

Lower Kings River Annual Trout and Non-Game Fish Population
Survey:
2018 Electrofishing Results

Kings River Conservation District
Environmental Resource Division

In-House Report
2019

The Kings River Conservation District (KRCD), in cooperation with the California Department of Fish and Wildlife (CDFW) and the Kings River Water Association (KRWA), have conducted annual population surveys of rainbow trout *Oncorhynchus mykiss* and other fish inhabiting the lower Kings River downstream of Pine Flat Dam from 1983 to the present. The population monitoring began as part of a Federal Energy Regulatory Commission (FERC) requirement for compliance with Item 4 of the Memorandum of Agreement between CDFW and KRCD, for FERC Project No. 2741 and as part of the Kings River Fishery Management Program.

A multiple pass mark-and-recapture electrofishing survey was employed from 1983 through 1989. In 1990, the annual electrofishing survey was modified to a single pass count of captured fish using only a single block seine net at the upstream end of each sample reach. The decision to change to a single pass survey was made due to an absence of trout detected in the late 1980's thought to be a result of extreme drought conditions (KRCD 1993). The single pass reaches were expanded in length in an effort to locate trout. As a result of the change in survey methods the single pass data collected from 1990 through 2006 serve as an index of relative abundance and do not reflect absolute population density. Extrapolating density estimates from the single pass data produces, at best, uncertain population abundance estimates that do not support rigorous statistical analysis. In the fall of 2007 the Kings River Fisheries Management Program's (KRFMP) Technical Steering Committee (KRCD, CDFW and KRWA) revised the electrofishing survey protocol to a multiple (3) pass depletion technique with upstream and downstream block seines, which resulted in improved statistical rigor and the ability to estimate 95% confidence intervals on abundance estimates. Results of the 2018 survey are presented below and compared to results of prior surveys.

Throughout the years, rainbow trout captured during the annual population surveys have been identified as being of either "wild" or "hatchery" origin. Over time revisions to stocking practices have occurred as well as changes to the contribution of trout fry via the KRFMP's incubation efforts. Such changes have included diploid to triploid stocks, triploid to diploid and back again, all female fry to both sexes, clipping to not clipping adipose fins and the number of trout stocked per size class. Beginning in October 2018 the KRFMP began purchasing catchable sized trout (approximately 3 fish per pound) for additional stocking of the Kings River beyond the

regular CDFW annual allotment. The changes in various management strategies has many times also changed the way that rainbow trout have been identified during the fall population surveys through the years.

Methods

Sampling occurred between November 1st and 8th using standard multiple-pass depletion electrofishing techniques (Reynolds 1996). Survey sites were 300 feet in length and both the and two Smith-Root LR-20B backpack electrofishers were utilized in each survey reach. Survey sites can be referenced in Figure 1.

From 2007 – 2011 electroshocker settings were standardized at 350volts, 10% Duty Cycle, and a 50Hz frequency. In an effort to safely maximize catch-per-unit-of-effort (CPUE), tests were conducted using the LR-24 backpack electrofisher prior to the 2012 population survey. These tests specifically targeted fish response in the presence of an electrical field. It was quickly determined that the previous settings (350volts, 10% Duty Cycle, 50Hz Frequency) were not providing enough power to the water based on the Power Transfer Theory (Kolz 1989) for efficient power transfer upstream and downstream ends of each survey reach were netted with ¼-inch mesh block seines to avoid fish immigration or emigration from the survey reach. Six to seven Smith-Root LR-24

resulting in fish escape (fishes evading capture). The Power Transfer Theory states that power is efficiently transferred to the fish when the conductivity of the fish is equal to the conductivity of the water. The difference in conductivities is commonly referred to as “mismatch.” By normalizing or standardizing the power curve, a constant transfer of power density ($\mu\text{W}/\text{cm}^3$) can be achieved (Kolz and Reynolds 1989) to increase power transfer to the fish in order to illicit the desired response.

By adjusting the electrofisher settings the voltage required to overcome the mismatch between water conductivity and fish conductivity

Table 1: Voltage Goals (Kolz and Reynolds 1989)

Peak Voltage Goal	
Conductivity	V goal
10	1892
20	1032
30	745
40	602
50	516
60	459
70	418
80	387
90	363
100	344
110	328
120	315
130	304
140	295
150	287
170	273
200	258
250	241
300	229
400	215
600	201
800	194

could be achieved. Data collected from the LR-24 backpack electroshocker's internal volt meter was used to generate a peak voltage goal chart (Table 1) based on water conductivity observed in the lower Kings River downstream of Pine Flat Dam. Since 2012, this chart was used to guide shocker voltage settings at each site during the fall 2018 population survey. Additionally, a Duty Cycle of 20% and a Frequency of 30Hz resulted in a high capture rate, quick recovery time and minimal mortality when compared to settings prior to 2012.

Electrofishing was conducted using six to seven, three person fishing teams and one or two data processing teams. Volunteers and staff from KRCD, CDFW, KRWA, California Department of Water Resources, Reedley College, the Kings River Conservancy, Kaweah, Kern and Fresno Fly Fishing clubs and other members of the public participated in the surveys.

Each fishing crew consisted of a backpack electrofisher operator, one or two netters and person with a bucket. Data processing teams consisted of one data recorder and one or two biologists. In the field, each fish was identified to the lowest practical taxon, weighed to the nearest tenth of a gram, and total length measured to the nearest 1mm, with the exception of rainbow trout which were measured to fork length and photographed. Scale samples were taken from each rainbow trout between the dorsal fin and lateral line for aging. Rainbow trout were classified by morphological features into three groups. Rainbow trout of moderate color, with worn down or missing fins were categorized as San Joaquin Hatchery trout. Rainbow with deep olive coloration and heavy spotting throughout the body and partially worn fins were classified as Calaveras Hatchery trout. Rainbow trout of any size which exhibited silver to moderate coloring and light to moderate spotting or parr marks and had fins in excellent condition were classified as wild rainbow trout. This last group of rainbow trout is assumed to have originated via natural in-river reproduction, from the KRFMP incubator facility or recruitment through Pine Flat Dam. After data collection was complete, captured fish were released outside of the netted survey reach. A minimum 30-minute hiatus was taken between passes. Biological data was manually recorded on data sheets printed on waterproof paper. Raw capture data was later entered into an Excel spreadsheet before importation into the MicroFish 3.0 program (Van Deventer 2007). MicroFish generated the total catch, biomass, density, 95% confidence intervals and population estimates.

KRCD Electrofishing Sites - Kings River Below Pine Flat Dam

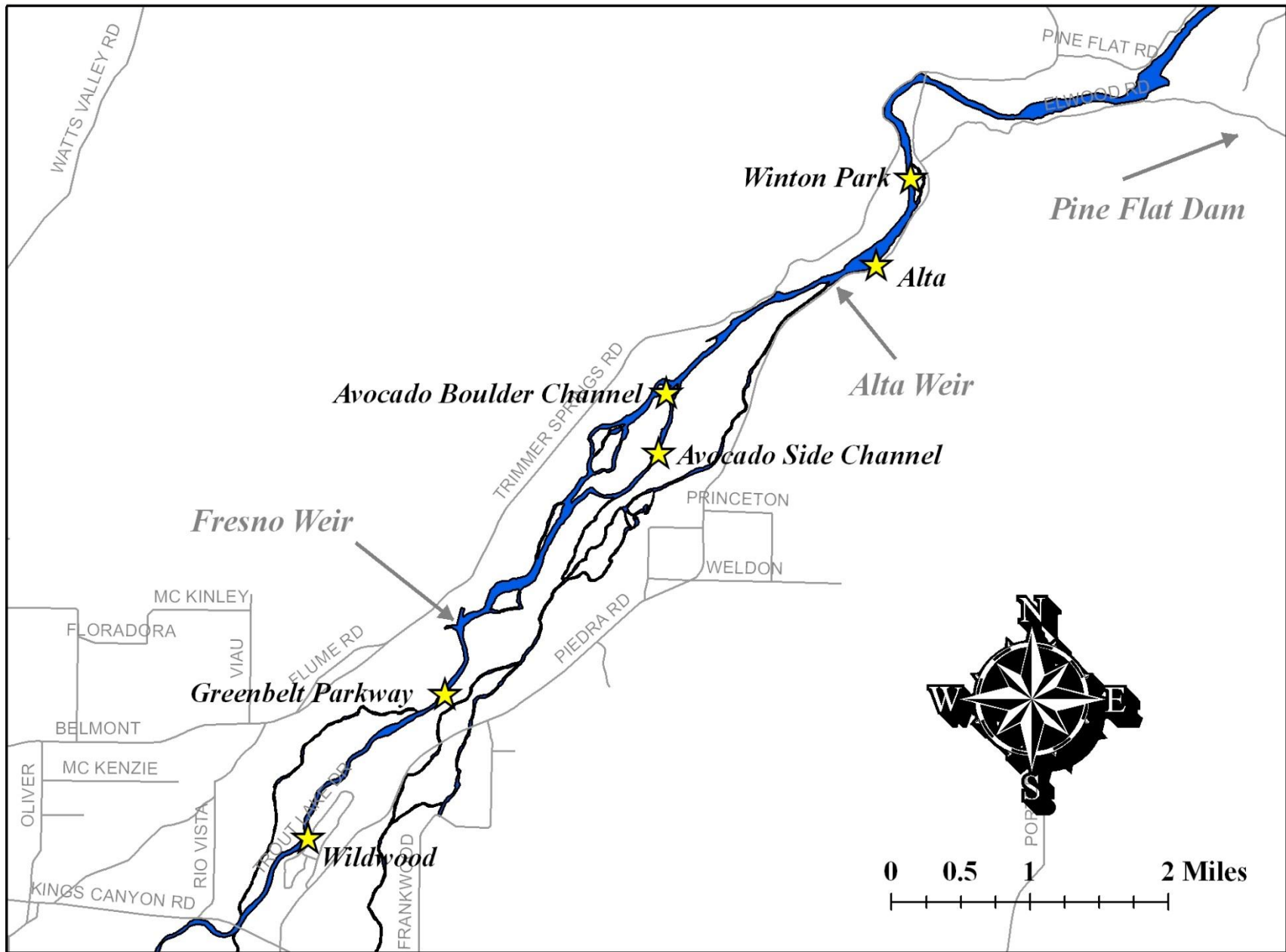


Figure 1: Electrofishing Survey Site Map.

Catch-Per-Unit-of-Effort

Catch-per-unit-of-effort (CPUE) is a measure of relative abundance used in fisheries management to assess changes in population abundance over time (Reynolds 1996; Chipps and Garvey 2007). This index is mathematically defined as:

$$C/f = N$$

where C is the number of each species caught per site, f is the amount of effort used, and N is the species catch rate (number per hour of effort). For this survey, effort (f) was measured as the collective time (seconds) that each shocker in the group was energized during the three survey passes at each site. Each backpack electrofisher was equipped with a timer that recorded the number of seconds in operation. The total time was converted to hours and the resulting CPUE was translated to “fish per hour.” CPUE was calculated for each species sampled.

Fish-Per-Hectare

Fish-per-hectare (fish*ha⁻¹) is a population density estimate which takes the maximum likelihood of occurrence from each site and divides it by the surface area of the sample reach. A hectare is equivalent to 10,000 square meters or approximately 2.5 acres. This estimate accounts for both the length and width of each site.

Condition Factor

Condition Factor (K-factor) is an index of an individual salmonid’s body fitness and condition. The score is based upon a mathematical formula (Fulton1902) which utilizes length (mm) and weight (g) parameters to determine the fitness of individuals within a population.

$$K = (W/L^3) \times 100,000$$

The condition factor assumes that heavier fish of a given length are in better condition (Bolger and Connolly 1989; Tasaduq et al. 2011). A fish is said to be in better condition when the value of a K-factor is more than 1.00 and in worse condition than an average individual of the same length, when its value is less than 1.00 (Tasaduq et al. 2011).

Rainbow Trout Density

The number of resident trout per mile is extrapolated from the annual population estimate. This estimate is an index used to monitor changes in resident trout density from year to year. The resident trout per mile estimate is based on population data collected from the six survey sites located within the 12.5 mile river reach, which extends from Pine Flat Dam to the Highway 180 Bridge. The six sites total 1,800 feet or 2.7% of the reach length.

Results

A total of 5,029 fishes were collected during the fall 2018 population survey and 5,028 entered into the MicroFish software program for analysis; one rainbow trout of unknown origin escaped before it could be measured. The numbers reflected in this report will be those produced by the MicroFish software with the exception of CPUE which will reflect the total catch. Species collected included; Sacramento sucker *Catostomus occidentalis*, sculpin *Cottus sp.*, California roach *Hesperoluecus symmetricus*, lamprey *Lampetra sp.*, Sacramento pikeminnow *Ptycheilus grandis*, three-spined stickleback *Gasterosteus aculeatus*, resident rainbow trout *Oncorhynchus mykiss*, hatchery reared rainbow trout *O. mykiss*, bass *Micropterus sp.*, catfish *Ameiurus sp.* and hardhead *Mylopharodon conocephalus*. Although more than one species of sculpin, lamprey, bass, etc. may have been collected during the survey they have been classified within their respective genus for the purpose of this report. The total catch by taxa and site is presented in Table 2. Population estimates by maximum likelihood are summarized in Table 3. Percent composition is summarized by species in Table 4 and 95% confidence intervals for the population estimates by taxa and survey site are summarized in Appendix A (Table A).

Table 2: Total Catch by species and survey site.

Total Catch by Species November 2018							
	Winton	Alta	Avo Boulder	Avo Side	Greenbelt	Wildwood	Species Total
Rainbow Trout	1	2	7	8	0	0	18
Hatchery Trout	4	4	4	3	0	0	15
Bass	0	0	0	1	1	0	2
California Roach	0	5	44	10	64	324	447
Catfish sp.	0	0	0	0	1	0	1
Hardhead	0	0	0	0	1	0	1
Lamprey sp.	2	71	10	153	6	6	248
Sacramento Pikeminnow	6	11	12	5	142	47	223
Sacramento Sucker	324	390	387	375	174	360	2010
Sculpin sp.	622	651	142	172	239	143	1969
Three-spined Stickleback	11	10	16	32	15	10	94
Site Total	970	1144	622	759	643	890	5028

Table 4: Total catch % by species

Total Catch (% by species) November 2018							
	Winton	Alta	Avo Boulder	Avo Side	Greenbelt	Wildwood	Species Total
Rainbow Trout	5.6%	11.1%	38.9%	44.4%	0.0%	0.0%	100.0%
Hatchery Trout	26.7%	26.7%	26.7%	20.0%	0.0%	0.0%	100.0%
Bass	0.0%	0.0%	0.0%	50.0%	50.0%	0.0%	100.0%
California Roach	0.0%	1.1%	9.8%	2.2%	14.3%	72.5%	100.0%
Catfish sp.	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%
Hardhead	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%
Lamprey sp.	0.8%	28.6%	4.0%	61.7%	2.4%	2.4%	100.0%
Sacramento Pikeminnow	2.7%	4.9%	5.4%	2.2%	63.7%	21.1%	100.0%
Sacramento Sucker	16.1%	19.4%	19.3%	18.7%	8.7%	17.9%	100.0%
Sculpin sp.	31.6%	33.1%	7.2%	8.7%	12.1%	7.3%	100.0%
Three-spined Stickleback	11.7%	10.6%	17.0%	34.0%	16.0%	10.6%	100.0%

Table 3: Population estimate by maximum likelihood

Population Estimate (maximum likelihood) November 2018						
	Winton	Alta	Avo Boulder	Avo Side	Greenbelt	Wildwood
Rainbow Trout	1	2	7	8	0	0
Hatchery Trout	4	4	4	3	0	0
Bass	0	0	0	1	1	0
California Roach	0	6	70	11	96	513
Catfish sp.	0	0	0	0	1	0
Hardhead	0	0	0	0	1	0
Lamprey sp.	2	81	10	181	6	9
Sacramento Pikeminnow	6	14	27	5	0	59
Sacramento Sucker	402	510	517	552	156	506
Sculpin sp.	724	799	156	209	261	165
Three-spined Stickleback	16	10	24	107	28	12
Site Total	1155	1426	815	1077	550	1264

Catch-Per-Unit-of-Effort

Collectively the total CPUE across all six sites was 104 fish per hour. The CPUE for each taxon is summarized by site in Table 5. A comparison of CPUE values from 2007 to 2018 is summarized in Appendix B.

Table 5: Catch-per-unit-of -effort

CPUE (fish/hr) 2018						
	Winton	Alta	Avo Boulder	Avo Side	Greenbelt	Wildwood
Rainbow Trout	0.08	0.27	1.11	1.25	0.00	0.00
Hatchery Trout	0.33	0.54	0.63	0.47	0.00	0.00
Bass	0.00	0.00	0.00	0.16	0.14	0.00
California Roach	0.00	0.67	6.95	1.57	8.68	37.16
Catfish sp.	0.00	0.00	0.00	0.00	0.14	0.00
Hardhead	0.00	0.00	0.00	0.00	0.14	0.00
Lamprey sp.	0.16	9.53	1.58	23.98	0.81	0.69
Sacramento Pikeminnow	0.49	1.48	1.90	0.78	19.27	5.39
Sacramento Sucker	26.47	52.35	61.14	58.78	23.61	41.28
Sculpin sp.	50.82	87.38	22.43	26.96	32.43	16.40
Three-spined Stickleback	0.90	1.34	2.53	5.02	2.04	1.15

Site 1 – Winton Park

Multiple-pass depletion sampling yielded 970 fishes representing seven taxa. Sculpin accounted for 64.1%, Sacramento sucker accounted for 33.4% and Three-spine stickleback for 1.1% of the catch. Sacramento pikeminnow, hatchery rainbow trout, lamprey and resident rainbow trout, accounted for the remainder of the catch.

Sculpin (3,845g), Sacramento sucker (2,558g), and hatchery rainbow trout (1,208g) represented the majority of the biomass collected. The estimated population density for this site is 3,122fish*ha⁻¹. By species, this represents 1,957 sculpin, 1,086 Sacramento sucker, 43 three-spine stickleback, 16 Sacramento pikeminnow, 11 hatchery rainbow trout, 5 lamprey and 3 resident rainbow trout.

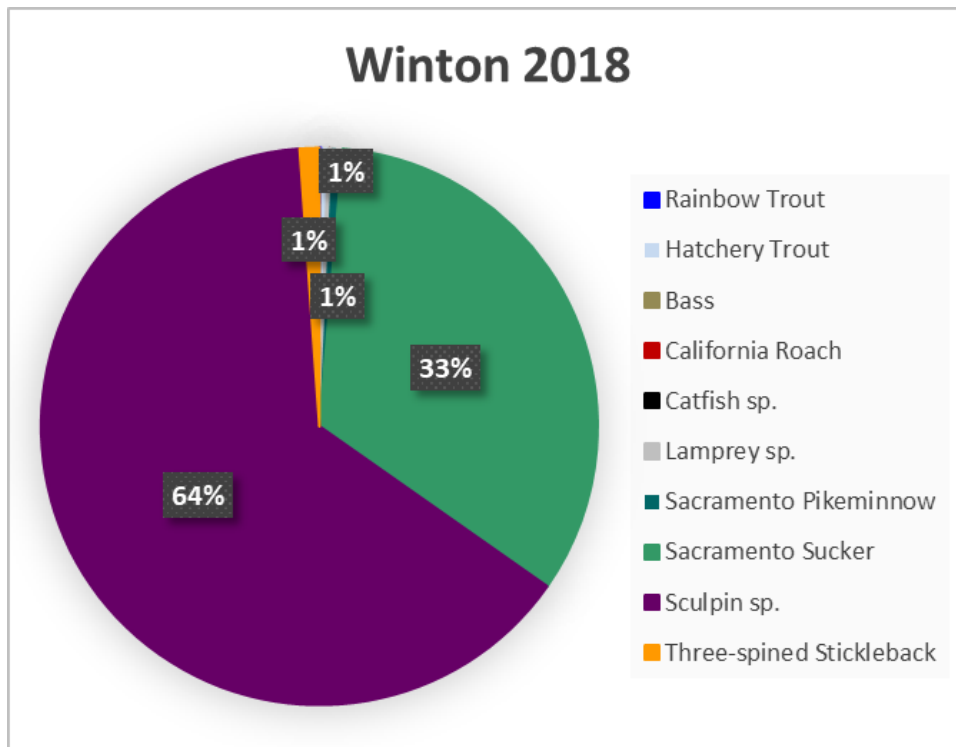


Figure 2: Species composition for Winton survey reach 2018. Values less than 1% not labeled

Site 2 – Alta

Multiple-pass depletion sampling yielded 1,144 fishes representing eight taxa. Sculpin accounted for 56.9%, Sacramento sucker accounted for 31.4%, lamprey accounted for 6.2% and Sacramento pikeminnow for 1.0% of the catch. Three-spine stickleback, California roach, hatchery rainbow trout and rainbow trout accounted for the remainder of the catch.

Sculpin (3,845g), Sacramento sucker (2,558g) and hatchery rainbow trout (1,208g) represented the majority of the biomass collected. The estimated population density for this site is 7,922fish*ha⁻¹. By species, this represents 4,439 sculpin, 2,833 Sacramento sucker, 450 lamprey, 78 Sacramento pikeminnow, 56 three-spine stickleback, 33 California roach, 22 hatchery rainbow trout and 11 resident rainbow trout.

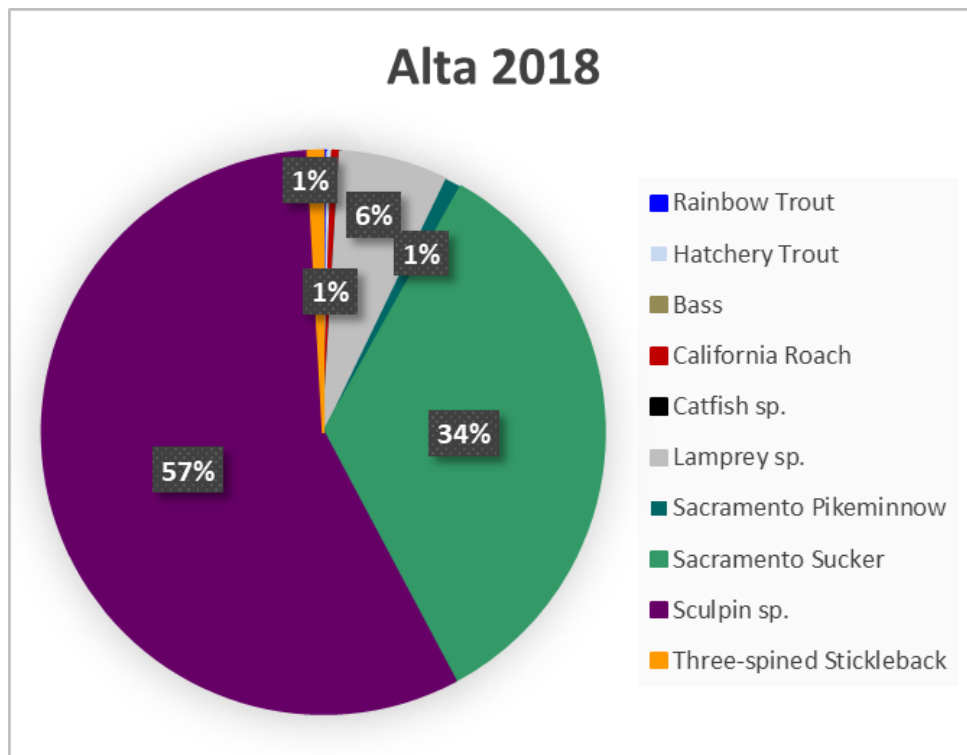


Figure 3: Species composition for Alta survey reach 2018. Values less than 1% not labeled.

Site 3 – Avocado Boulder

Multiple-pass depletion sampling yielded 622 fishes representing eight taxa. Sacramento sucker accounted for 62.2%, Sculpin accounted for 22.8%, California roach accounted for 7.1% and Three-spine stickleback accounted for 2.6% of the catch. Sacramento pikeminnow, lamprey, rainbow trout, and hatchery rainbow trout accounted for the remainder of the catch. Sacramento sucker (18,586g), hatchery rainbow trout (2,090.9g) and sculpin (942g) represented the majority of the biomass collected.

The estimated population density for this site is 4,794 fish*ha⁻¹. By species, this represents 3,041 Sacramento sucker, 918 sculpin, 411 California roach, 158 Sacramento pikeminnow, 141 three-spine stickleback, 59 lamprey, 41resident rainbow trout and 24 hatchery rainbow trout.

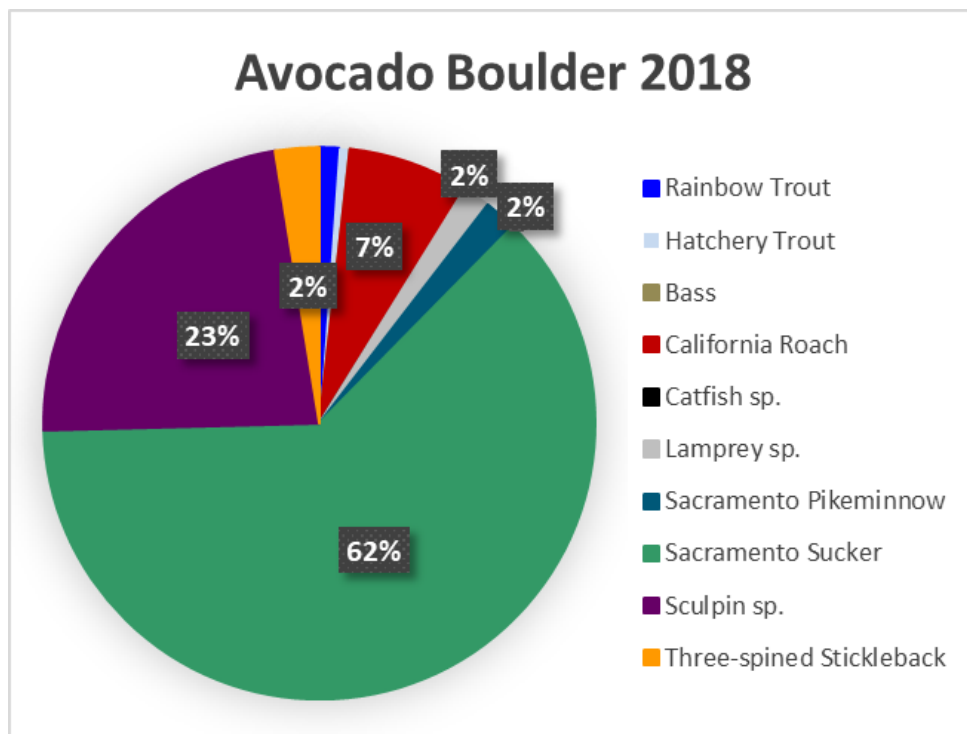


Figure 4: Species composition for Avocado Boulder survey reach 2018. Values less than 1% not labeled.

Site 4 – Avocado Side Channel

Multiple-pass depletion sampling yielded 759 fishes representing nine taxa. Sacramento sucker accounted for 49.4%, Sculpin accounted for 22.7%, lamprey accounted for 20.2% and Three-spine stickleback accounted for 4.2% of the catch. California roach, rainbow trout, Sacramento pikeminnow, hatchery rainbow trout and bass accounted for the remainder of the catch. Sacramento sucker (12,041g), rainbow trout (398g) and Sculpin (912g) represented the majority of the biomass collected.

The estimated population density for this site is 7,180 fish*ha⁻¹. By species, this represents 3,680 Sacramento sucker, 1,393 sculpin, 1,207 lamprey, 713 three-spine stickleback, 73 California roach, 53 resident rainbow trout, 33 Sacramento pikeminnow, 20 hatchery rainbow trout and 7 bass.

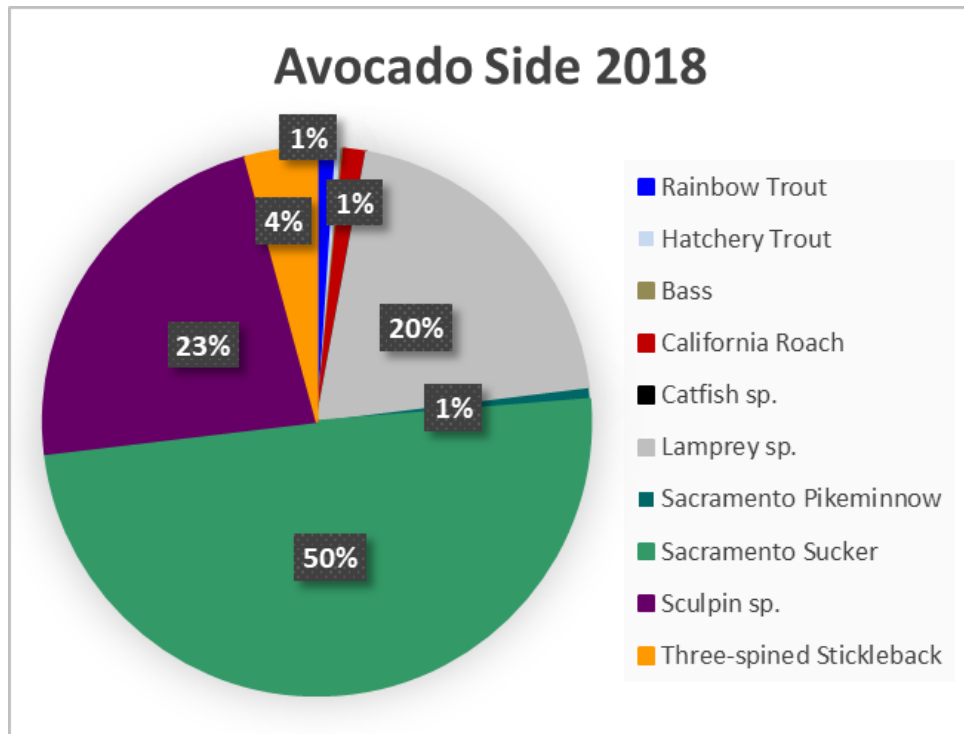


Figure 5: Species composition for Avocado Side Channel survey reach 2018. Values less than 1% not labeled.

Site 5 – Greenbelt Parkway

Multiple-pass depletion sampling yielded 643 fishes representing nine taxa. Sculpin accounted for 37.2%, Sacramento sucker accounted for 27.1%, Sacramento pikeminnow accounted for 22.1%, and California roach accounted for 10% of the catch. Three-spined stickleback, lamprey, bass, catfish, and hardhead accounted for the remainder of the catch. Sculpin (1,704g) Sacramento sucker (1,227g), and catfish (395g) represented the majority of the biomass collected.

The estimated population density for this site is 2,037 fish*ha⁻¹. By species, this represents 967 sculpin, 578 Sacramento sucker, 356 California roach, 103 three-spined stickleback, 22 Sacramento pikeminnow, 4 lamprey, 4 bass, 4 catfish and 4 hardhead.

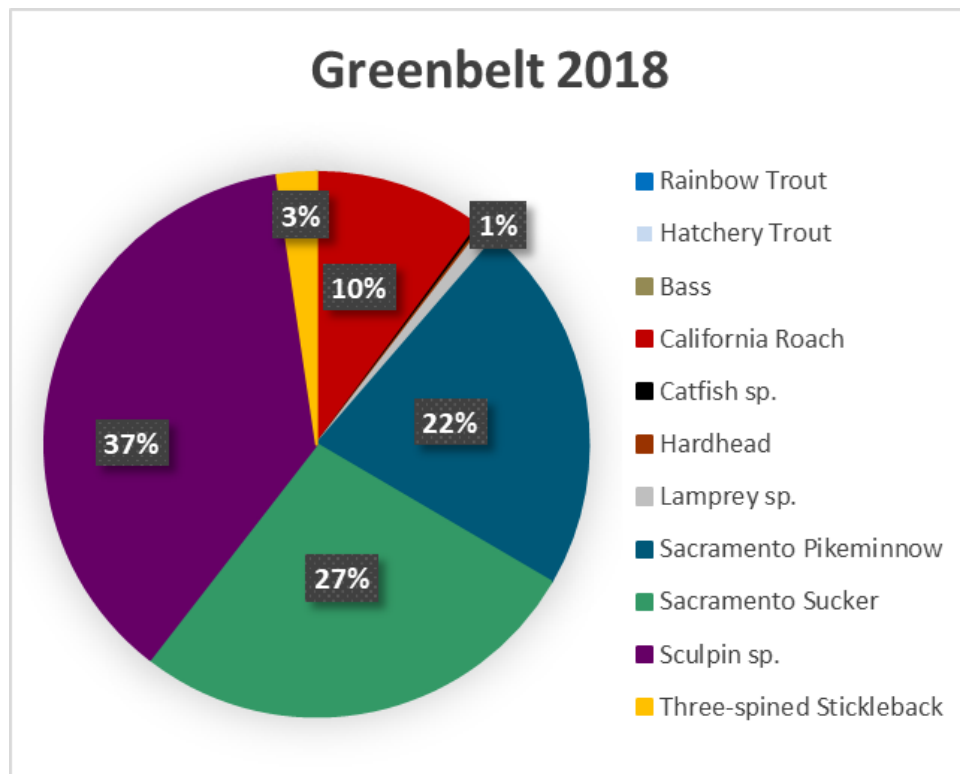


Figure 6: Species composition for the Greenbelt survey reach 2018. Values less than 1% not labeled.

Site 6 – Wildwood

Multiple-pass depletion sampling yielded 890 fishes representing six taxa. Sacramento sucker accounted for 40.4%, California roach accounted for 36.4%, Sculpin accounted for 16.1%, and Sacramento pikeminnow accounted for 5.3% of the catch. Three-spined stickleback and lamprey accounted for the remainder of the catch. Sacramento sucker (4,467g), sculpin (1,534g) and California roach (1,450g) represented the majority of the biomass collected.

The estimated population density for this site is 5,056 fish*ha⁻¹. By species, this represents 2,052 California roach, 2,024 Sacramento sucker, 660 sculpin, 236 Sacramento pikeminnow, 48 three-spined stickleback and 36 lamprey.

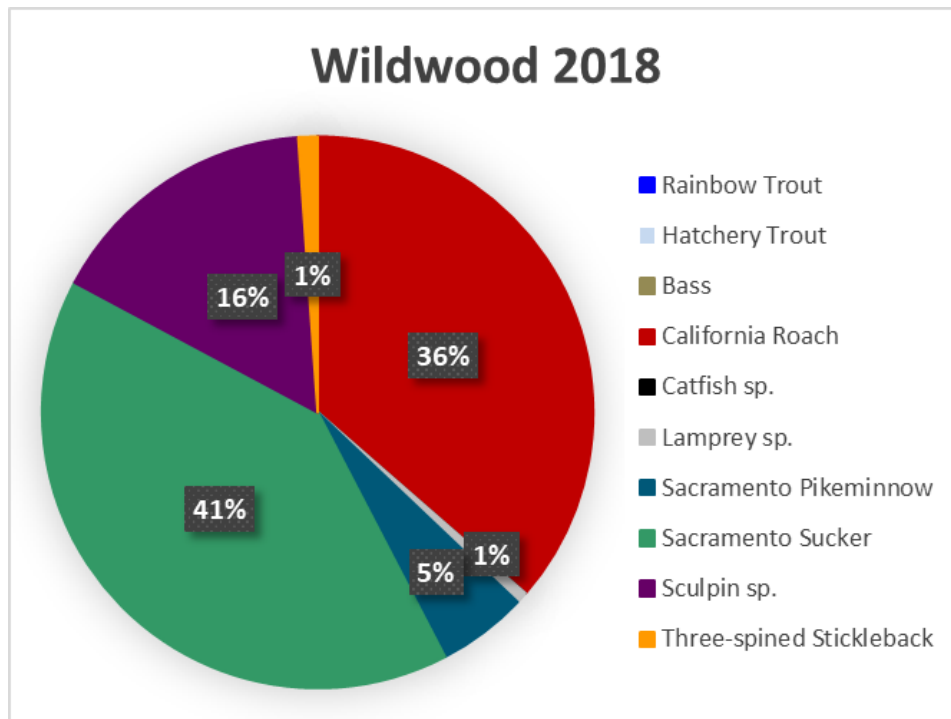


Figure 7: Species composition for the Greenbelt survey reach 2018. Values less than 1% not labeled.

Species Composition

Species composition reflects a combination of environmental and historical events at a site; hence, changes in species composition can provide a sensitive measure of ecologically relevant changes in the environment (Philippi et al. 1998). Altogether eleven taxa of fish were collected during the 2018 survey (Figure 7). Comparative charts of species composition from 2010 – 2018 are presented in Appendix C.

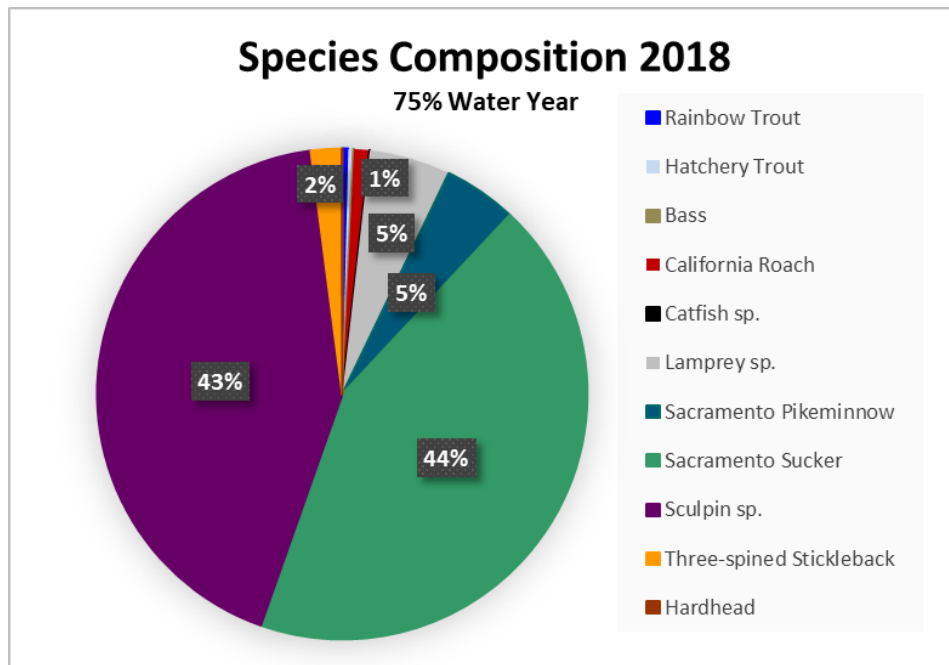


Figure 8: Species composition of total catch 2018

Resident Trout Density

Six sites were sampled over six days resulting in the capture of eighteen resident trout during the 2018 survey. This roughly translates to 53 resident trout per mile in similar reaches of the fishery. The average trout per mile estimate from 2008 – 2016 is also 53 resident trout per mile in similar reaches of the fishery. Since survey sites became standardized in 2007, the number of resident rainbow trout per mile has ranged from 0 to 88.

Biomass

Biomass represents the weight of the fish population. The biomass for a given year equals the biomass of the previous year plus recruitment and growth minus harvest and mortality (Chippis and Garvey 2007). In 2018 the total biomass collected was 62,820g (138.5lbs.). Sacramento sucker accounted for 67% (42,008g; 93lbs.), sculpin accounted for 18% (11,105.9g; 24.49 lbs.) and hatchery trout accounted for 7% (4,281g; 9.43 lbs.). California roach, resident rainbow trout, Sacramento pikeminnow, lamprey, catfish, hardhead, bass and three-spine stickleback accounted for the remaining 8% (5,425g; 11.98 lbs.). Biomass results for the 2018 survey are summarized by site in Table 6 and Figure 9.

Table 6: Biomass, weight in pounds

Total Weight (lbs) November 2018							
	Winton	Alta	Avo Boulder	Avo Side	Greenbelt	Wildwood	Species Total
Rainbow Trout	0.07	0.18	1.28	0.88	0.00	0.00	2.41
Hatchery Trout	2.66	1.32	4.61	0.84	0.00	0.00	9.43
Bass	0.00	0.00	0.00	0.00	0.14	0.00	0.14
California Roach	0.00	0.06	0.51	0.15	0.32	3.20	4.24
Catfish sp.	0.00	0.00	0.00	0.00	0.87	0.00	0.87
Hardhead	0.00	0.00	0.00	0.00	0.03	0.00	0.03
Lamprey sp.	0.00	0.63	0.13	1.13	0.05	0.04	1.98
Sacramento Pikeminnow	0.03	0.31	0.86	0.03	0.38	0.55	2.16
Sacramento Sucker	5.64	6.90	40.97	26.55	2.70	9.85	92.61
Sculpin sp.	8.48	4.78	2.08	2.01	3.76	3.38	24.49
Three-spined Stickleback	0.01	0.01	0.03	0.05	0.03	0.02	0.15
Site Total	16.89	14.19	50.47	31.64	8.28	17.04	138.51
Biomass %	12.2%	10.2%	36.4%	22.8%	6.0%	12.3%	100.0%

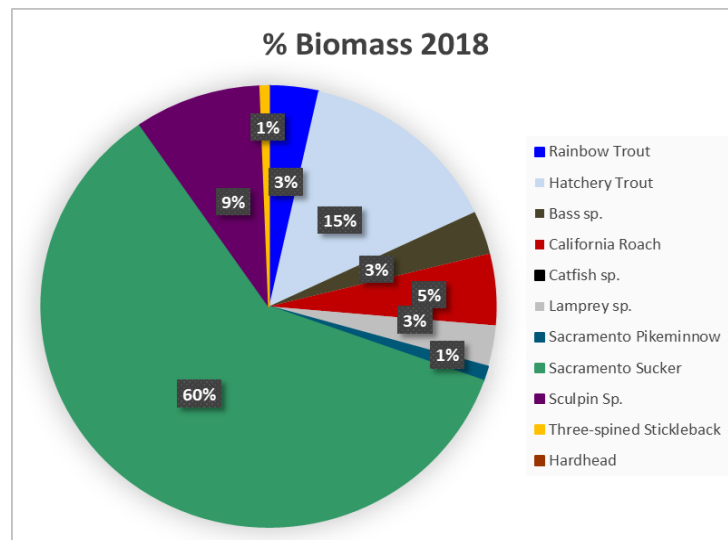


Figure 9: Collective biomass of fishes captured during the 2018

Condition Factor (K)

All of the resident trout collected in 2018 were found to be in good condition (Table 7). The condition factor for these trout ranged from 0.9 to 1.4.

Age

Scale samples from seventeen of the eighteen wild rainbow trout collected in 2018 were used to estimate trout age based on counts of annuli and circuli. The majority of resident rainbow trout sampled appeared to be young-of-the-year (YOY). Ages were further verified by back calculating fork length using the estimated growth rate of 0.5mm per day (FishBio, 2014). Back calculations of rainbow trout believed to be YOY placed emergence timing between January and mid-April. This aligns with assumed timing for resident rainbow trout fry emergence in the lower Kings River as well as the anthropomorphic input of incubator reared trout fry. The mean age of resident rainbow trout caught since 2008 is 1.8 years. A depiction of the age/length frequency distribution for 2018 can be referenced in Figure 11.

Conclusion

2018 marked the eleventh year of multiple pass depletion sampling since the KRFMP returned to triple-pass depletion in 2007. In addition, this year marked the seventh

Table 7: Wild rainbow trout age class and condition factor (K-factor) where 1 is equal to good.

SITE	AGE	K-FACTOR
Alta	<1	1.1
Alta	<1	0.9
Avocado Boulder	<1	1.3
Avocado Boulder	<1	1.4
Avocado Boulder	<1	1.2
Avocado Boulder	<1	1.3
Avocado Boulder	1	1.3
Avocado Boulder	1	0.9
Avocado Boulder	2	1.3
Avocado Side	<1	1.3
Avocado Side	<1	0.9
Avocado Side	<1	1.3
Avocado Side	<1	1.1
Avocado Side	<1	1.1
Avocado Side	<1	1.4
Avocado Side	1	1.1
Winton	<1	1.0

Least Squares Means

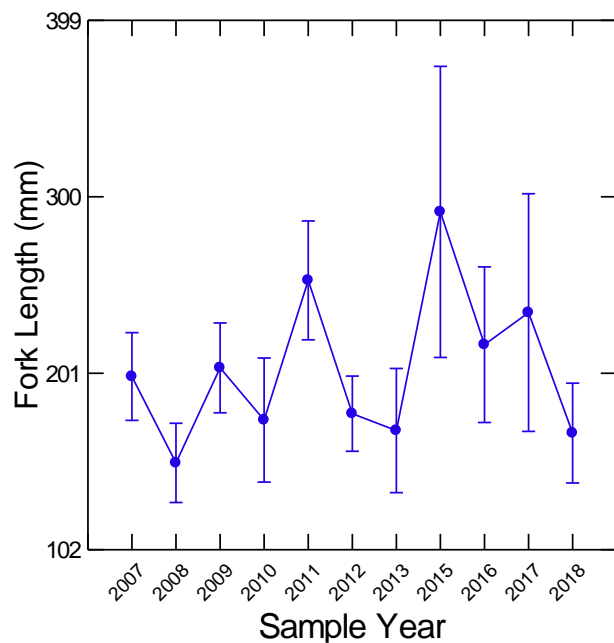


Figure 10: Changes in mean fork length 2007 - 2018

Age/Length Frequency Distribution 2018

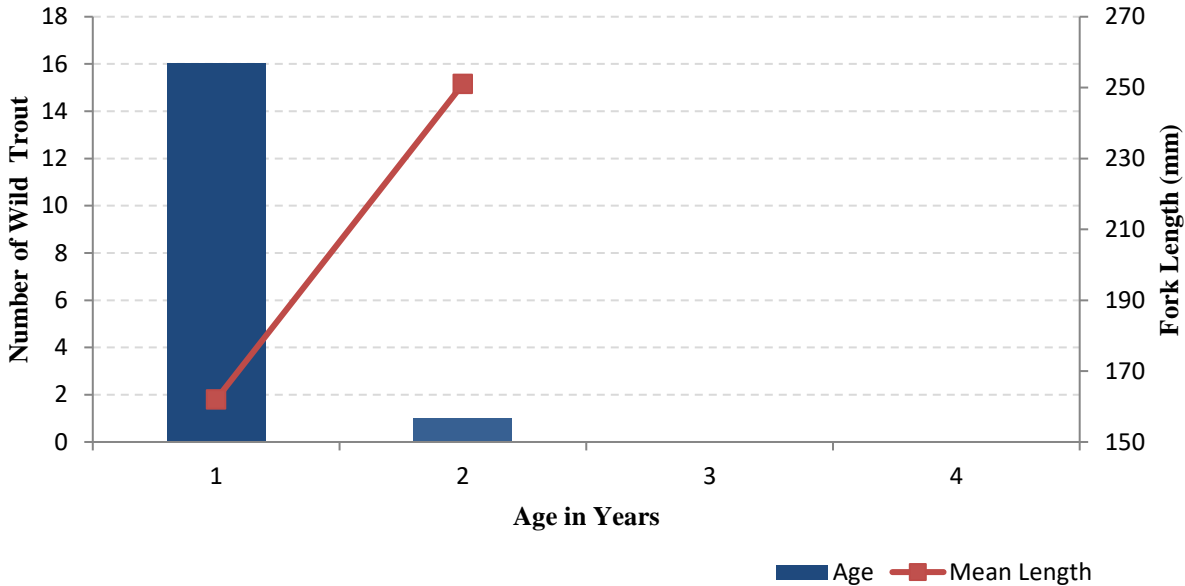


Figure 10: Age/Length frequency distribution of resident rainbow trout collected during the 2018 fall population survey.

year that the KRFMP utilized deliberate voltage adjustment by site for the LR-24 units in concurrence with water conductivity. It is not certain how this may have influenced 2012 – 2018 catch efficiency and the interpretation of trends over time in survey results.

Collectively, 5,029 fishes were collected within the six survey areas. Collected fish represented 11 species, with only 0.06% of the total catch ($n = 3$) represented by non-natives. The 2018 survey results were dominated by Sacramento sucker (44%) and sculpin (43%), which together represented 87% of fish surveyed. Total (resident + hatchery) rainbow trout numbers were at a 5 year high with trout derived from San Joaquin Hatchery, Calaveras Hatchery and young-of-the-year all represented in the survey. Conversely, California roach were at a 5 year low and Sacramento pikeminnow at a six year low.

Since our return to triple-pass-depletion in 2007 we have yet to discover any affirmative correlations linking observed environmental variables to species composition or abundance. It is

unlikely that variations in species composition can be attributed to any one cause and far more likely that a combination of environmental and anthropogenic factors influence the fishery. The KRCD and the KRFMP will continue comprehensive monitoring and investigation of environmental and population variables within the tailwater fishery

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Appendix A

Table A: 95% confidence interval population estimates for each species summarized by site. Population estimates were generated using Microfish 3.0

95% Confidence Interval (Adjust to lower CI) November 2018						
	Winton	Alta	Avo Boulder	Avo Side	Greenbelt	Wildwood
Rainbow Trout	1 - 1	2 - 2	7 - 10	8 - 9	0 - 0	0 - 0
Hatchery Trout	4 - 4	4 - 4	4 - 6	3 - 4	0 - 0	0 - 0
Bass	0 - 0	0 - 0	0 - 0	1 - 1	1 - 1	0 - 0
California Roach	0 - 0	5 - 15	44 - 120	10 - 16	96 - 96	385 - 641
Catfish sp.	0 - 0	0 - 0	0 - 0	0 - 0	1 - 1	0 - 0
Hardhead	0 - 0	0 - 0	0 - 0	0 - 0	1 - 1	0 - 0
Lamprey sp.	2 - 2	71 - 94	10 - 11	157 - 205	6 - 10	9 - 9
Sacramento Pikeminnow	6 - 8	11 - 26	12 - 105	5 - 8	142 - 170	47 - 79
Sacramento Sucker	356 - 448	444 - 576	445 - 589	446 - 658	182 - 248	420 - 592
Sculpin sp.	680 - 768	737 - 861	142 - 170	179 - 239	244 - 278	145 185
Three-spined Stickleback	16 - 16	10 - 12	24 - 24	32 - 436	15 - 79	10 - 21

Appendix B

Table B – L: Catch per Unit of Effort by species; 2007 – 2017. Note: Nine sites were sampled during the 2007 survey and eight sites were sampled during the 2010 survey. Data collected from the additional sites were not used in this comparison.

Table B: CPUE 2007

CPUE (fish/hr) 2007						
	Winton	Alta	Avo Boulder	Avo Side	Greenbelt	Wildwood
Rainbow Trout	0.9	0.4	1.1	0.0	0.3	0.0
Hatchery Trout	1.2	2.3	0.3	0.7	0.0	0.0
California Roach	0.4	0.3	2.7	3.1	16.2	7.5
Green Sunfish	0.0	0.0	0.0	0.0	0.0	0.0
Lamprey sp.	0.1	22.5	0.7	19.0	0.3	0.6
Sacramento Pikeminnow	11.9	2.2	10.1	21.8	25.6	53.6
Sacramento Sucker	41.7	50.5	52.4	34.7	32.7	44.7
Sculpin sp.	48.1	50.1	23.5	29.5	23.7	34.3
Three-spined Stickleback	0.9	3.5	0.9	2.2	0.0	1.8

Table C: CPUE 2008

CPUE (fish/hr) 2008						
	Winton	Alta	Avo Boulder	Avo Side	Greenbelt	Wildwood
Rainbow Trout	1.1	0.8	1.1	1.4	0.1	0.0
Hatchery Trout	0.0	0.0	0.2	0.0	0.0	0.0
California Roach	0.0	1.2	12.8	2.8	29.5	40.8
Lamprey sp.	0.3	9.4	0.8	13.2	0.3	0.0
Mosquitofish	0.0	0.4	0.0	0.0	0.0	0.0
Sacramento Pikeminnow	8.8	3.0	21.7	8.3	20.1	18.7
Sacramento Sucker	12.9	31.3	34.5	17.5	13.5	2.6
Sculpin sp.	23.7	26.6	20.2	12.5	3.8	5.7
Three-spined Stickleback	0.0	7.2	3.0	3.3	0.0	6.0
White Catfish	0.0	0.0	0.2	0.0	0.1	0.0

Table D: CPUE 2009

CPUE (fish/hr) 2009						
	Winton	Alta	Avo Boulder	Avo Side	Greenbelt	Wildwood
Rainbow Trout	0.9	0.1	1.3	0.3	0.0	0.0
Hatchery Trout	0.1	0.1	0.0	0.0	0.0	0.0
Bluegill	0.0	0.0	0.0	0.0	0.1	0.0
Bullhead Catfish	0.0	0.0	0.0	0.0	0.1	0.0
California Roach	0.0	1.3.7	3.4	1.0	6.0	38.9
Lamprey sp.	0.5	8.4	0.6	13.4	0.1	0.1
Large mouth Bass	0.0	0.0	0.0	0.2	0.1	0.0
Sacramento Pikeminnow	1.8	7.1	6.8	4.9	10.3	17.2
Sacramento Sucker	3.8	18.0	26.4	9.1	6.2	2.1
Sculpin sp.	35.9	40.5	27.8	18.5	9.8	5.8
Small Mouth Bass	0.0	0.0	0.0	0.0	0.2	0.0
Three-spined Stickleback	0.1	5.7	2.4	2.9	0.6	2.6
White Catfish	0.0	0.0	0.0	0.0	0.1	0.0

Table E: CPUE 2010

CPUE (fish/hr) 2010						
	Winton	Alta	Avo Boulder	Avo Side	Greenbelt	Wildwood
Rainbow Trout	1.1	0.0	0.0	0.7	0.0	0.0
Hatchery Trout	0.0	0.2	0.3	0.0	0.0	0.0
Brook Trout	0.1	1.0	0.0	0.2	0.0	0.0
California Roach	0.7	3.0	7.4	1.2	13.0	54.2
Lamprey sp.	0.0	8.9	1.0	6.7	0.2	0.7
Sacramento Pikeminnow	1.3	2.0	4.3	1.7	8.7	11.2
Sacramento Sucker	4.7	29.5	17.7	10.0	2.6	8.4
Sculpin sp.	51.8	42.5	28.3	22.9	14.7	11.8
Three-spined Stickleback	2.0	9.2	0.6	0.0	0.0	6.2

Table F: CPUE 2011

CPUE (fish/hr) 2011						
	Winton	Alta	Avo Boulder	Avo Side	Greenbelt	Wildwood
Rainbow Trout	0.0	0.6	0.6	0.7	0.0	0.0
Hatchery Trout	0.0	0.0	0.7	0.2	0.0	0.0
California Roach	0.7	1.5	2.7	5.6	4.1	28.8
Green Sunfish	0.1	0.0	0.0	0.0	0.0	0.0
Lamprey sp.	0.0	10.2	2.0	20.1	0.0	0.0
Sacramento Pikeminnow	4.0	4.7	1.1	0.5	1.9	1.1
Sacramento Sucker	7.7	20.9	8.0	9.8	2.0	10.5
Sculpin sp.	30.6	45.4	10.0	32.1	9.4	12.6
Three-spined Stickleback	1.1	8.1	1.1	0.9	0.2	0.4

Table G: CPUE 2012

CPUE (fish/hr) 2012						
	Winton	Alta	Avo Boulder	Avo Side	Greenbelt	Wildwood
Rainbow Trout	0.9	0.3	1.4	0.8	0.1	0.0
Hatchery Trout	0.0	0.0	0.0	1.2	0.0	0.0
California Roach	0.0	3.4	9.3	4.0	15.2	19.9
Lamprey sp.	0.0	9.5	2.7	10.2	0.5	0.0
Mosquitofish	0.0	0.0	0.0	1.2	0.0	0.0
Sacramento Pikeminnow	0.1	1.5	19.9	22.6	8.1	17.1
Sacramento Sucker	13.0	36.5	39.4	32.6	12.2	65.1
Sculpin sp.	41.0	36.0	32.4	24.1	13.1	11.7
Three-spined Stickleback	0.0	3.3	0.7	3.2	0.5	2.6
White Catfish	0.0	0.0	0.0	0.0	0.1	0.0

Table H: CPUE 2013

CPUE (fish/hr) 2013						
	Winton	Alta	Avo Boulder	Avo Side	Greenbelt	Wildwood
Rainbow Trout	0.43	0.00	0.58	0.63	0.00	0.00
Hatchery Trout	0.29	0.16	0.15	0.16	0.00	0.00
Bass	0.00	0.00	0.00	0.00	0.62	0.00
California Roach	0.00	9.92	28.61	39.22	27.09	57.51
Lamprey sp.	0.43	6.30	1.02	15.94	0.37	0.00
Mosquitofish	0.00	0.16	0.00	0.00	0.00	0.00
Sacramento Pikeminnow	24.43	22.52	50.66	20.63	46.18	98.32
Sacramento Sucker	51.15	53.07	40.88	11.88	6.28	20.98
Sculpin sp.	70.83	37.64	49.34	29.38	21.67	16.84
Three-spined Stickleback	2.16	11.18	1.17	1.56	1.85	13.08
White Catfish	0.00	0.00	0.00	0.00	0.37	0.00

Table I: CPUE 2014

CPUE (fish/hr) 2014						
	Winton	Alta	Avo Boulder	Avo Side	Greenbelt	Wildwood
Rainbow Trout	0.00	0.00	0.00	0.00	0.00	0.00
Hatchery Trout	0.00	0.00	0.13	0.00	0.00	0.00
Bass	0.00	0.13	0.13	0.00	3.65	0.13
California Roach	2.16	12.77	25.00	11.38	24.96	60.55
Lamprey sp.	0.19	13.78	5.32	23.55	0.42	0.13
Mosquitofish	0.00	0.13	0.00	0.23	0.42	1.82
Sacramento Pikeminnow	16.14	6.19	36.17	6.60	16.41	37.89
Sacramento Sucker	10.69	11.25	19.81	7.62	4.77	10.42
Sculpin sp.	33.77	6.83	17.15	9.22	4.77	7.68
Three-spined Stickleback	3.00	27.69	4.26	6.60	0.56	8.20
White Catfish	0.19	0.00	0.27	0.23	2.10	0.00

Table J: CPUE 2015

CPUE (fish/hr) 2015						
	Winton	Alta	Avo Boulder	Avo Side	Greenbelt	Wildwood
Rainbow Trout	0.12	0.00	0.12	0.00	0.00	0.00
Hatchery Trout	0.00	0.00	0.12	0.00	0.00	0.00
Bass	0.00	0.14	0.00	0.18	7.90	0.49
California Roach	3.92	25.17	36.05	38.86	10.49	87.59
Lamprey sp.	0.24	14.72	3.09	9.94	0.00	0.12
Mosquitofish	0.24	3.16	0.00	0.00	1.87	2.31
Sacramento Pikeminnow	14.96	6.88	24.69	29.10	15.52	19.22
Sacramento Sucker	50.12	51.03	35.68	36.83	3.45	2.80
Sculpin sp.	19.00	0.96	3.33	0.74	1.01	0.73
Three-spined Stickleback	5.70	4.26	1.73	3.68	0.00	1.09
White Catfish	0.00	0.00	0.00	0.00	0.29	0.00

Table K: CPUE 2016

CPUE (fish/hr) 2016						
	Winton	Alta	Avo Boulder	Avo Side	Greenbelt	Wildwood
Rainbow Trout	0.00	0.00	0.30	0.78	0.00	0.17
Hatchery Trout	0.27	0.00	1.20	0.39	0.00	0.00
Bass	0.00	0.00	0.00	0.00	2.41	0.17
Bluegill	0.00	0.00	0.00	0.00	0.16	0.00
California Roach	1.51	61.70	54.12	32.36	14.29	95.87
Green Sunfish	0.00	0.00	0.00	0.00	0.32	0.00
Lamprey sp.	0.41	24.53	3.90	26.74	0.32	0.00
Mosquitofish	0.00	2.83	0.00	0.00	0.16	2.64
Sacramento Pikeminnow	7.12	13.58	26.69	1.94	6.42	7.26
Sacramento Sucker	73.84	73.77	95.80	40.12	78.33	91.75
Sculpin sp.	28.77	5.09	3.60	0.78	5.94	0.17
Three-spined Stickleback	12.60	14.72	14.24	25.00	0.96	19.47

Table L: CPUE 2017 (NS = not surveyed)

CPUE (fish/hr) 2017						
	Winton	Alta	Avo Boulder	Avo Side	Greenbelt	Wildwood
Rainbow Trout	NS	NS	NS	0.38	0.00	NS
Hatchery Trout	NS	NS	NS	0.50	0.10	NS
Bass	NS	NS	NS	0.00	0.31	NS
California Roach	NS	NS	NS	12.47	17.82	NS
Green Sunfish	NS	NS	NS	0.00	0.52	NS
Lamprey sp.	NS	NS	NS	14.99	0.84	NS
Sacramento Pikeminnow	NS	NS	NS	1.76	2.62	NS
Sacramento Sucker	NS	NS	NS	40.55	17.40	NS
Sculpin sp.	NS	NS	NS	18.89	16.35	NS
Three-spined Stickleback	NS	NS	NS	3.65	8.60	NS

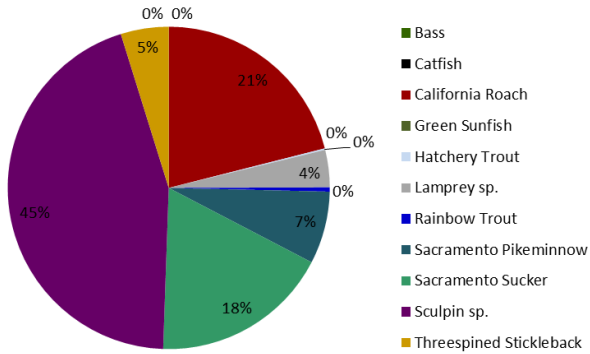
Table M: CPUE 2018

CPUE (fish/hr) 2018						
	Winton	Alta	Avo Boulder	Avo Side	Greenbelt	Wildwood
Rainbow Trout	0.08	0.27	1.11	1.25	0.00	0.00
Hatchery Trout	0.33	0.54	0.63	0.47	0.00	0.00
Bass	0.00	0.00	0.00	0.16	0.14	0.00
California Roach	0.00	0.67	6.95	1.57	8.68	37.16
Catfish sp.	0.00	0.00	0.00	0.00	0.14	0.00
Hardhead	0.00	0.00	0.00	0.00	0.14	0.00
Lamprey sp.	0.16	9.53	1.58	23.98	0.81	0.69
Sacramento Pikeminnow	0.49	1.48	1.90	0.78	19.27	5.39
Sacramento Sucker	26.47	52.35	61.14	58.78	23.61	41.28
Sculpin sp.	50.82	87.38	22.43	26.96	32.43	16.40
Three-spined Stickleback	0.90	1.34	2.53	5.02	2.04	1.15

Appendix C

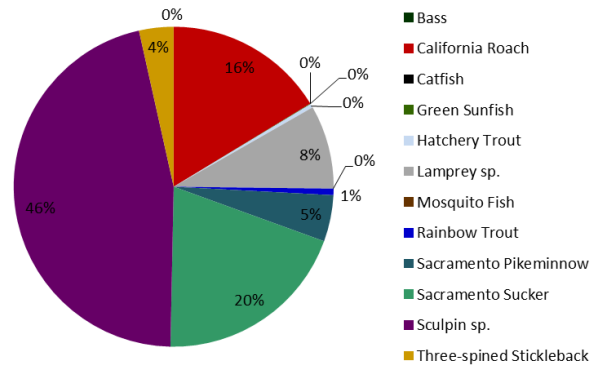
Species Composition 2010

121% Water Year



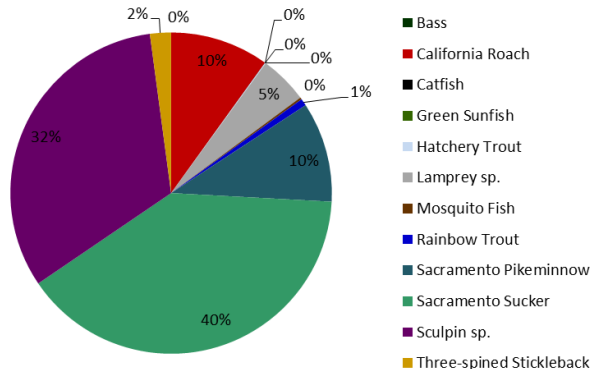
Species Composition 2011

193% Water Year



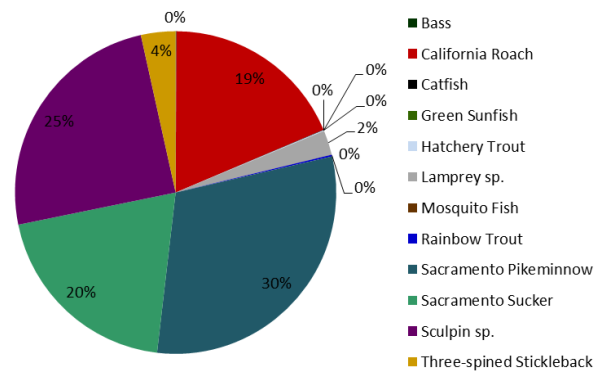
Species Composition 2012

48.8% Water Year



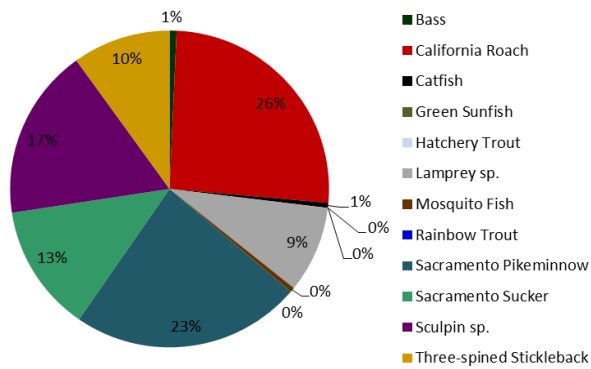
Species Composition 2013

40.69% Water Year



Species Composition 2014

32% Water Year



Species Composition 2015

22% Water Year

