

Lower Kings River Annual Trout and Non-Game Fish Population
Survey:
2012 Electrofishing Results

Kings River Conservation District
Environmental Resource Division

In-House Report

2013

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 downstream of Pine Flat Dam from 1983 to the present. The population monitoring is performed as part of a Federal Energy Regulatory Commission (FERC) requirement for compliance with Item 4 of the Memorandum of Agreement for FERC Project No. 2741.

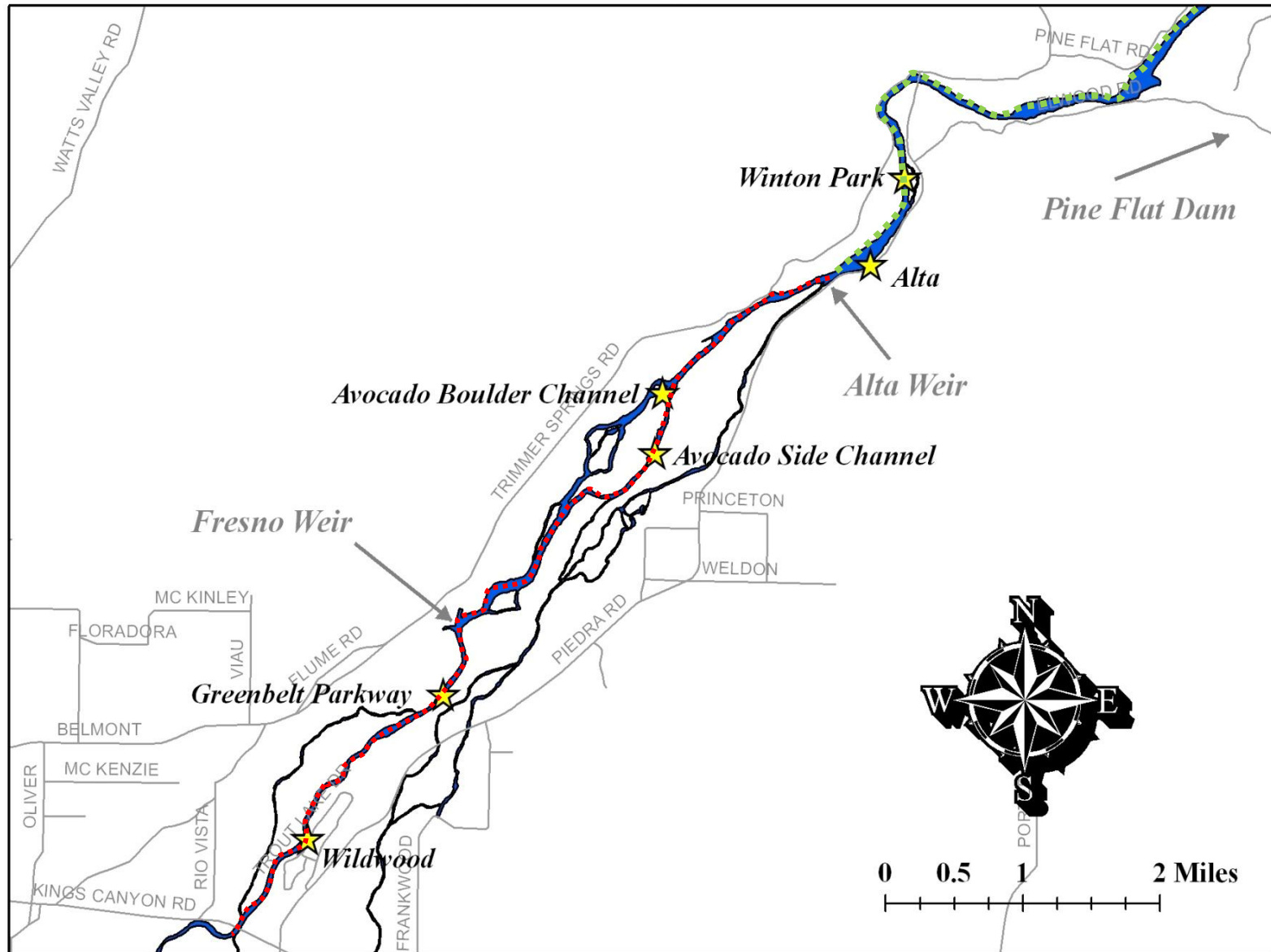
A multiple pass mark and recapture electrofishing survey was employed from 1983 through 1989. In 1990, the annual electrofishing survey was modified to a single pass count of captured trout using only a single block seine net at the upstream end of the sample reach. The decision to change to a single pass survey was made due to an absence of trout detected in the late 1980's as a result of extreme drought conditions and low flow 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 abundance and do not accurately reflect absolute population, density or abundance. Extrapolating density estimates from the single pass data produces, at best, an uncertain estimate that does not stand up to rigorous statistical analysis. In the fall of 2007 the Fisheries Management Program's (FMP) Technical Steering Committee (KRCD, CDFW and the KRWA) revised the electrofishing survey protocol using a multiple (3) pass depletion technique with upstream and downstream block seines, which resulted in more confidence and reliable quantitative estimates of fish biomass density and abundance, age, length and condition metrics for fish inhabiting the Kings River below Pine Flat Dam.

Methods

Six survey sites (Figure 1) were sampled between November 11 and 20 2012 using standard multiple-pass depletion electrofishing techniques (Reynolds 1996). Survey sites were 300 feet in length and both the upstream and downstream ends were netted with ¼-inch mesh block seines to avoid fish immigration or emigration from the survey reach. Smith-Root LR-24 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

KRCD Electrofishing Sites - Kings River Below Pine Flat Dam



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Figure 1: Electrofishing Survey Site Map. Green areas indicate the Put and Take management area and red areas indicate the Catch and Release management area.

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 a high number of 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.

A voltage goal is the voltage required to overcome the mismatch between water conductivity and fish conductivity. Data collected from the LR-24 backpack electroshocker’s internal volt meter was used to generate a peak voltage goal chart (Figure 2) based on water conductivity observed in the Kings River below Pine Flat Dam. This chart was used to guide shocker voltage settings during the fall 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 and quick recovery when compared to previous settings.

Electrofishing was conducted using four to eight fishing crews and one work-up crew when possible. Fishing crews consisted of a backpack electrofisher operator and a netter. Work-up crews consisted of one data recorder and one to two biologists. In the field each fish captured was identified to the lowest practical taxon, weighed to the nearest tenth of a gram, and measured total length (1mm), with the exception of rainbow trout, which were measured to fork length. Scale samples were taken from each rainbow trout just behind the dorsal fin for aging in the lab. Rainbow trout exhibiting obvious signs of hatchery origin (i.e. worn or abraded fins, clipped adipose fins) were treated as a separate species than those considered to be stream reared and therefore classified *wild*. After data

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

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 and Population Estimate (Maximum Likelihood) tables used for analysis of the data. Biomass, density, and population estimates were also calculated using the MicroFish software.

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 & Garvey 2007).

This index is mathematically defined as:

$$C/f = N$$

where C is the number of each species caught, 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 in time (seconds). 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 a qualitative assessment of an individual salmonid's body fitness and condition. The score is based upon a mathematical formula (Fulton, 1902) which utilizes length and weight 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, H. Shah et al. 2011). A fish is said to be in better condition when the value of a condition 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, H. Shah et al. 2011). Condition factors were calculated for wild rainbow trout collected from the 2012 survey and a one-sample t-test was used to test the sample mean for statistically significant differences among survey reaches.

Results

A total of 4,251 fish were collected during the fall 2012 population survey. Species collected included; California roach *Hesperoluecus symmetricus*, lamprey *Lampetra spp*; (several species may be present but not distinguished), Sacramento pikeminnow *Ptycheilus grandis*, rainbow trout (both wild and hatchery reared) *Oncorhynchus mykiss*, Sacramento sucker *Catostomus occidentalis*, sculpin *Cottus spp.*, three-spined stickleback *Gasterosteus aculeatus* and white catfish *Ameiurus catus*. The total catch is displayed by species and site in Table 2. These data represent the total number of each species caught at each survey site. Percent composition is summarized by species in Table 3. Population estimates are summarized in Table 4 and 95% confidence intervals for the population estimates by survey site are summarized in Appendix A (Table A).

Table 2: Total catch across sites by species

Total Catch by species November 2012							
	Winton	Alta	Avo Boulder	Avo Side	Greenbelt	Wildwood	Total
California Roach	0	37	79	30	121	155	422
Hatchery Trout	0	0	3	0	0	0	3
Lamprey sp.	0	103	23	76	4	0	206
Mosquito Fish	0	0	0	9	0	0	9
Sacramento Pikeminnow	1	17	44	169	64	133	428
Rainbow Trout	8	3	12	6	1	0	30
Sacramento Sucker	107	396	334	244	97	507	1685
Sculpin sp.	336	391	275	180	104	91	1377
Three-spined Stickleback	0	36	6	24	4	20	90
White Catfish	0	0	0	0	1	0	1
	452	983	776	738	396	906	4251

Table 3: Total catch % by species

Total Catch (% by species) November 2012							
	Winton	Alta	Avo Boulder	Avo Side	Greenbelt	Wildwood	Total
California Roach	0.0%	8.8%	18.7%	7.1%	28.7%	36.7%	100.0%
Hatchery Trout	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%
Lamprey sp.	0.0%	50.0%	11.2%	36.9%	1.9%	0.0%	100.0%
Mosquito Fish	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	100.0%
Sacramento Pikeminnow	0.2%	4.0%	10.3%	39.5%	15.0%	31.0%	100.0%
Rainbow Trout	24.2%	10.3%	41.4%	20.7%	3.4%	0.0%	100.0%
Sacramento Sucker	6.4%	23.5%	19.8%	14.5%	5.8%	30.0%	100.0%
Sculpin sp.	24.4%	28.4%	20.0%	13.0%	7.6%	6.6%	100.0%
Three-spined Stickleback	14.1%	59.4%	14.1%	6.3%	1.5%	4.6%	100.0%
White Catfish	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%

Table 4 : Population estimate by maximum likelihood

Population Estimate (maximum likelihood) November 2012						
	Winton	Alta	Avo Boulder	Avo Side	Greenbelt	Wildwood
California Roach	0	39	348	45	146	545
Hatchery Trout	0	0	3	0	0	0
Lamprey sp.	0	154	24	114	4	0
Mosquito Fish	0	0	0	9	0	0
Sacramento Pikeminnow	1	21	46	254	69	531
Rainbow Trout	11	3	12	9	1	0
Sacramento Sucker	128	466	415	319	108	760
Sculpin sp.	372	469	302	212	130	127
Three-spined Stickleback	0	54	6	36	4	30
White Catfish	0	0	0	0	1	0

Site 1 – Winton Park

Multiple-pass depletion sampling yielded 452 fishes representing four species. Sculpin spp. accounted for 74.3% of the catch while Sacramento sucker accounted for 23.6%. Other species collected included wild rainbow trout and Sacramento pikeminnow. Sculpin spp. (2,757.9g), Sacramento sucker (1,145.8g), and wild rainbow trout (510.6g), represented the majority of the biomass collected.

The estimated population density for this site is 1,381.1 fish*ha⁻¹. By species, this represents one thousand five Sacramento sucker, three-hundred forty-six Sculpin and thirty wild rainbow trout.

Site 2 – Alta

Multiple-pass depletion sampling yielded 983 fishes representing seven species. Sacramento sucker accounted for 40.2%, sculpin accounted for 39.8% of the catch and lamprey sp. accounted for 10.5%. Other species collected included California roach, three-spined stickleback, Sacramento pikeminnow, and wild rainbow trout. Sacramento sucker (2384.3g) and Sculpin spp. (1,919.1g) represented the majority of the biomass collected.

The estimated population density for this site is 6,700.0 fish*ha⁻¹. By species, this represents two thousand six hundred six sculpin, two thousand five hundred eighty-eight Sacramento sucker, eight hundred fifty-five lamprey spp., three hundred three-spined stickleback, two hundred seventeen California roach, one hundred seventeen Sacramento pikeminnow, and seventeen wild rainbow trout.

Site 3 – Avocado Boulder Project

Multiple-pass depletion sampling yielded 776 fishes representing eight species. Sacramento sucker accounted for 43% of the catch, sculpin accounted for 35.4% and California roach accounted for 10.2%. Other species collected included Sacramento pikeminnow, lamprey, wild rainbow trout, three-spined stickleback, and hatchery rainbow trout. Sacramento sucker (37,844g), sculpin (1,593.90g), wild rainbow trout (619.1g) and Sacramento pikeminnow (550.4g) represented the majority of the biomass collected.

The estimated population density for this site is 6,783.0 fish*ha⁻¹. By species, this represents two thousand four hundred forty Sacramento sucker, two thousand forty-seven

California roaches, one thousand seven hundred seventy-seven sculpin spp., two hundred seventy-one Sacramento pikeminnows, one hundred forty-one lamprey, seventy-one wild rainbow trout, eighteen hatchery trout and eighteen three-spined stickleback.

Site 4 – Avocado Side Channel

Multiple-pass depletion sampling yielded 738 fishes representing eight species. Sacramento sucker accounted for 33.1%, Sculpin accounted for 24.4%, and Sacramento pikeminnow accounted for 22.8%. Other Species collected included lamprey spp., California roach, three-spined stickleback, mosquito fish and wild rainbow trout. Sacramento sucker (7818.2g), sculpin spp. (857.2g), and “wild” rainbow trout (619.1g) represented the majority of the biomass collected.

The estimated population density for this site is 6,653.0 fish*ha⁻¹. By species, this represents two thousand one hundred twenty seven Sacramento sucker, one thousand six hundred ninety-three Sacramento pikeminnow, one thousand four hundred thirteen sculpin, seven hundred sixty lamprey, three hundred California roach, two hundred forty stickleback, sixty wild rainbow trout, and sixty mosquito fish.

Site 5 – Greenbelt Parkway

Multiple-pass depletion sampling yielded 396 fishes representing eight species. California roach accounted for 30.6%, sculpin, 26.2%, and Sacramento sucker represented 24.4%. Sacramento pikeminnow, three-spined stickleback, lamprey spp., one wild rainbow trout and one white catfish accounted for the rest of the catch. Sacramento sucker (1,580.0g), sculpin (833.1g), and wild rainbow trout (747.5g) represented the majority of the biomass collected.

The estimated population density for this site is 1,715.0 fish*ha⁻¹. By species, this represents five hundred forty California roach, four hundred eighty-three sculpin, four hundred Sacramento sucker, two hundred fifty-six Sacramento pikeminnow, fifteen lamprey, fifteen three-spined stickleback, four wild rainbow trout and four white catfish.

Site 6 – Wildwood

Multiple-pass depletion sampling yielded 906 fishes representing five species. Sacramento sucker accounted for 56% of the catch while California roach accounted for 17.1% and Sacramento pikeminnow 14.7%. Other species collected included sculpin and three-spined stickleback. Sacramento sucker (3,795.5g), sculpin (850.7g) and California roach (479.3g) represented the majority of the biomass collected.

The estimated population density for this site is 7,972 fish*ha⁻¹. By species, this represents three thousand forty Sacramento sucker, two thousand one hundred eighty California roach, two thousand one hundred twenty-four Sacramento pikeminnow, five hundred eight sculpin, and one hundred twenty three-spined stickleback.

Catch Per Unit of Effort

The Catch per Unit of Effort for each species is summarized by site in Table 5. The Avocado Boulder Channel was the most productive in terms of wild rainbow trout, generating 1.4 trout per hour. A comparison of CPUE values from 2007 to 2012 is summarized in Appendix B.

Table 5: Catch per unit of effort

C.P.U.E (fish/hr) 2012						
	Winton	Alta	Avo Boulder	Avo Side	Greenbelt	Wildwood
California Roach	0.0	3.4	9.3	4.0	15.2	19.9
Mosquito fish	0.0	0.0	0.0	1.2	0.0	0.0
Hatchery Trout	0.0	0.0	0.4	0.0	0.0	0.0
Lamprey sp.	0.0	9.5	2.7	10.2	0.5	0.0
Sacramento Pikeminnow	0.1	1.5	19.9	22.6	8.1	17.1
Rainbow Trout	0.9	0.3	1.4	0.8	0.1	0.0
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

Wild Trout Density

The number of wild trout per mile is extrapolated from the annual population estimate. This estimate is an index of trout density and is used to monitor changes in wild trout density from year to year. The wild trout per mile estimate is based on population data collected from the six survey sites throughout the coldwater fishery from Pine Flat Dam to the Highway 180 Bridge. The six sites total 1,800 feet or 37% of the total coldwater fishery length. Six hundred feet of river length is surveyed in both the Put and Take and Catch and Release sections of river above Fresno Weir. In addition six hundred feet of the Catch & Release section downstream of Fresno Weir are also surveyed representing 2.3%, 2.9% and 3.3% of the section length respectively.

Thirty wild trout were collected during the 2012 electrofishing survey. The estimated wild trout density is eighty-eight (88) trout per mile between Pine Flat Dam and the Highway 180 Bridge (Table 6). Historical wild trout density estimates dating back to 1983 are summarized in Figure 2.

Table 6: The estimated number of “wild” trout per mile based on data collected November 2012

Wild Trout Per-Mile November 2012			
Site Name	Number	Site	Wild Trout
	Wild Trout	Length (ft.)	per mile
Winton Park	8	300	141
Alta	3	300	53
Avo Boulder	12	300	211
Avo Side	6	300	106
Greenbelt	1	300	18
Wildwood	0	300	0
Total:	$(30 / 1800ft.) \cdot 5,280 \text{ ft. per mile} = 88$		

Estimated "Wild" Trout Per Mile 1983 - 2012

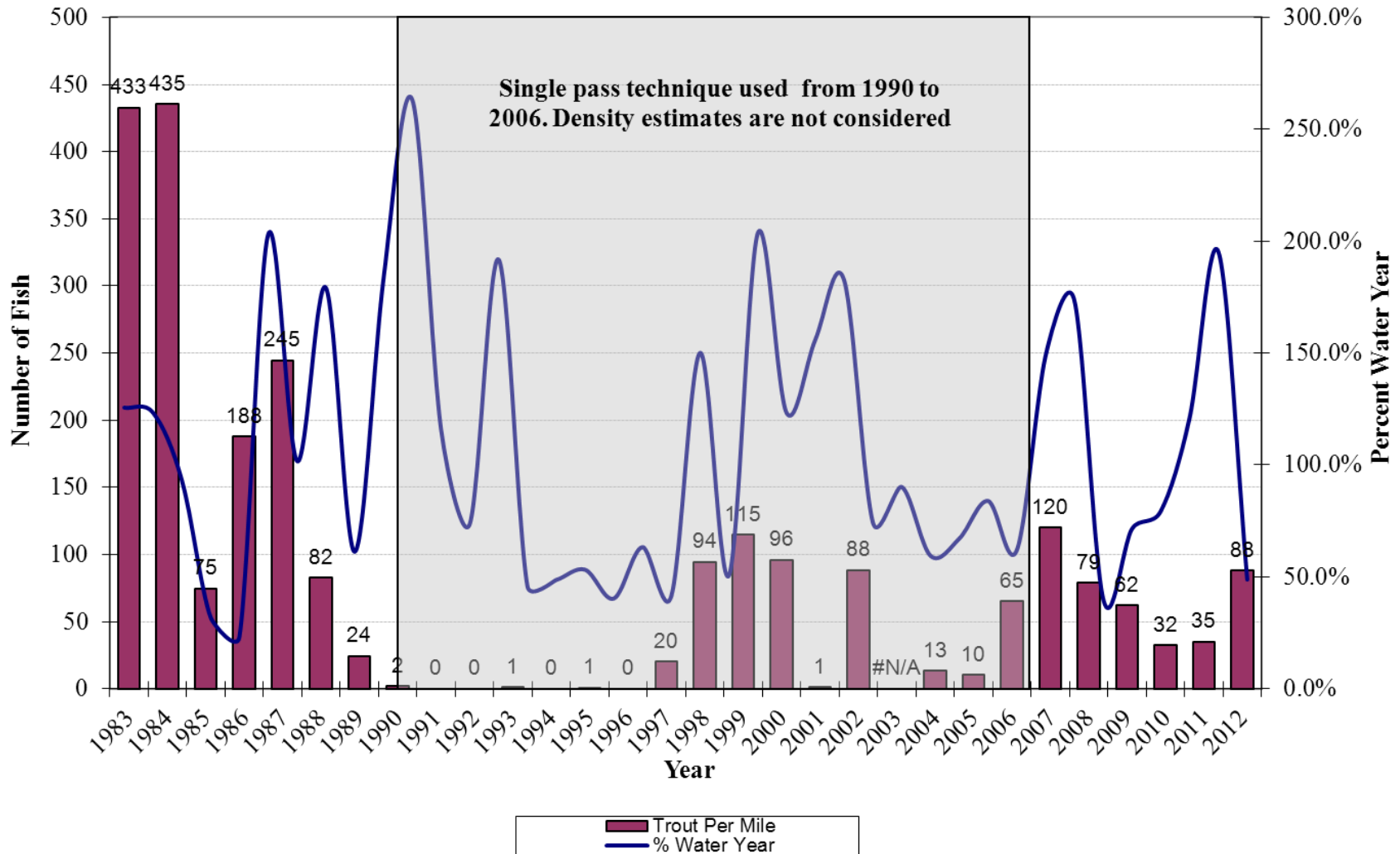


Figure 2: Estimated number of “wild” trout per mile in the Kings River between Pine Flat Dam and the Highway 180 bridge, Fresno County. Density is extrapolated from the number of wild trout collected from six sample sites located within the reach of the Kings River between Pine Flat Dam and the Highway 180 bridge. (Kings River Conservation District, 2011).

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 & Garvey 2007). In 2012, the total biomass collected was 70,084.5g (154.5lbs). Wild trout biomass totaled 2,577.5g (5.69lbs). This represents 3.7% of the total biomass collected during the survey. Sacramento sucker accounted for 77.9% of the biomass (54,567.8g; 120.3lbs). sculpin accounted for 12.6% of the total biomass with California roach, Sacramento pikeminnow, lamprey, hatchery trout, three-spined stickleback, mosquito fish and white catfish accounted for the final 5.8%. Biomass results for the 2012 survey are summarized by site in Table 7.

Table 7: Biomass summary, in pounds, by Site and Species.

Total Weight (lbs) - November 2012							
	Winton	Alta	Avo Boulder	Avo Side	Greenbelt	Wildwood	Total
California Roach	0.00	0.63	0.97	0.22	0.92	1.06	3.80
Hatchery Trout	0.00	0.00	0.93	0.00	0.00	0.00	0.93
Lamprey sp.	0.00	0.75	0.28	0.53	0.03	0.00	1.59
Mosquito Fish	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sacramento Pikeminnow	0.00	0.37	1.21	0.18	0.30	0.62	2.68
Rainbow Trout	1.13	0.18	1.36	1.37	1.65	0.00	5.69
Sacramento Sucker	2.53	5.26	83.43	17.23	3.48	8.37	120.30
Sculpin sp.	6.08	4.23	3.51	1.89	1.84	1.88	19.43
Three-spined Stickleback	0.00	0.04	0.01	0.02	0.00	0.02	0.09
White Catfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Site Total	9.7	11.5	91.7	21.4	8.2	12.0	154.5
Biomass %	5.3%	3.4%	72.0%	12.5%	3.0%	3.8%	100.0%

Length

The mean fork length for wild rainbow trout collected during the 2012 survey was 18.4cm (approx. 7.25 inches). Mean fork length for wild rainbow trout collected in 2011 was 25.5cm (approx. 10 inches). A significant (ANOVA, $p = 0.00$) decrease of 7.1cm subsequent to the 2011 survey was recorded amongst trout surveyed in 2012 (Figure 3). Mean length for the 2012 survey was not significantly different however from mean lengths observed during the 2007 through 2010 surveys. The length-frequency distribution from 2007 - 2012 is illustrated in Figure 4. Length frequency data for non-game species is located in Appendix B.

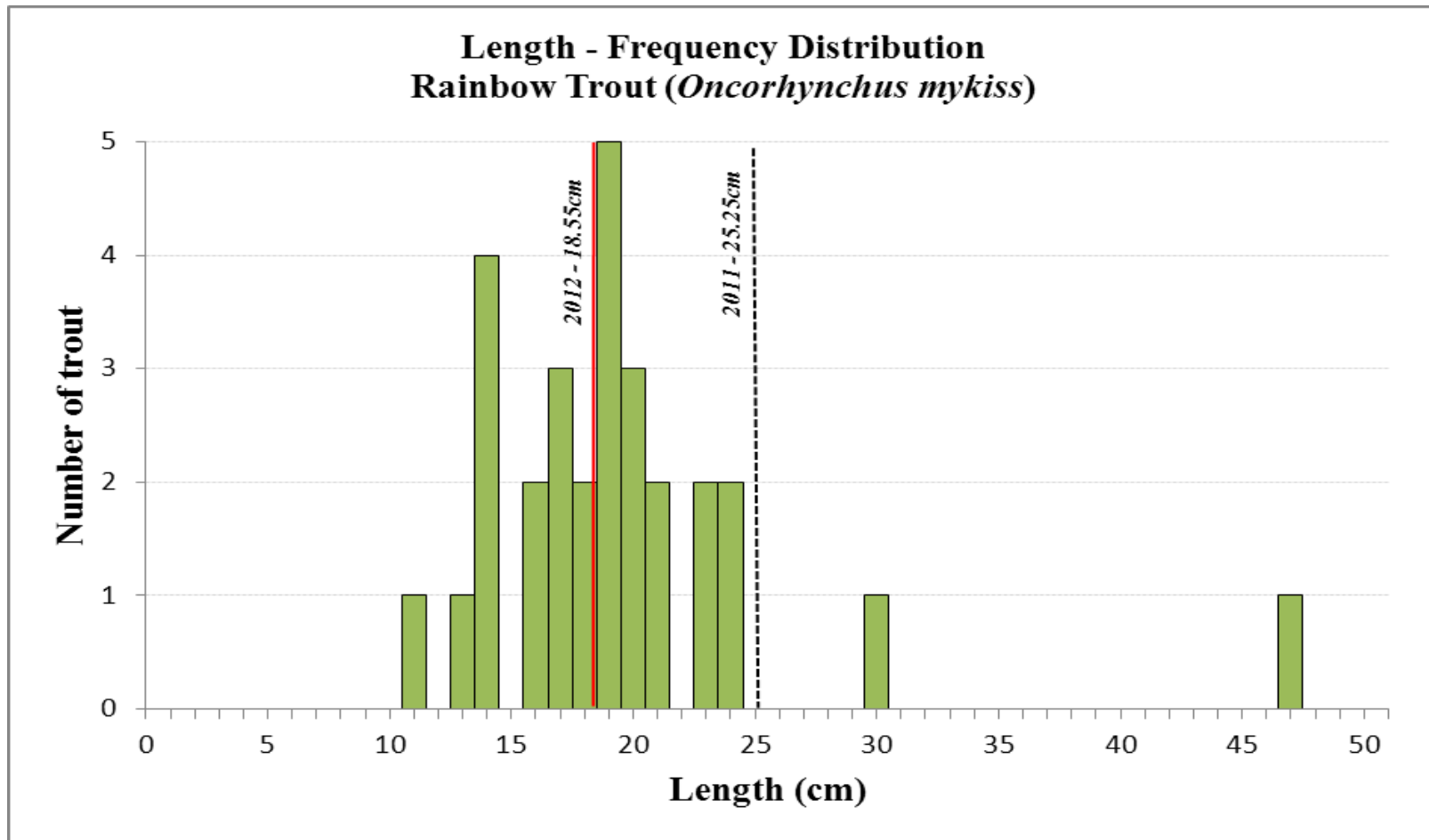


Figure 4: Length-frequency distribution of rainbow trout collected from the Kings River during the 2012 population survey, Fresno County. Average fork length of "wild" trout was approximately 7.5 inches (18.55cm). (Kings River Conservation District, 2011).

Age

Scale samples collected from 28 of the 30 wild rainbow trout in the field were analyzed in the lab. Counts of annuli and circuli produced approximate ages for the wild trout and two hatchery trout. Analysis of scales samples revealed ages ranging from 1 to 5 years for wild trout. One hatchery trout was estimated to be 3 years of age and the other was estimated to be 4 years of age. The median age of wild trout captured in 2012 was 2 years. A notable degree of variation has been observed amongst the annual median age of wild trout collected from 2007 through 2012 (Figure 5).

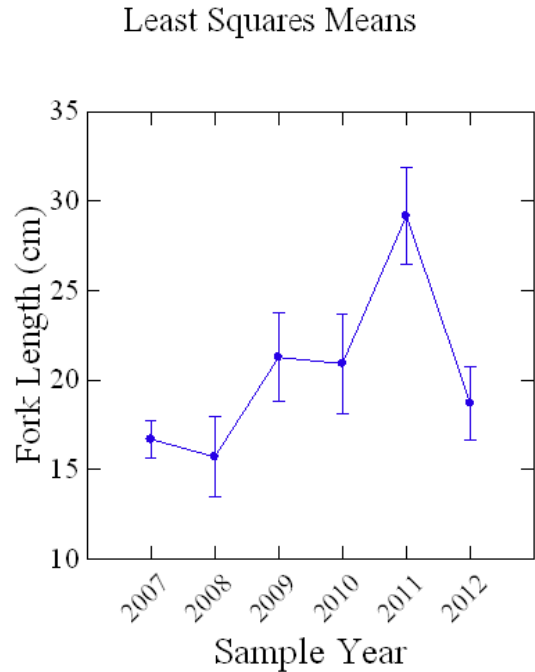


Figure 4: Median length of wild trout collected from the Kings River from Pine Flat Dam to the 180 Bridge; 2007 to 2012

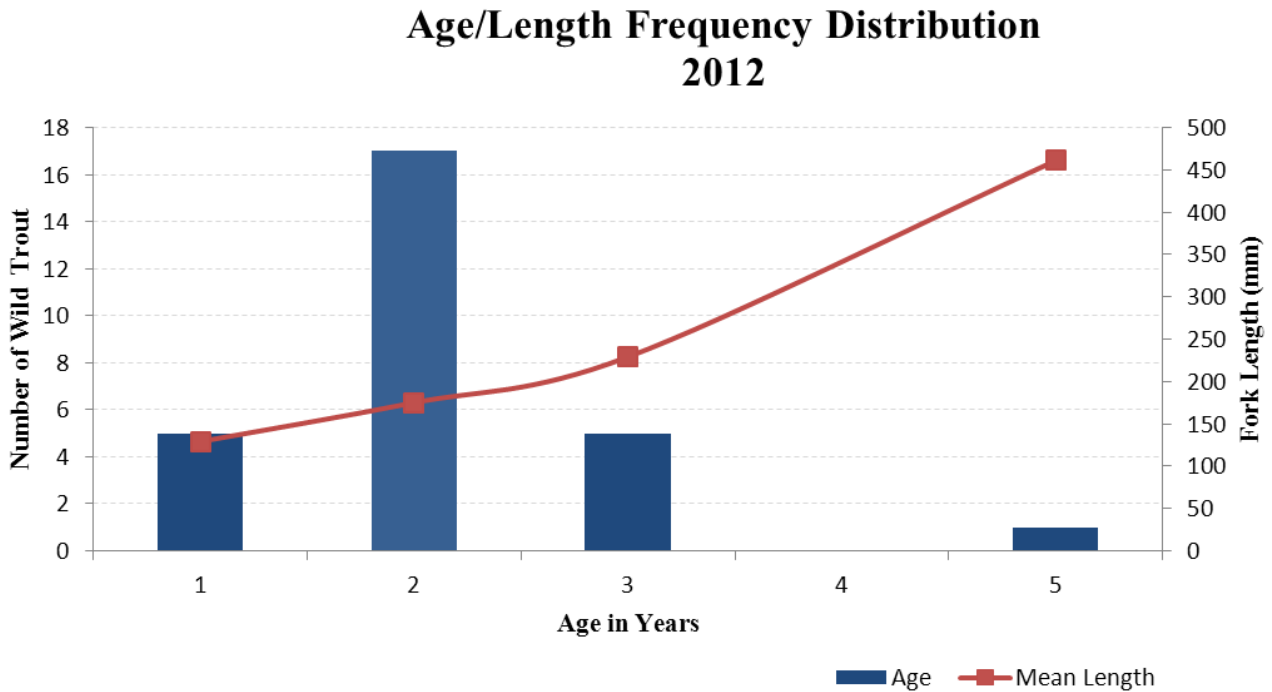


Figure 6: Age length comparison of wild trout sampled during the 2012 survey

Condition Factor

The condition factor of wild trout ranged from 0.67 (very poor) to 1.25 (excellent) with a sample mean of 0.98 (good). Results were not significantly lower (one-sample t-test; $P = 0.287$) than the 1.00 rating for rainbow trout. Of twenty-eight wild trout analyzed, a slight decline in condition factor was observed with increased age (Figure 7). The healthiest trout were collected from the Avocado Side Channel with an average K-factor of 1.15 ($n = 6$).

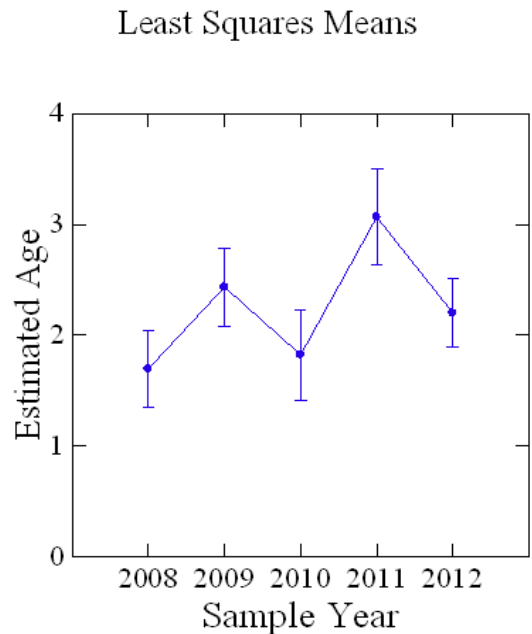
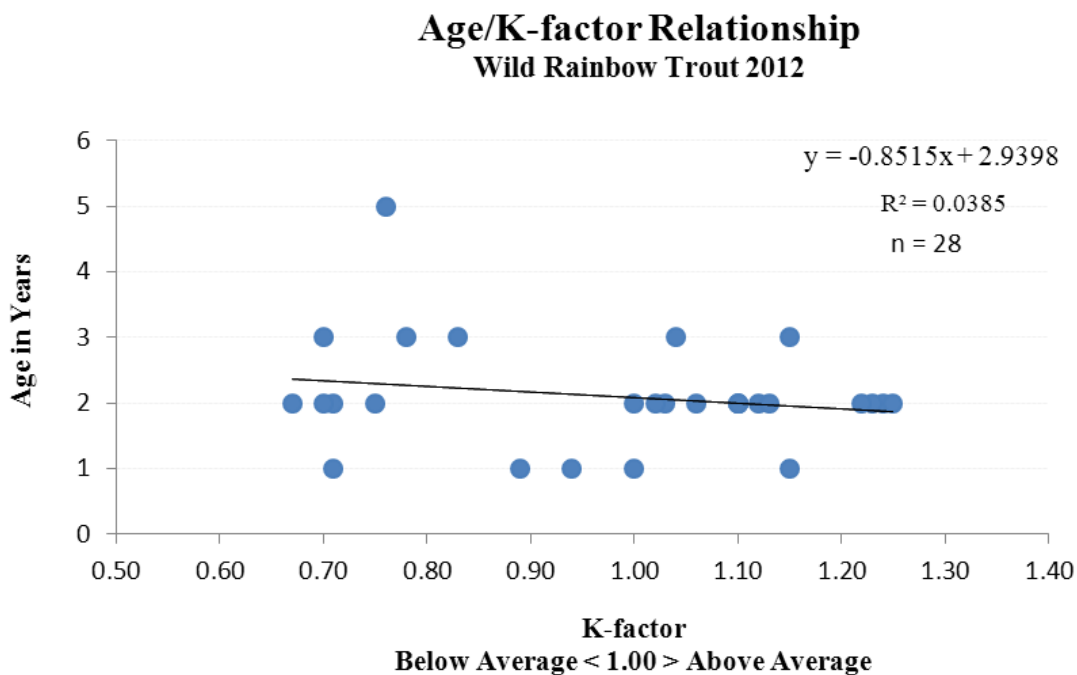


Figure 5: Median age of wild trout collected from the Kings River from Pine Flat Dam to the 180 Bridge; 2007 to 2012



Conclusion

This year marked the fifth year of multiple pass depletion sampling since the FMP returned to triple-pass depletion in 2007. In addition, this year marked the first year that the FMP initiated 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 catch numbers.

A total of 4,251 fishes were collected during the 2012 survey. An increase in abundance from the 2011 survey was observed in all eight of the regularly collected species. Standing stock continues to be dominated by the same two species; sculpin and Sacramento sucker.

Figure 7: Age/Condition factor relationship of wild trout 2012.

Sacramento sucker accounted for 39.6% of the total catch while sculpin accounted for 32.4%.

Wild rainbow trout accounted for less than 1 % (0.7%) of the total catch.

The total number of hatchery trout collected in 2012 decreased by 57% (from 7 in 2011 to 3 in 2012), however total abundance of trout increased by 232%. The total number of wild trout

collected during the survey (30) was up eighteen from the twelve wild trout collected in 2011(Kings River Conservation District, 2011). This translated to approximately eighty-eight trout per mile; the highest estimate collected since 2007. Variation in catch numbers amongst sites from 2007 to 2012 are illustrated in Figure 8.

Though the number of wild trout increased, overall fork-length decreased, which is consistent with a decline in age. Although smaller, on average, the wild trout collected in 2012 were in good condition. The mean age of wild trout was two years. Surprisingly, zero trout under one year of age have been collected in the past five years.

The Kings River Fisheries Management Program continues comprehensive monitoring and investigation within the tailwater fishery; pursuing a deeper understanding of those factors which drive population dynamics and variations in species richness within the river.

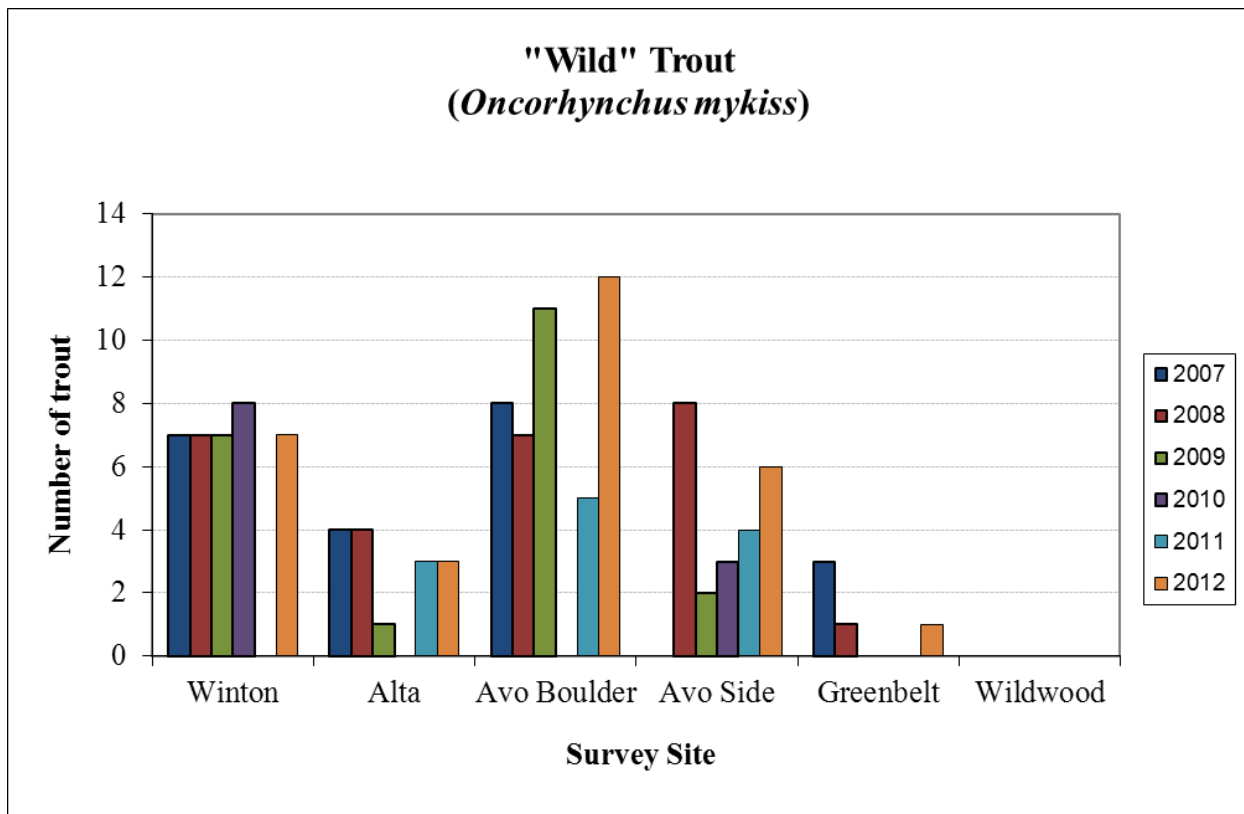


Figure 8: Analysis of within site variation of "wild" trout collected from 2007 to 2012. KRCD (Kings River Conservation District), 2011.

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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)						
Common Name	Winton	Alta	Avo Boulder	Avo Side	Greenbelt	Wildwood
California Roach	6 - 140	7 - 7	23 - 28	25 - 75	26 - 79	220 - 560
Green Sunfish	1 - 1	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0
Hatchery Trout	0 - 0	0 - 0	6 - 7	1 - 1	0 - 0	0 - 0
Lamprey sp.	0.0 - 0.0	3.4 - 4.9	5.0 - 6.6	5.1 - 5.7	0.0 - 0.0	0.0 - 0.0
Northern Pikeminnow	50 - 50	22 - 27	9 - 16	2 - 7	18 - 18	8 - 10
Rainbow Trout	0 - 0	3 - 8	5 - 8	4 - 5	0 - 0	0 - 0
Sacramento Sucker	63 - 1,198	98 - 128	68 - 115	44 - 71	13 - 19	77 - 293
Sculpin sp.	276 - 376	216 - 242	85 - 91	145 - 173	60 - 1,068	93 - 224
Three-spined Stickleback	9 - 390	38 - 72	9 - 11	4 - 7	1 - 1	3 - 8

Sample Year(i)	Sample Year(j)	Difference	p-Value	95% Confidence Interval	
				Lower	Upper
2008	2009	-0.739	0.004	-1.237	-0.241
2008	2010	-0.128	0.640	-0.668	0.412
2008	2011	-1.371	0.000	-1.932	-0.810
2008	2012	-0.504	0.035	-0.973	-0.036
2009	2010	0.611	0.027	0.071	1.152
2009	2011	-0.632	0.028	-1.193	-0.071
2009	2012	0.235	0.322	-0.233	0.703
2010	2011	-1.243	0.000	-1.842	-0.645
2010	2012	-0.376	0.148	-0.889	0.136
2011	2012	0.867	0.002	0.332	1.401

Appendix B

Table B – F: Catch per Unit of Effort by species; 2007 – 2011. 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

C.P.U.E. (fish/hr) 2007						
Common Name	Winton	Alta	Avo Boulder	Avo Side	Greenbelt	Wildwood
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
Hatchery Trout	1.2	2.3	0.3	0.7	0.0	0.0
Lamprey sp.	0.1	22.5	0.7	19.0	0.3	0.6
Northern Pikeminnow	11.9	2.2	10.1	21.8	25.6	53.6
Rainbow Trout	0.9	0.4	1.1	0.0	0.3	0.0
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

C.P.U.E. (fish/hr) 2008						
Common Name	Winton	Alta	Avo Boulder	Avo Side	Greenbelt	Wildwood
California Roach	0.0	1.2	12.8	2.8	29.5	40.8
Hatchery Trout	0.0	0.0	0.2	0.0	0.0	0.0
Kern Brook Lamprey	0.3	9.4	0.8	13.2	0.3	0.0
Mosquito Fish	0.0	0.4	0.0	0.0	0.0	0.0
Northern Pikeminnow	8.8	3.0	21.7	8.3	20.1	18.7
Rainbow Trout	1.1	0.8	1.1	1.4	0.1	0.0
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

C.P.U.E. (fish/hr) 2009						
Common Name	Winton	Alta	Avo Boulder	Avo Side	Greenbelt	Wildwood
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	13.7	3.4	1.0	6.0	38.9
Hatchery Trout	0.1	0.1	0.0	0.0	0.0	0.0
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
Rainbow Trout	0.9	0.1	1.3	0.3	0.0	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
Smallmouth 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

C.P.U.E (fish/hr) 2010						
Common Name	Winton	Alta	Avo Boulder	Avo Side	Greenbelt	Wildwood
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
Hatchery Trout	0.0	0.2	0.3	0.0	0.0	0.0
Lamprey sp.	0.0	8.9	1.0	6.7	0.2	0.7
Sacramento Sucker	1.3	2.0	4.3	1.7	8.7	11.2
Rainbow Trout	1.1	0.0	0.0	0.7	0.0	0.0
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

C.P.U.E (fish/hr) 2011						
	Winton	Alta	Avo Boulder	Avo Side	Greenbelt	Wildwood
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
Hatchery Trout	0.0	0.0	0.7	0.2	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
Rainbow Trout	0.0	0.6	0.6	0.7	0.0	0.0
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

C.P.U.E (fish/hr) 2012						
	Winton	Alta	Avo Boulder	Avo Side	Greenbelt	Wildwood
California Roach	0.0	3.4	9.3	4.0	15.2	19.9
Mosquito fish	0.0	0.0	0.0	1.2	0.0	0.0
Hatchery Trout	0.0	0.0	0.4	0.0	0.0	0.0
Lamprey sp.	0.0	9.5	2.7	10.2	0.5	0.0
Sacramento Pikeminnow	0.1	1.5	19.9	22.6	8.1	17.1
Rainbow Trout	0.9	0.3	1.4	0.8	0.1	0.0
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