Lower Kings River Annual Trout and Non-Game Fish Population Survey:
2017 Electrofishing Results

Kings River Conservation District
Environmental Resource Division

In-House Report
2018

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, results in 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 using 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 2017 survey are presented below and compared to results of prior surveys.

Methods

In 2017 only 2 survey sites could safely be sampled due to higher than normal in stream flows resulting from the wet hydrologic conditions of the 2016/17 water year (Figure 1). Sampling occurred between November 28th and 29th using standard multiple-pass depletion electrofishing techniques (Reynolds 1996). Survey sites were 300 feet in length and both the 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. Five to seven Smith-Root LR-24 and two Smith-Root LR-20B backpack electrofishers were utilized in the surveys.

Prior to the 2012 population survey, a series of tests were run using the LR-24 backpack electrofisher in the Kings River. 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 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 ($\mu W/cm^3$) 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 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. This chart was used to guide shocker voltage settings at each site during the fall 2016 population survey. It was also determined during the testing period that 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 previous settings.

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

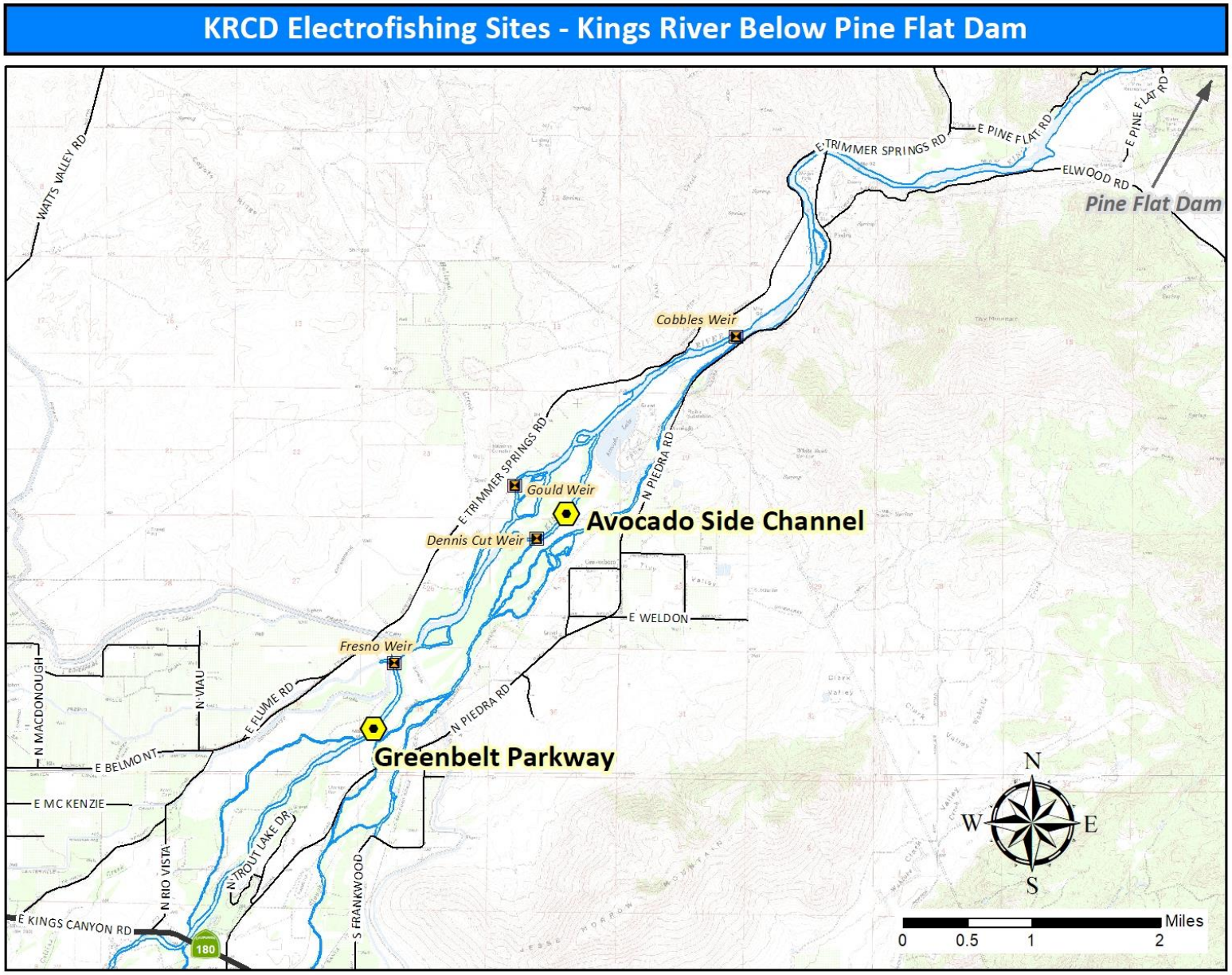


Figure 1: Electrofishing Survey Site Map.

Electrofishing was conducted using five 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, Fresno State University, Reedley College, Fresno Fly Fishers for Conservation, Kaweah Fly Fishers and the general public participated in the surveys.

Each fishing crew consisted of backpack electrofisher operators, netters and bucketers. 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 and all rainbow trout bearing adipose fins had blood drawn for diploid/triploid identification; diploid trout being reproductively viable and triploid being non-reproductive hatchery input. Rainbow trout found to have clipped adipose fins or triploid blood samples were treated as a separate species; trout considered to be stream reared with diploid blood samples were classified as *wild*, with the exception of trout thought to have been hatchery brood stock. 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.

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).

Wild Trout Density

The number of wild trout per mile is extrapolated from the annual population estimate. This estimate is an index used to monitor changes in wild trout density from year to year. The wild trout per mile estimate is usually 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 (Figure 1). The six sites total 1,800 feet or 2.7% of the reach length. Because of unusually high flows only the Greenbelt and Avocado Side Channel sites were surveyed in 2017. The two sites sampled total 600 feet or 0.91% of the tailwater fishery.

Results

A total of 1,356 fishes were collected during the fall 2017 population survey and entered into the MicroFish software program for analysis. 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 symettricus*, lamprey *Lampetra spp*, three-spined stickleback *Gasterosteus aculeatus,* Sacramento pikeminnow *Ptycheilus grandis*, Green Sunfish *Lepomis cyanellus*, hatchery reared rainbow trout and "wild" rainbow trout *Oncorhynchus mykiss*, and bass *Micropterus sp*. 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. Areas marked as NS were not surveyed.

Total Catch by Species November 2017							
	Winton	**Alta**	**Avo Boulder**	**Avo Side**	**Greenbelt**	**Wildwood**	**Total**
Rainbow Trout	NS	NS	NS	3	0	NS	3
Hatchery Trout	NS	NS	NS	4	1	NS	5
Bass	NS	NS	NS	0	3	NS	3
California Roach	NS	NS	NS	99	170	NS	269
Green Sunfish	NS	NS	NS	0	5	NS	5
Lamprey sp.	NS	NS	NS	119	8	NS	127
Sacramento Pikeminnow	NS	NS	NS	14	25	NS	39
Sacramento Sucker	NS	NS	NS	322	166	NS	488
Sculpin sp.	NS	NS	NS	150	156	NS	306
Three-spined Stickleback	NS	NS	NS	29	82	NS	111
Site Total	**0**	**0**	**0**	**740**	**616**	**0**	**1356**

Catch-Per-Unit-of-Effort

The CPUE for each taxon is summarized by site in Table 5. A comparison of CPUE values from 2007 to 2017 is summarized in Appendix B.

Table 3: Population estimate by maximum likelyhood

Population Estimate (maximum likelihood) November 2017						
	Winton	Alta	Avo Boulder	Avo Side	Greenbelt	Wildwood
Rainbow Trout	NS	NS	NS	3 - 8	0 - 0	NS
Hatchery Trout	NS	NS	NS	4 - 6	1 - 1	NS
Bass	NS	NS	NS	0-0	3 - 4	NS
California Roach	NS	NS	NS	97 - 139	174 - 220	NS
Green Sunfish	NS	NS	NS	0 - 0	5 - 6	NS
Lamprey sp.	NS	NS	NS	119 - 858	8 - 21	NS
Sacramento Pikeminnow	NS	NS	NS	14 - 69	25 - 39	NS
Sacramento Sucker	NS	NS	NS	337 - 385	171 - 223	NS
Sculpin sp.	NS	NS	NS	152 - 192	156 - 171	NS
Three-spined Stickleback	NS	NS	NS	29 - 136	82 - 159	NS

Table 4: Total catch % by species

Total Catch (% by species) November 2017						
	Winton	Alta	Avo Boulder	Avo Side	Greenbelt	Wildwood
Rainbow Trout	NS	NS	NS	100.0%	0.0%	NS
Hatchery Trout	NS	NS	NS	80.0%	20.0%	NS
Bass	NS	NS	NS	0.0%	100.0%	NS
California Roach	NS	NS	NS	36.8%	63.2%	NS
Green Sunfish	NS	NS	NS	0.0%	100.0%	NS
Lamprey sp.	NS	NS	NS	93.7%	6.3%	NS
Sacramento Pikeminnow	NS	NS	NS	35.9%	64.1%	NS
Sacramento Sucker	NS	NS	NS	66.0%	34.0%	NS
Sculpin sp.	NS	NS	NS	49.0%	51.0%	NS
Three-spined Stickleback	NS	NS	NS	26.1%	73.9%	NS

Table 5: Catch per unit of effort

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
Bluegill	NS	NS	NS	0.00	0.00	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
Mosquitofish	NS	NS	NS	0.00	0.00	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

Site 4 – Avocado Side Channel

Multiple-pass depletion sampling yielded 740 fishes representing eight taxa. Sacramento sucker accounted for 44%, Sculpin accounted for 20%, lamprey accounted for 16% and California roach accounted for 13% of the catch. Three-spine stickleback, Sacramento pikeminnow, wild rainbow trout, and hatchery rainbow trout accounted for the remainder of the catch. Sacramento sucker (8,292.4g), hatchery rainbow trout (1,527.7g) and Sculpin (590.9g) represented the majority of the biomass collected.

The estimated population density for this site is 48,488 fish*ha^{-1}. By species, this represents 15,928 lamprey, 15,884 Sacramento sucker, 7,500 Sculpin, 5,192 California roach, 2,508 three-spine stickleback, 1,100 Sacramento pikeminnow, 132 hatchery rainbow trout and 132 wild rainbow trout.

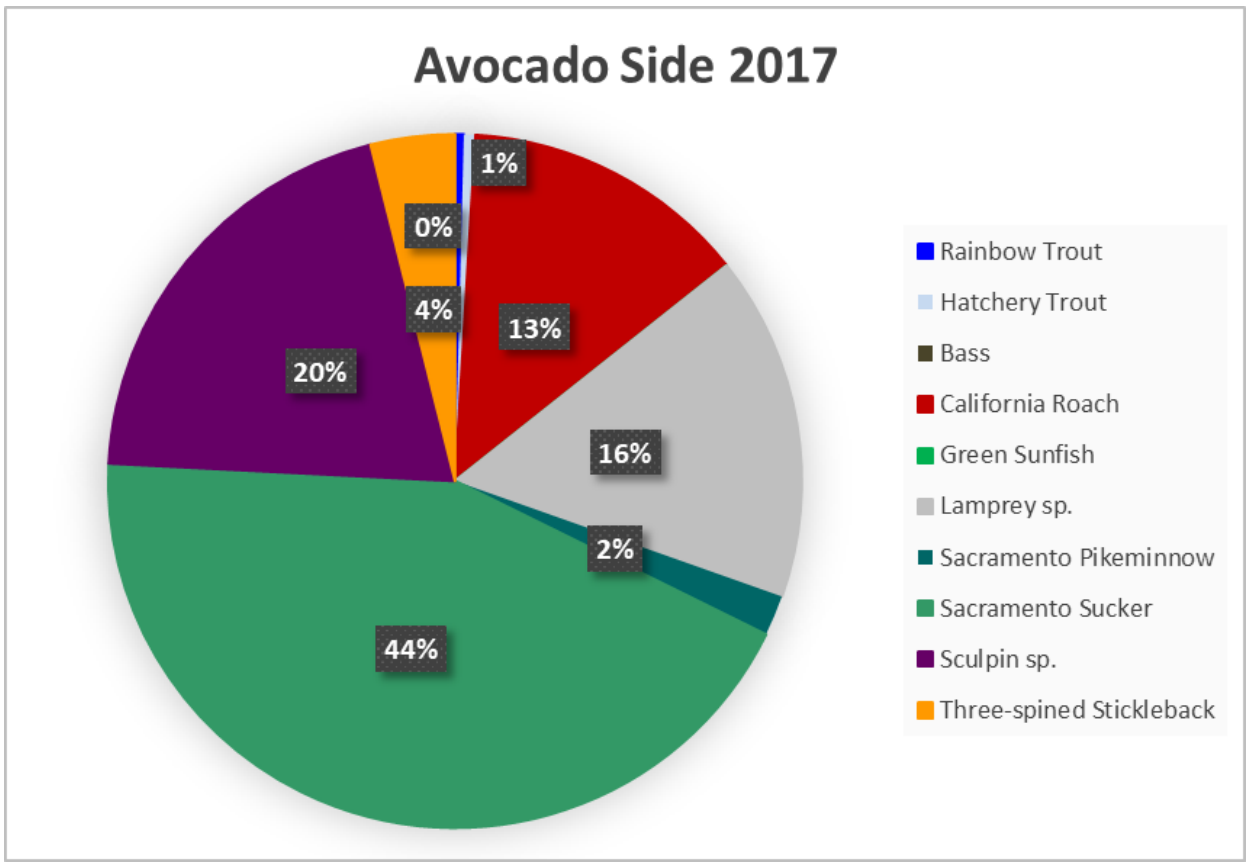


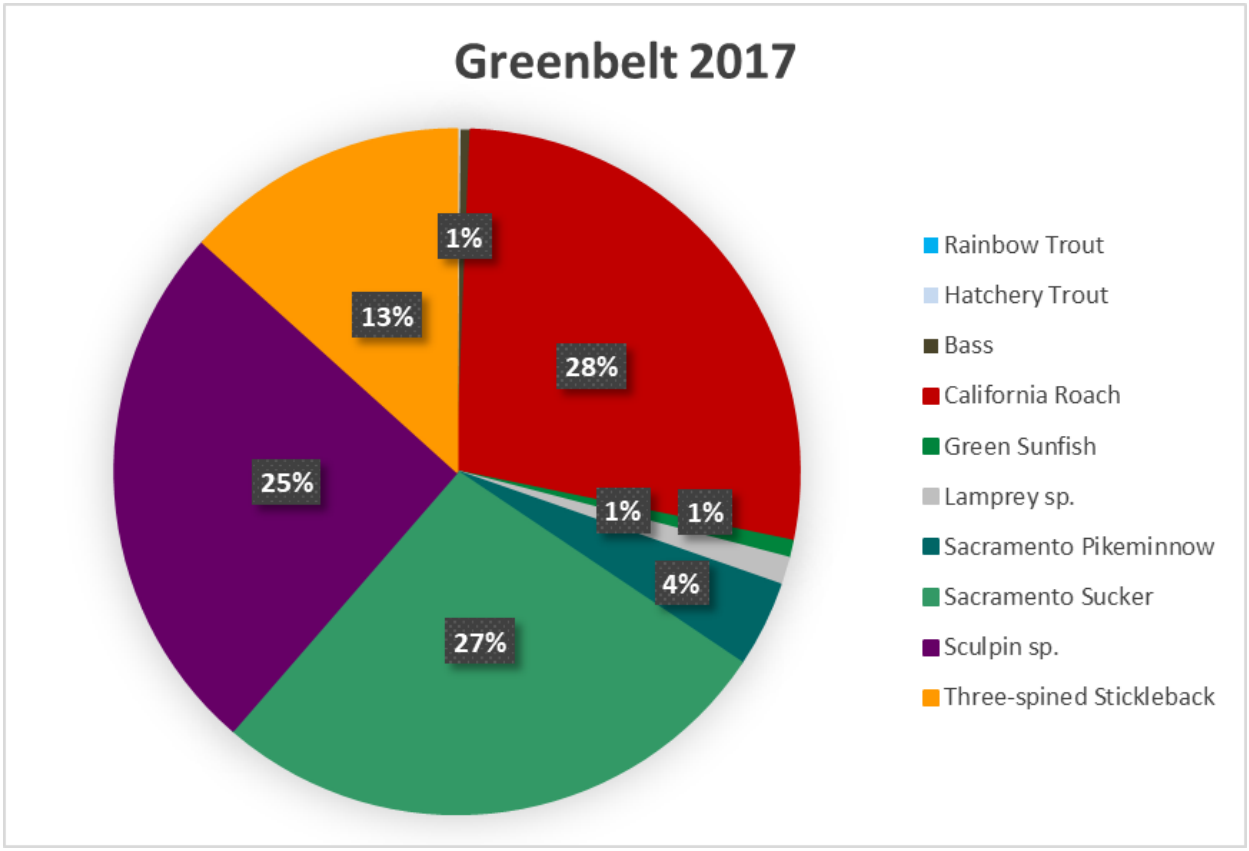
Figure 2: Species composition for Avocado Side Channel survey reach 2017

Site 5 – Greenbelt Parkway

Multiple-pass depletion sampling yielded 616 fishes representing nine taxa. California roach accounted for 28%, Sacramento sucker accounted for 27%, and Sculpin accounted for 25%, and Three-spined Stickleback accounted for 13% of the catch. Sacramento pikeminnow, bass, green sunfish, and lamprey accounted for the remainder of the catch. Sacramento sucker (1,220.0g), sculpin (815.1g) and hatchery rainbow trout (714.7g) represented the majority of the biomass collected.

The estimated population density for this site is 9,880 fish*ha^{-1}. By species, this represents 2,700 Sacramento sucker, 2,700 California roach, 2,233 sculpin, 1,590 three-spine stickleback, 397 Sacramento pikeminnow, 137 lamprey, 69 green sunfish, 40 bass and 4 hatchery trout.

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 ten taxa of fish were collected during the 2017 survey (Figure 4). Comparative charts of species composition from 2010 – 2017 are presented in Appendix C.

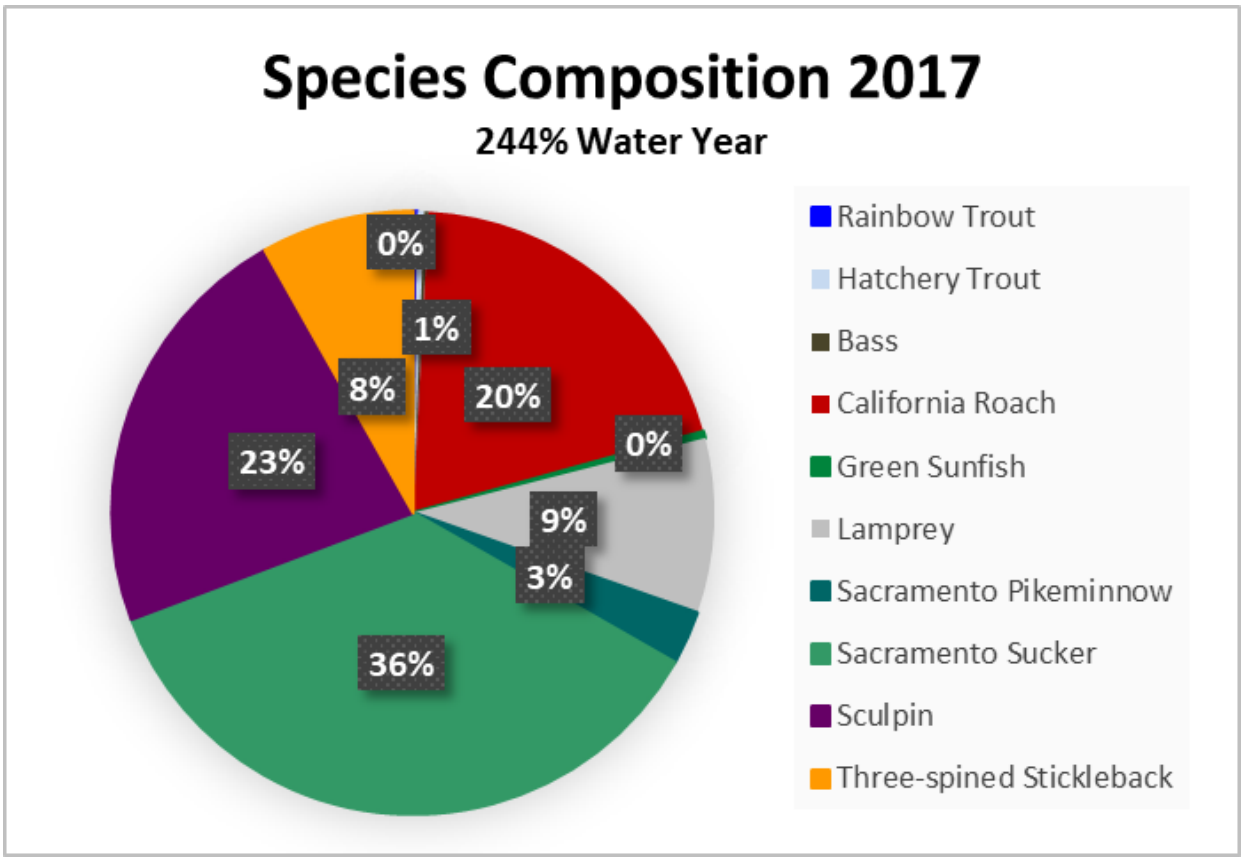


Figure 4: Total species composition of total catch 2017

Wild Trout Density

Two sites were sampled over two days resulting in the capture of three wild trout during the 2017 survey. This roughly translates to 26.40 wild trout per mile in similar reaches of the fishery. Taken on its own, data from the Avocado side channel translates to approximately 52.80 wild trout per mile.

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 (Chipps and Garvey 2007). In 2017, the total biomass collected was 15,861g (35.23 lbs.). Sacramento sucker accounted for 59% (9512.4g; 20.7 lbs.), hatchery trout accounted for (14%; 4.95 lbs.) sculpin accounted for 9% (1406.0g; 3.1 lbs.) and California roach accounted for 5% (818.9g; 1.8 lbs.). Wild rainbow trout, bass, lamprey, Sacramento pikeminnow, three-spine stickleback, and Green sunfish accounted for the remaining 13% (1,881.6g; 4.4 lbs.). Biomass results for the 2017 survey are summarized by site in Table 6.

Table 6: Biomass, weight in pounds

Total Weight (lbs) November 2017							
	Winton	**Alta**	**Avo Boulder**	**Avo Side**	**Greenbelt**	**Wildwood**	**Total**
Rainbow Trout	NS	NS	NS	1.20	0.00	NS	1.20
Hatchery Trout	NS	NS	NS	3.40	1.60	NS	4.95
Bass	NS	NS	NS	0.00	1.10	NS	1.10
California Roach	NS	NS	NS	0.92	0.89	NS	1.81
Green Sunfish	NS	NS	NS	0.00	0.48	NS	0.48
Lamprey sp.	NS	NS	NS	1.00	0.04	NS	1.04
Sacramento Pikeminnow	NS	NS	NS	0.06	0.31	NS	0.37
Sacramento Sucker	NS	NS	NS	18.00	2.70	NS	20.97
Sculpin sp.	NS	NS	NS	1.30	1.80	NS	3.10
Three-spined Stickleback	NS	NS	NS	0.07	0.14	NS	0.21
Site Total	**0.00**	**0.00**	**0.00**	**25.95**	**9.06**	**0.00**	**35.23**
Biomass %	**0.0%**	**0.0%**	**0.0%**	**73.7%**	**25.7%**	**0.0%**	**100.0%**

Length

The mean fork length for wild rainbow trout collected during the 2017 survey was 23.5 cm (approx. 9.25 inches). The mean fork length for wild rainbow trout collected between 2007 and 2017 (n = 146) is 19.0cm (approx. 7.5 inches).

Condition Factor (K)

All of the wild trout collected in 2017 were found to be in good condition (Table 7). The condition factor for these trout ranged from 1.03 to 1.20.

Age

Scale samples from the three wild rainbow trout collected in 2017 were used to estimate trout age based on counts of annuli and circuli. The mean age of wild trout captured in 2017 was 1.3 (1 – 2) years. The mean age of wild rainbow trout caught since 2008 is 2 years. A depiction of the age/length frequency distribution 2017 can be referenced in Figure 11.

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

SITE	AGE	K-FACTOR
Avocado Side	1	1.04
Avocado Side	1	1.2
Avocado Side	2	1.2

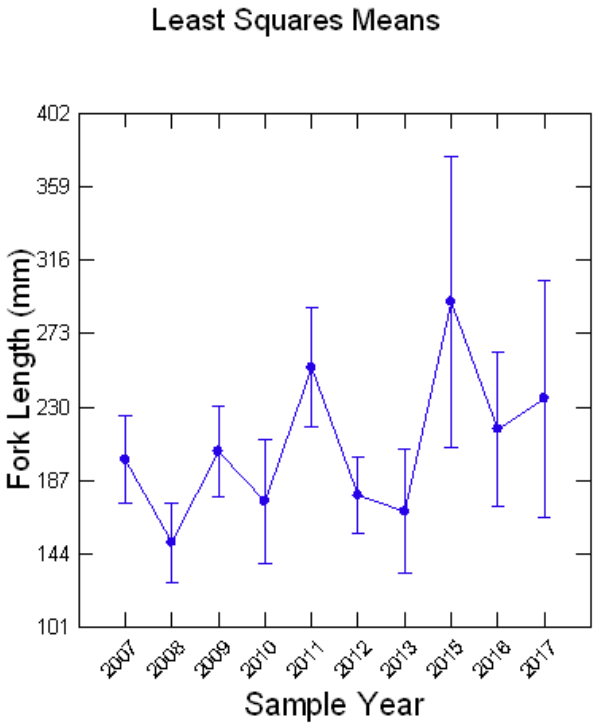


Figure 5: Changes in mean fork length 2007 - 2017

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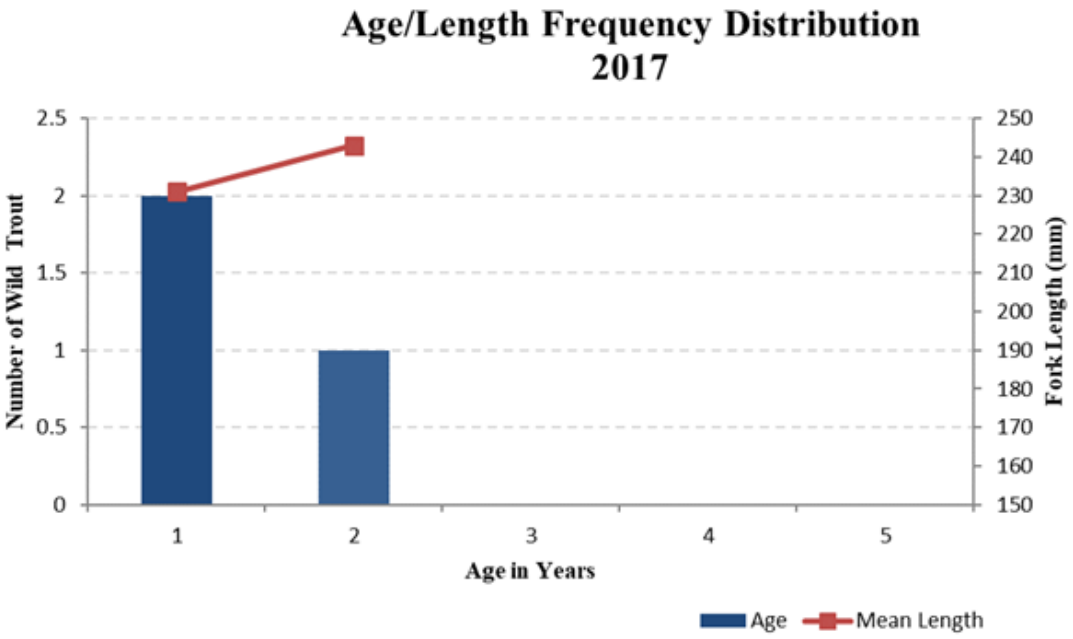

Figure 6: Average age/length frequency distribution for wild rainbow trout 2016

Conclusion

2017 marked the tenth year of multiple pass depletion sampling since the KRFMP returned to triple-pass depletion in 2007. In addition, this year marked the sixth 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 – 2017 catch efficiency and the interpretation of trends over time in survey results.

A total of 1,356 fishes were collected during the 2017 survey and analyzed with Microfish software. In comparison with the same two sites sampled in 2016, decreases were documented in the abundance of Sacramento sucker (29.8%) and bass (80%). The most significant increases in abundance were seen in three-spine stickleback (170.7%) and sculpin (126.7%). Standing stock was dominated by Sacramento sucker, Sculpin and California roach which accounted for 79% of the total catch, Sacramento sucker accounted for 36%, Sculpin 23% and California roach 20%. In all, fishes native to the Kings River made up 99.5% of fish captured.

This year's two-site survey produced five hatchery trout and three wild rainbow trout. This translated to 26 wild trout per mile. The condition factor of the wild trout captured during the 2017 survey was fair to good, indicating that the trout were within normal parameters. Wild trout ages ranged from one to two years old. Diploid blood samples and back calculated growth rates indicate a strong possibility that the two younger rainbow trout likely originated from the KRFMP incubator facility.

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. There appears to be a congruent 1 to 2 year delay in wild trout population response to increase/decrease in annual flows. This observational relationship was not statistically significant in 2016 (Spearman's Rho: df = 3.03, 3.02, R = 0.63) however the 10 year sample size is small. A significant correlation found between wild trout populations and percent runoff could suggest that annual climatic conditions in the Kings River watershed have a greater effect on wild trout populations than anthropogenic factors alone. New approaches to analyzing this data will be examined in the coming year. 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 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 2017						
	Winton	**Alta**	**Avo Boulder**	**Avo Side**	**Greenbelt**	**Wildwood**
Rainbow Trout	NS	NS	NS	3 - 8	0 - 0	NS
Hatchery Trout	NS	NS	NS	4 - 6	1 - 1	NS
Bass	NS	NS	NS	0-0	3 - 4	NS
California Roach	NS	NS	NS	97 - 139	174 - 220	NS
Green Sunfish	NS	NS	NS	0 - 0	5 - 6	NS
Lamprey sp.	NS	NS	NS	119 - 858	8 - 21	NS
Sacramento Pikeminnow	NS	NS	NS	14 - 69	25 - 39	NS
Sacramento Sucker	NS	NS	NS	337 - 385	171 - 223	NS
Sculpin sp.	NS	NS	NS	152 - 192	156 - 171	NS
Three-spined Stickleback	NS	NS	NS	29 - 136	82 - 159	NS

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
Largemouth 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

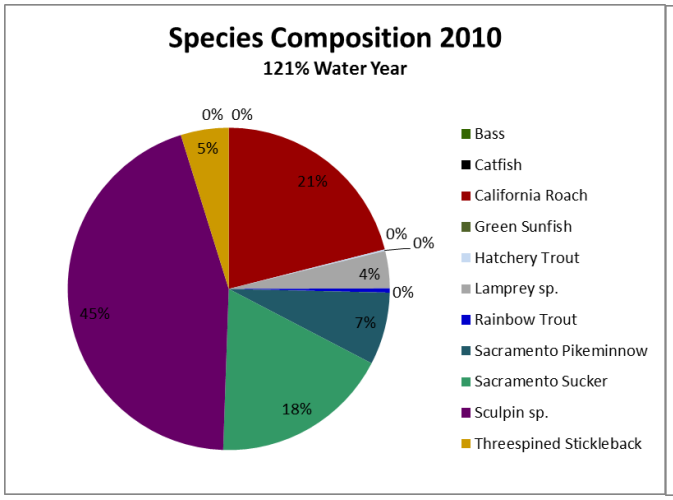
Table K: CPUE 2016

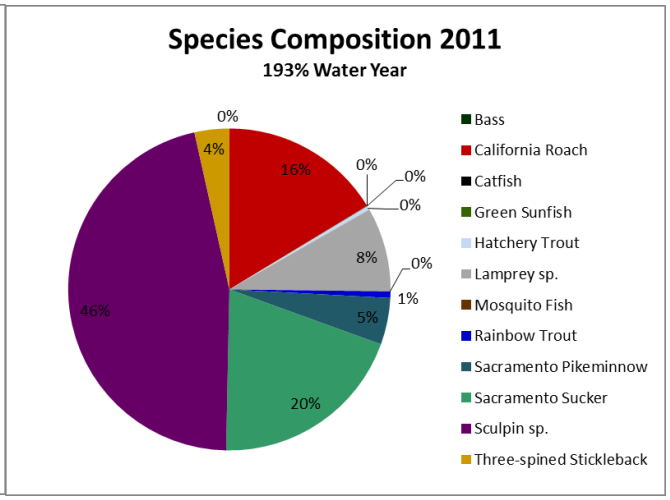
CPUE (fish/hr) 2016						
	Winton	**Alta**	**Avo Boulder**	**Avo Side**	**Greenbelt**	**Wildwood**
Rainbow Trout	0.00	0.00	0.30	0.78	0.00	0.17
Hatchery Trout	0.27	0.00	1.20	0.39	0.00	0.00
Bass	0.00	0.00	0.00	0.00	2.41	0.17
Bluegill	0.00	0.00	0.00	0.00	0.16	0.00
California Roach	1.51	61.70	54.12	32.36	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

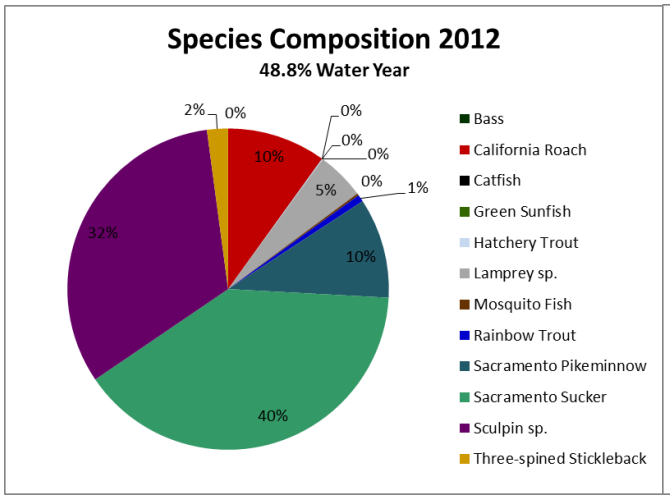
Table L: CPUE 2017 (NS = not surveyed)

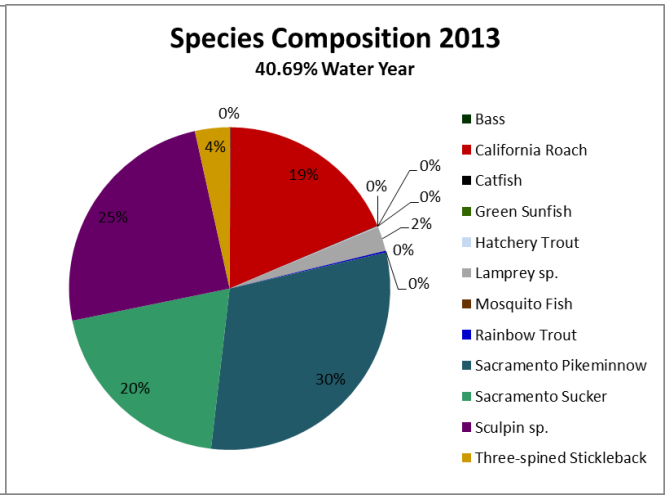
CPUE (fish/hr) 2017						
	Winton	**Alta**	**Avo Boulder**	**Avo Side**	**Greenbelt**	**Wildwood**
Rainbow Trout	NS	NS	NS	0.38	0.00	NS
Hatchery Trout	NS	NS	NS	0.50	0.10	NS
Bass	NS	NS	NS	0.00	0.31	NS
California Roach	NS	NS	NS	12.47	17.82	NS
Green Sunfish	NS	NS	NS	0.00	0.52	NS
Lamprey sp.	NS	NS	NS	14.99	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

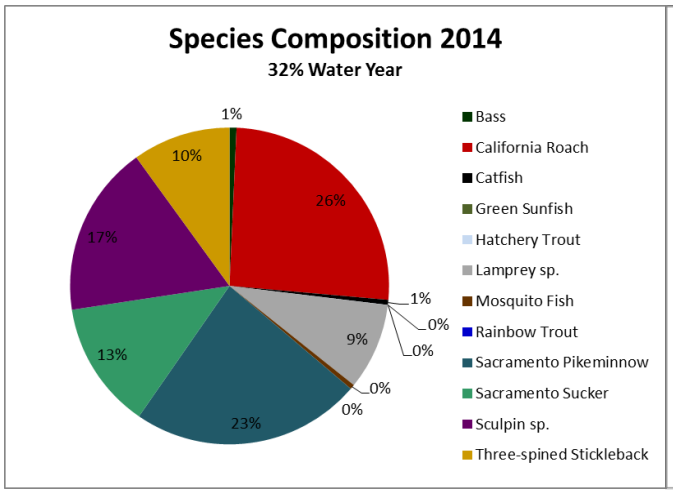
Appendix C

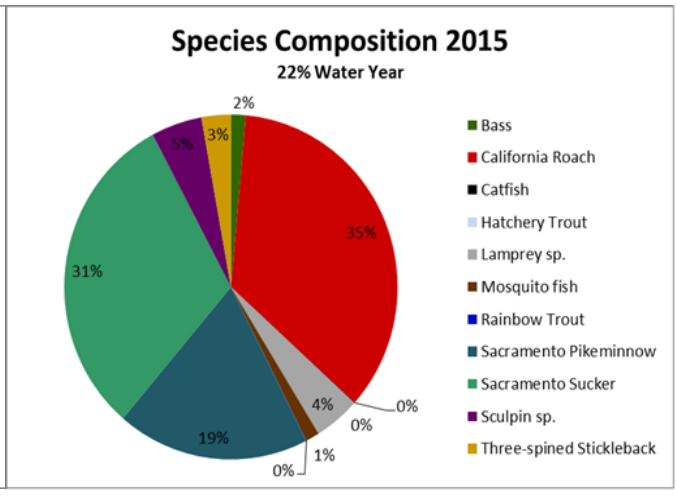

Species Composition 2010
121% Water Year
0% 0%
5%
21%
0%
0%
4%
0%
7%
18%
45%
Bass
Catfish
California Roach
Green Sunfish
Hatchery Trout
Lamprey sp.
Rainbow Trout
Sacramento Pikeminnow
Sacramento Sucker
Sculpin sp.
Threespined Stickleback

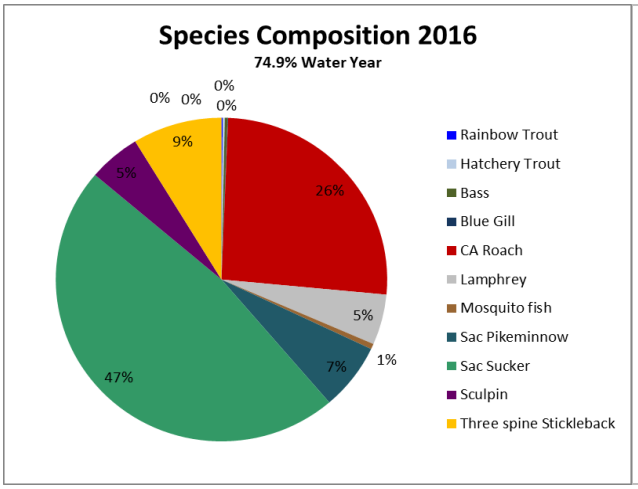

Species Composition 2011
193% Water Year
0%
4%
16%
0%
0%
0%
8%
0%
1%
5%
20%
46%
Bass
California Roach
Catfish
Green Sunfish
Hatchery Trout
Lamprey sp.
Mosquito Fish
Rainbow Trout
Sacramento Pikeminnow
Sacramento Sucker
Sculpin sp.
Three-spined Stickleback

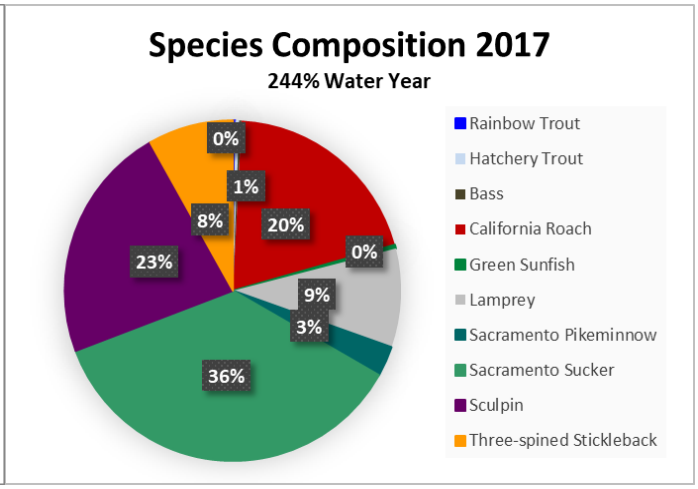

Species Composition 2012
48.8% Water Year
2%
0%
10%
0%
0%
0%
5%
0%
1%
10%
32%
40%
Bass
California Roach
Catfish
Green Sunfish
Hatchery Trout
Lamprey sp.
Mosquito Fish
Rainbow Trout
Sacramento Pikeminnow
Sacramento Sucker
Sculpin sp.
Three-spined Stickleback


Species Composition 2013
40.69% Water Year
0%
4%
19%
0%
0%
0%
2%
0%
0%
25%
20%
30%
Bass
California Roach
Catfish
Green Sunfish
Hatchery Trout
Lamprey sp.
Mosquito Fish
Rainbow Trout
Sacramento Pikeminnow
Sacramento Sucker
Sculpin sp.
Three-spined Stickleback


Species Composition 2014
32% Water Year
1%
10%
26%
17%
1%
0%
0%
9%
13%
0%
0%
23%
Bass
California Roach
Catfish
Green Sunfish
Hatchery Trout
Lamprey sp.
Mosquito Fish
Rainbow Trout
Sacramento Pikeminnow
Sacramento Sucker
Sculpin sp.
Three-spined Stickleback


Species Composition 2015
22% Water Year
2%
3%
5%
35%
31%
4%
0%
0%
19%
1%
0%
Bass
California Roach
Catfish
Hatchery Trout
Lamprey sp.
Mosquito fish
Rainbow Trout
Sacramento Pikeminnow
Sacramento Sucker
Sculpin sp.
Three-spined Stickleback


Species Composition 2016
74.9% Water Year
0%
0%
0%
9%
5%
26%
5%
1%
7%
47%
Rainbow Trout
Hatchery Trout
Bass
Blue Gill
CA Roach
Lamphrey
Mosquito fish
Sac Pikeminnow
Sac Sucker
Sculpin
Three spine Stickleback


Species Composition 2017
244% Water Year
0%
1%
8%
20%
0%
23%
9%
3%
36%
Rainbow Trout
Hatchery Trout
Bass
California Roach
Green Sunfish
Lamprey
Sacramento Pikeminnow
Sacramento Sucker
Sculpin
Three-spined Stickleback