road Crossing. This crossing is located approximately 10.0 km downstream of the Vaki and is a major barrier to fish migration. The peak flow in the days prior to the detection of the Chinook salmon on December 22, 2018 was 172.0 cfs at the ALERT stream gage 5058 at Edenvale. The peak flow prior to the detection of the Chinook salmon on January 23, 2019 was 290.4 cfs. Based on this information it appears that passage is possible for Chinook salmon at the Singleton Road crossing at a flow level less than 172.0 cfs at the ALERT stream gage 5058 at Edenvale. Passage for steelhead is likely occurring within the same flow range.

Based on the date and time of the Pacific lamprey detections it is likely that the 8 detections were of four individual lamprey. Due to Pacific lampreys’ ability to latch onto walls and fit through small spaces, it is likely that additional Pacific lamprey were undetected by traversing around the Vaki system.
WORKS CITED


