Steelhead Population Assessment in the

Ventura River / Matilija Creek Basin

2008 Summary Report

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INTRODUCTION

The Ventura River Basin is a large southern California watershed that historically provided abundant habitat for the now endangered southern steelhead (*Oncorhynchus mykiss*) (Moore 1980). Ocean migrant steelhead are reported to have utilized the mainstem Ventura River, as well as the principal subbasins including the Coyote Creek basin, the San Antonio Creek basin, the lower North Fork Matilija Creek basin, and the upper Matilija Creek basin. The amount of habitat available to anadromous steelhead for spawning and rearing declined over time with the construction of water supply facilities, such as Matilija Dam in 1947 (blocking access to the upper Matilija basin), Casitas Dam in 1957 (blocking access to the Coyote Creek basin), and Robles Diversion Dam in 1958, which until recently effectively blocked access to the upper portion of the Ventura River and the lower North Fork Matilija Creek. In addition, habitat has been impaired by other anthropomorphic activities such as point/non-point waste discharges, periodic channel modifications, and encroachment of development into the riparian corridor. In 2004, a new fish passage facility was constructed in Robles Diversion Dam, which gives access to several miles of important spawning and rearing habitat (TRPA 2004), and sets the stage for the restoration of upper Matilija Creek. Matilija Dam was constructed for the purpose of supplying water storage and flood control, but reservoir sedimentation and construction of newer projects has reduced the necessity of the dam, and efforts are currently underway to restore access to the upper Matilija basin through removal of Matilija Dam (NMFS 2007).

Thomas R. Payne & Associates (TRPA) was contracted by the Ventura County Flood Control District (County) to conduct detailed habitat analyses above and below Matilija Dam to help assess the benefits of dam removal to southern steelhead (TRPA 2003, 2004). TRPA was subsequently awarded, with County sponsorship, grant funds in 2006 and 2007 through the California Department of Fish & Game's (CDFG) Fisheries Restoration Grant Program (FRGP) to conduct basin-wide distribution and abundance surveys of juvenile steelhead (TRPA 2007, 2008). In 2008, TRPA continued the steelhead surveys using remaining funds from the FRGP, with additional financial assistance from the County, CDFG's Adaptive Watershed Initiative Program, Patagonia's Environmental Grants program, and Surfrider Foundation. The 2008 survey was more limited in scope than the 2006 and 2007 surveys, but was designed to provide statistically rigorous and directly comparable abundance estimates for comparison with the earlier datasets.

METHODS

The 2008 study replicated the 2006 and 2007 fish population sampling by returning to the same mesohabitat units in ten study sites sampled in 2006 and 2007, except that only the deeper-water mesohabitat types (e.g., pools and large channel flatwaters) were sampled by direct observation (i.e., snorkeling) methodologies. In previous years, electrofishing was employed to sample shallow water mesohabitat types (e.g., riffles and small channel flatwaters), but budget and permitting constraints limited 2008 sampling to mesohabitat units that could be effectively surveyed by divers. For a detailed description of the 10 study sites, the dive counting protocols, and general estimation procedures used in 2008, refer to the 2007 report (TRPA 2008). This description of methods will only detail differences in estimators used for some study sites in 2008.

The 2008 estimates of abundance of *O. mykiss* fry (<10cm FL) and juvenile+ ($\geq$10cm) are directly compared to the 2006 and 2007 results according to three spatial scales:

1. *mesohabitat type*: pools or (in larger channels only) flatwaters;
2. *study site*: see Figure 1 for location of the 10 study sites; and
3. *basin segment*: lower segment is below Robles Diversion Dam, middle segment is between Robles DD and Matilija Dam, upper segment is above Matilija Dam

Estimates of abundance were converted to density as number of fish/100ft^2 by reference to mesohabitat unit dimensions (i.e., measured lengths and widths).

Statistical comparison of abundance between mesohabitat types, study sites, or years (2006 vs. 2007) was visually assessed by overlap (or lack thereof) of 95% confidence intervals. Statistical comparison of annual differences between 2007 and 2008 were improved by using difference formulas according to the principles of "Sampling on Repeated Occasions" (Cochran 1977). These estimators utilize the expected correlation in counts of fish in individual sampling units between years to reduce estimated variances, e.g., pools having a relatively high count of fish in year 1 would be expected to also have a relatively high count in year 2. When this correlation is positive and sufficiently high, the ability to discern statistically significant differences in abundance between years can be greatly improved.

It must be noted that the given estimates of abundance by basin segment does not encompass several significant tributaries, such as Coyote Creek, Murietta Creek, and Old Man Creek. Nor do the estimates encompass habitat located above terminal barriers, as defined in TRPA 2003. Although sampling did occur in a San Antonio Creek study site in 2007 (using qualitative electrofishing) and in 2008 (using quantitative dive counts), those estimates of abundance were not statistically compared.

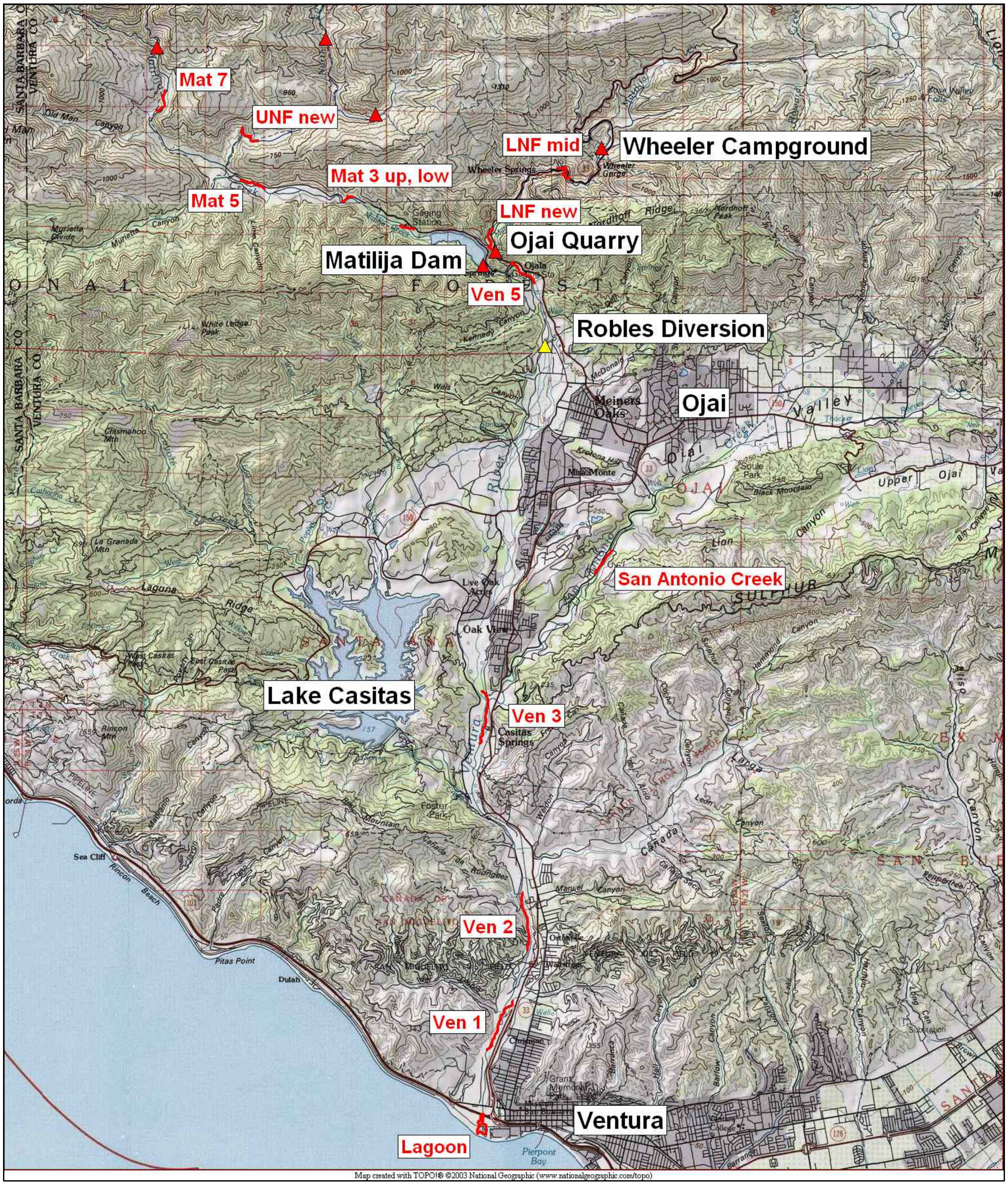

Figure 1. Map of Ventura/Matilija Basin showing landmarks, study sites (red lines), and impassable barriers (red triangles).

RESULTS

Fish sampling was conducted in the Ventura/Matilija basin from 3-11 September 2008, which was 4-6 weeks later than surveys conducted in 2006 and 2007. Basic sampling statistics for each study site are presented in Table 1. Overall, 96 pool habitat units and 32 flatwater units were sampled (flatwaters in the mainstem Ventura River only), resulting in a total dive count of 104 *O. mykiss* fry (<10cm FL) and 865 juvenile+ (≥10cm) fish. The fish sampling results are presented as abundance (total # of fish) and as density (#/100 ft^2) for each study site (according to each mesohabitat type or combined across mesohabitat types), and for each study segment (expanded and combined across study sites) in Table 2. Habitat mapping data for each study site can be found in TRPA 2008). Photographs of each sampling unit can be made available on CD upon request.

Table 1. Summary of sampling statistics according to segment and study site.

Reach	Dates	Zone	# Sampling Units Pools	# Sampling Units Flatwaters	Est Flow cfs	Water Temps °C Min	Water Temps °C Max	# O. mykiss (cm) ** <10	# O. mykiss (cm) ** 10+
Ven 1	3-4 Sep	Anadromous	7	8	14.6	20	27	0	0
Ven 2	6-7 Sep	Anadromous	6	8	16.6	20	25	0	0
Ven 3	4-5 Sep	Anadromous	5	8	9.9	18	23	25	685
San Antonio *	5,11 Sep	Anadromous	19	0	1.7	19	24	9	28
Ven 5	8 Sep	Anadromous	8	8	10.3	20.5	25	6	42
LNF new	10 Sep	Anadromous	8	0	0.8	18.5	19	12	16
LNF mid	10 Sep	Anadromous	8	0	1.1	18	18.5	16	47
Mat 3	8-9 Sep	Resident	8	0	-	19	28	0	2
Mat 5	9 Sep	Resident	10	0	3.1 - 0.0	18	25	1	9
Mat 7	10 Sep	Resident	9	0	1.4	18	21.5	9	27
UNF new	11 Sep	Resident	8	0	1.7	15	17	26	9
Totals		**Lower**	37	24	-	18	27	34	713
		Middle	24	8	-	15	25	34	105
		Upper	35	0	-	15	28	36	47
		Basin	96	32	-	15	28	104	865

* data pooled from one random and two non-random reaches

** numbers from first-pass dive counts only

Streamflows during the September 2008 survey were approximately 2x-5x greater than flows encountered during the July-Aug 2007 survey, but were only $^1/_2$ to $^1/_3$ of the flows present during the July-Aug 2006 survey (Figure 2). Maximum water temperatures measured during sampling in 2008 were generally 1-3°F cooler than in 2007 and 0-2°F cooler than in 2006. Note that these temperature measurements are spot measurements only and may not reflect overall differences in annual summertime temperatures in this basin.

Like most central and southern California basins, seasonal rainfall and associated streamflows in the Ventura River Basin are highly variable. Large differences in streamflows and in the overall availability and quality of fish habitat occurred between 2005 and 2008. In 2005, the year preceding the initial fish survey, winter flows were very high, with a January flood peak of over 40,000 cfs and a February peak flow over 10,000 cfs, which sustained summer flows well above normal (average July-October flows at Foster Park are <10cfs). In 2006, flows were lower than normal during the winter, but late-season storm events occurred during the March and April spawning/incubation periods (April peak flows exceeded 9,000 cfs), which again resulted in higher than normal flows throughout the summer months. Flows were high enough during the July 2006 survey to sample the Ven 4 study site just below the Robles Diversion Dam, which is an area typically dry during the summer months (Figure 1). Streamflows throughout the late-winter, spring, and summer of 2007 were very low at only one-half or less of the mean flows in most months. Two winter storm events in January 2008 produced flows of 1,300 to 6,000 cfs in the Ventura River that carried over into moderate summer slows during the late-summer sampling period.

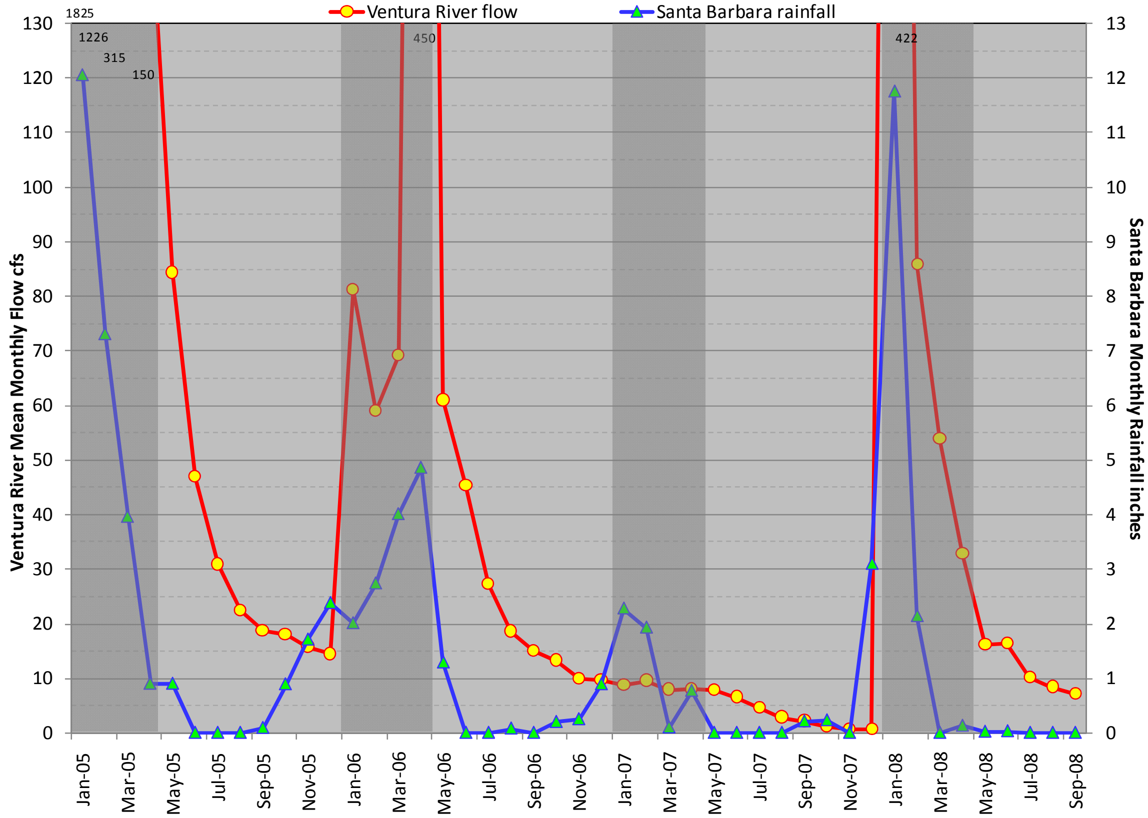

Figure 2. Mean monthly flows (cfs) in the Ventura River at Foster Park (USGS gage #8500) and total monthly rainfall at Santa Barbara (inches), 2005-2008. Shaded areas approximate the spawning and incubation periodicity for steelhead and rainbow trout.

Abundance of *O. mykiss* was estimated in each sampled habitat unit using single pass dive counts in pools in all study sites and in flatwater habitats in all mainstem Ventura River study sites. All riffles and all flatwaters in the tributary sites and the mainstem Matilija Creek sites were too shallow to effectively sample by snorkeling. Single-pass dive counts were calibrated with a subsample of multiple-count habitat units. The basic fish statistics for each study site and habitat type are shown in Table 2, with associated figures for abundance and density in #/100ft^2 for *O. mykiss* fry (<10cm FL) and juvenile+ (see below). Estimates pooled among study sites to represent abundance and density at the study segment scale are also presented. Photos of each habitat unit sampled in 2008 are available on CD by request; for photos representative of each study site see prior reports (TRPA 2007, 2008).

Table 2. 2008 fish abundance estimates according to study site.

Size Class	Habitat Type	Statistic	Ven 1	Ven 2	Ven 3	Ven 4	Ven 5	LNF new	LNF mid	Mat 3	Mat 5	Mat 7	UNF new
Fry <10cm	Pools	# Units Sampled	7	6	5	0	8	8	8	8	10	9	8
		Abundance	0	0	28	0	8	69	70	0	1	38	149
		Variance	0	0	23	0	19	152	259	0	0	332	393
		95% C.I.	0	0	13	0	10	29	38	0	0	42	47
		Density (#/mi)	0.0	0.0	108.3	0.0	40.9	237.0	331.5	0.0	17.8	186.0	871.6
		Variance (#/mi)	0	0	350	0	502	1793	5813	0	0	7814	13423
		95% C.I. (#/mi)	0.0	0.0	52.0	0.0	53.0	100.1	180.3	0.0	0.0	203.8	274.0
		Density (#/100ft^2)	0.00	0.00	0.07	0.00	0.03	0.33	0.58	0.00	0.02	0.21	1.72
		Variance (#/100ft^2)	0.0000	0.0000	0.0001	0.0000	0.0002	0.0035	0.0179	0.0000	0.0000	0.0099	0.0522
		95% C.I. (#/100ft^2)	0.00	0.00	0.03	0.00	0.04	0.14	0.32	0.00	0.00	0.23	0.54
	Flatwaters	# Units Sampled	8	8	8	0	8	n/a	n/a	n/a	n/a	n/a	n/a
		Abundance	0	0	54	0	33	-	-	-	-	-	-
		Variance	0	0	4104	0	829	-	-	-	-	-	-
		95% C.I.	0	0	151	0	68	-	-	-	-	-	-
		Density (#/mi)	0.0	0.0	116.5	0.0	136	-	-	-	-	-	-
		Variance (#/mi)	0.00	0.00	19,108	0	14,599	-	-	-	-	-	-
		95% C.I. (#/mi)	0.0	0.0	326.9	0.0	286	-	-	-	-	-	-
		Density (#/100ft^2)	0.00	0.00	0.11	0.00	0.11	-	-	-	-	-	-
		Variance (#/100ft^2)	0.0000	0.0000	0.0158	0.0000	0.0092	-	-	-	-	-	-
		95% C.I. (#/100ft^2)	0.00	0.00	0.30	0.00	0.23	-	-	-	-	-	-
Juv+ $\geq$10cm	Pools	# Units Sampled	7	6	5	0	8	8	8	8	10	9	8
		Abundance	0	0	806	0	97	100	208	5	12	151	52
		Variance	0	0	28459	0	769	1259	3013	1	4	3689	215
		95% C.I.	0	0	468	0	66	84	130	3	5	140	35
		Density (#/mi)	8	0.0	3,163.6	0.0	496.1	345	986	38.6	200	733.5	304.9
		Variance (#/mi)	0	0.00	438,569	0	20,090	14,897	67,571	82.92	1,085	86,871	7,337
		95% C.I. (#/mi)	0	0.0	1,838.7	0.0	335.2	289	615	21.5	75	679.7	202.5
		Density (#/100ft^2)	0.00	0.00	2.02	0.00	0.34	0.48	1.73	0.03	0.26	0.83	0.60
		Variance (#/100ft^2)	0.0000	0.0000	0.1783	0.0000	0.0097	0.0293	0.2078	0.00004	0.0019	0.1104	0.0286
		95% C.I. (#/100ft^2)	0.00	0.00	1.17	0.00	0.23	0.40	1.08	0.02	0.10	0.77	0.40

Table 2. (continued).

Size Class	Habitat Type	Statistic	Ven 1	Ven 2	Ven 3	Ven 4	Ven 5	LNF new	LNF mid	Mat 3	Mat 5	Mat 7	UNF new
Juv+ ≥10cm	Flatwaters	# Units Sampled	8	8	8	0	8	n/a	n/a	n/a	n/a	n/a	n/a
		Abundance	0	0	414	0	143	-	-	-	-	-	-
		Variance	0	0	96404	0	3138	-	-	-	-	-	-
		95% C.I.	0	0	734	0	132	-	-	-	-	-	-
		Density (#/mi)	0.0	0.0	893.0	0.0	600	-	-	-	-	-	-
		Variance (#/mi)	0.00	0.00	448,846	0	55,271	-	-	-	-	-	-
		95% C.I. (#/mi)	0.0	0.0	1,584.2	0.0	556	-	-	-	-	-	-
		Density (#/100ft²)	0.00	0.00	0.81	0.00	0.48	-	-	-	-	-	-
		Variance (#/100ft²)	0.0000	0.0000	0.3721	0.0000	0.0350	-	-	-	-	-	-
		95% C.I. (#/100ft²)	0.00	0.00	1.44	0.00	0.44	-	-	-	-	-	-
All O. mykiss	Pools	# Units Sampled	7	6	5	0	8	8	8	8	10	9	8
		Abundance	0	0	833	0	105	169	278	5	13	189	201
		Variance	0	0	28481	0	788	1411	3273	1	4	4020	609
		95% C.I.	0	0	469	0	66	89	135	3	5	146	58
		Density (#/mi)	0.0	0	3,272	0.0	537	582	1,318	39	218	920	1,176
		Variance (#/mi)	0	0	438,919	0	20,591	16,690	73,384	83	1,085	94,686	20,760
		95% C.I. (#/mi)	0	0	1,839	0.0	339	305	641	22	75	710	341
		Density (#/100ft²)	0.0000	0.000	2.086	0.00	0.37	0.82	2.31	0.03	0.28	1.04	2.32
		Variance (#/100ft²)	0.0000	0.000000	0.1785	0.0000	0.0099	0.0328	0.2257	0.00004	0.0019	0.1203	0.0808
		95% C.I. (#/100ft²)	0.000	0.000	1.173	0.00	0.24	0.43	1.12	0.02	0.10	0.80	0.67
All O. mykiss	Flatwaters	# Units Sampled	8	8	8	0	8	n/a	n/a	n/a	n/a	n/a	n/a
		Abundance	0	0	468	0	176	-	-	-	-	-	-
		Variance	0	0	100508	0	3966	-	-	-	-	-	-
		95% C.I.	0	0	750	0	149	-	-	-	-	-	-
		Density (#/mi)	0.0	0	1,010	0.0	737	-	-	-	-	-	-
		Variance (#/mi)	0	0	467,953	0	69,870	-	-	-	-	-	-
		95% C.I. (#/mi)	0	0	1,618	0.0	625	-	-	-	-	-	-
		Density (#/100ft²)	0.0000	0.000	0.919	0.00	0.59	-	-	-	-	-	-
		Variance (#/100ft²)	0.0000	0.000000	0.3880	0.0000	0.0442	-	-	-	-	-	-
		95% C.I. (#/100ft²)	0.000	0.000	1.473	0.00	0.50	-	-	-	-	-	-

The relative proportion of each size class (fry <10cm FL and juvenile+ ≥10cm FL) differed dramatically each year (Figure 3). These visually-estimated size classes may grossly represent the proportion of 0+ young-of-year *O. mykiss* vs. 1+ and older juvenile/adult fish, however previous length-frequency distributions based on actual measured fish showed considerable overlap in what appeared to be young-of-year fish and older fish, as well as significant differences in length-frequency distributions between mainstem study sites (with larger fish) and upper tributary sites (with smaller fish) (TRPA 2007). Also, because the 2008 sampling was conducted 4-6 weeks after the 2006 and 2007 surveys, the proportion of fry that grew into the juvenile+ size class (e.g., grew larger than 10cm) is expected to be higher in 2008. Despite these differences, the dive-based size frequency distributions strongly suggest that the 2008 *O. mykiss* population was dominated by juvenile+ fish, likely due in part to the relatively strong year class of fry observed in the preceding year.

Lower Segment

The lower segment is represented by four one-mile study sites on the mainstem Ventura River below Robles Diversion Dam (Figure 1). The estimated abundance of fry and juvenile+ *O. mykiss* has been zero or near zero in the lower segment during the preceding two years of study (TRPA 2008), however in 2008 *O. mykiss* were very abundant in the Ven 3 study site near the San Antonio Creek confluence. The dramatic difference in abundance of *O. mykiss* in Ven 3 over the three-year period illustrates both the potential rearing capacity of the mainstem Ventura River (at least in the Casitas "live reach"), and the high magnitude of natural variability that can be exhibited by *O. mykiss* populations in a Southern California watershed.

In contrast to *O. mykiss*, the native fish species arroyo chub (*Gila orcutti*) and threespine stickleback (*Gasterosteus aculeatus*) were observed in most pool and flatwater habitats in the lower segment, and the exotic carp (*Cyprinus carpio*) was common throughout the Ven 1 and Ven 2 study sites. Native sculpin (*Cottus* spp.) and exotic mosquitofish (*Gambusia*) were occasionally observed in the lowermost reaches.

Ven 1. No fry or juvenile+ *O. mykiss* were observed in the Ven 1 study site in 2008, resulting in estimates of abundance (Figure 4) and density (Figure 5) of zero for both size classes. Abundance estimates were likewise zero for fry and juveniles in 2006 and 2007 (Figures 6 and 7), although two adult steelhead were observed during the 2007 dive counts (TRPA 2008). Two pool habitats contained small pockets (4-8 ft^2) of water 1-3^{o}C cooler than the surrounding water. One of these pockets held an adult steelhead in 2007; however these cool-water areas were devoid of salmonids during the 2008 survey.

Ven 2. In 2006, occasional observations of *O. mykiss* produced estimates of abundance of two fry and two juvenile+ in Ven 2 riffles, however no salmonids were observed in either 2007 (all habitat types) or 2008 (pools and flatwaters only).

Ven 3. The Ven 3 study site occurs in a region of rising groundwater, which historically provided rearing habitat and high productivity for juvenile trout and steelhead (Moore

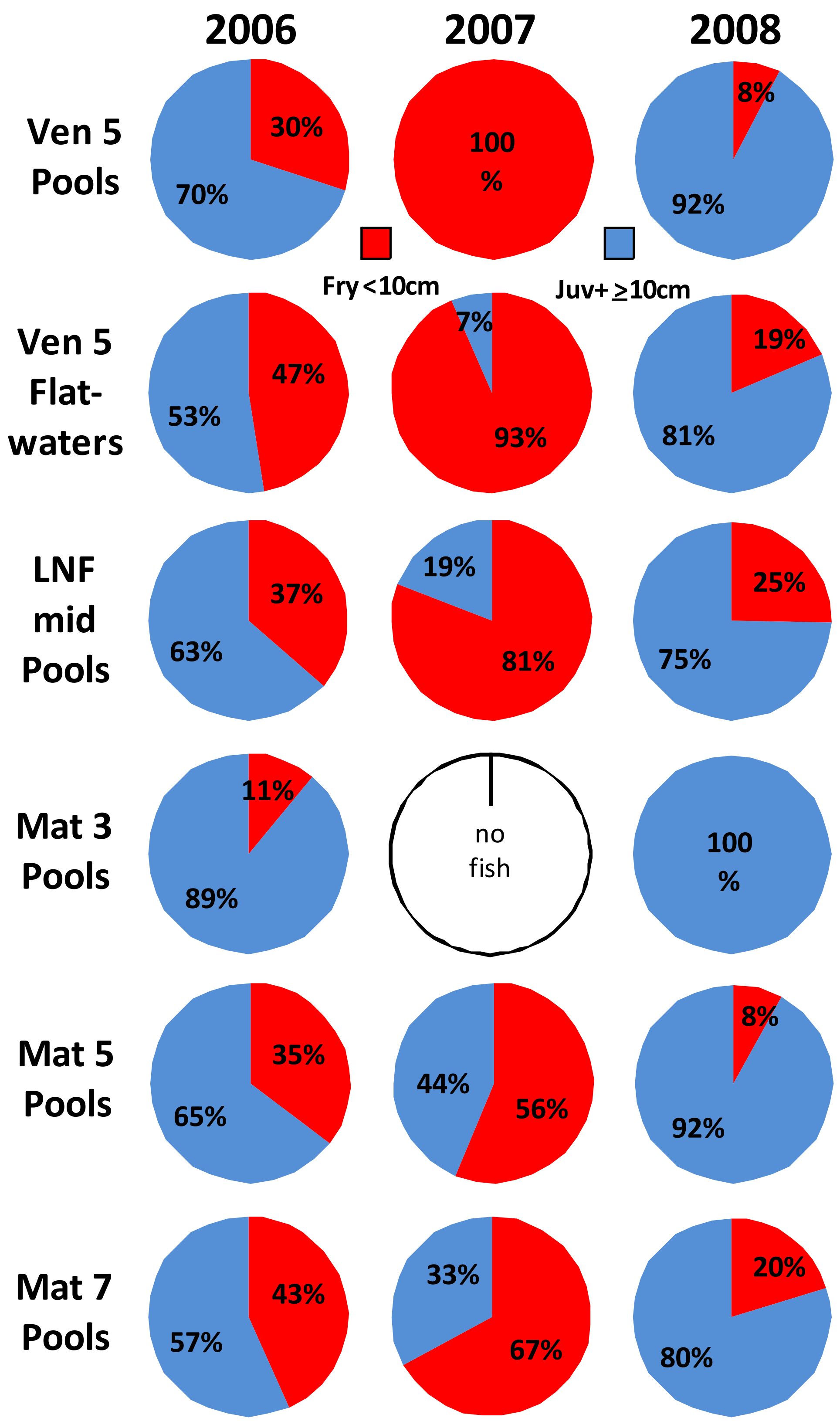

Figure 3. Relative proportion of *O. mykiss* fry and juvenile+ by year and study site.

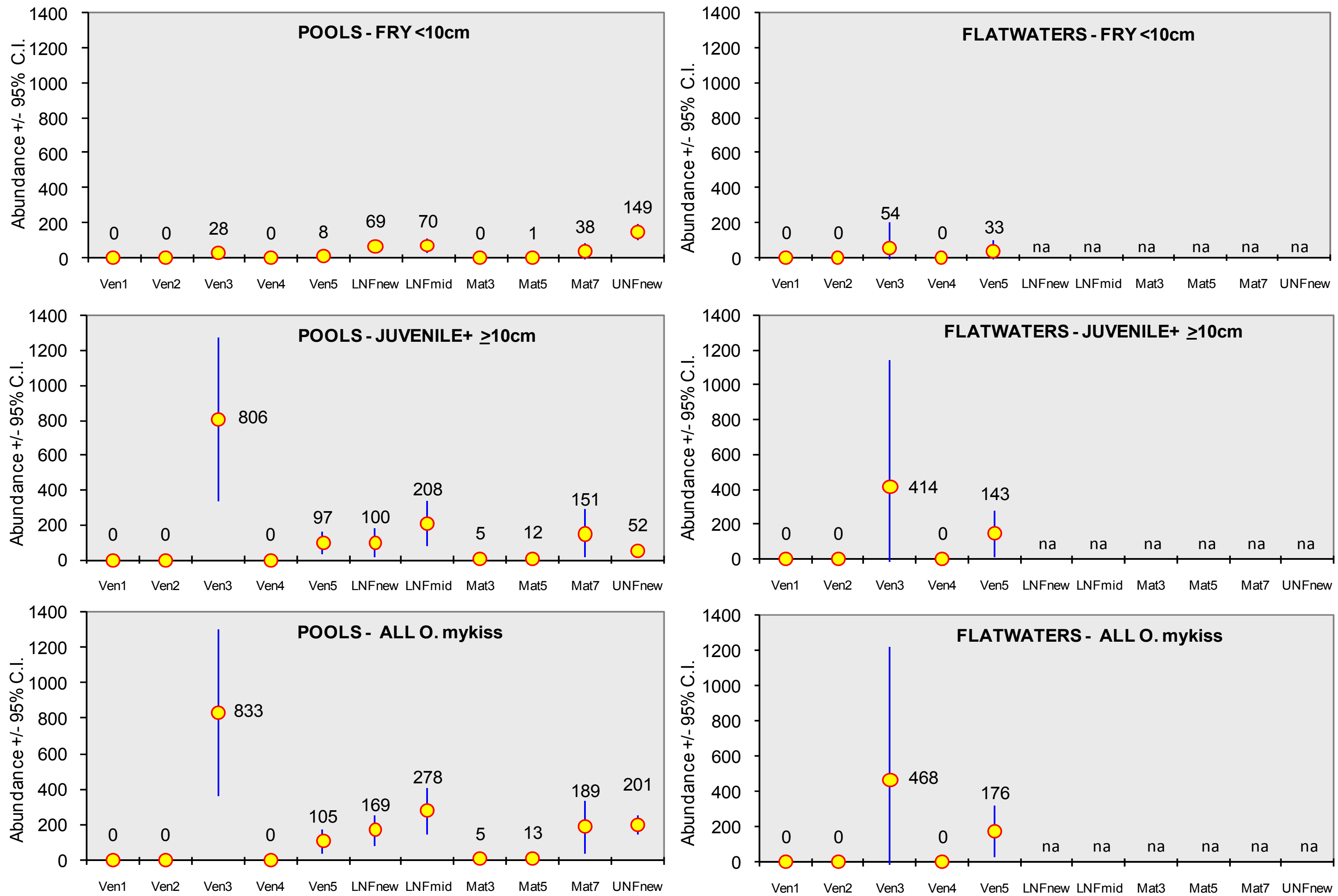

Figure 4. Estimated abundance of *O. mykiss* fry, juvenile+, and combined sizes according to study site and habitat type.

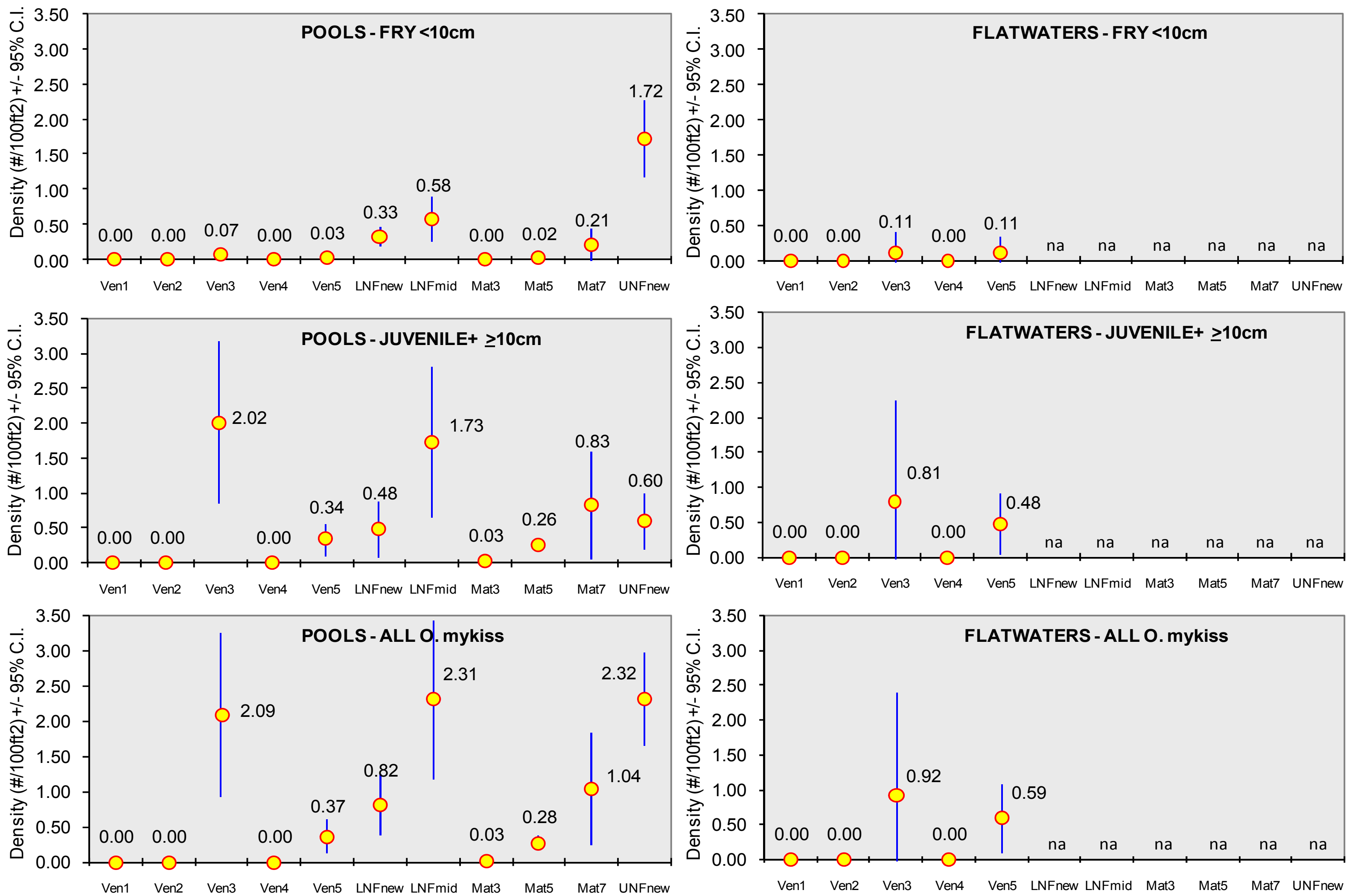

Figure 5. Estimated density (#/100ft^2) of *O. mykiss* fry, juvenile+, and combined sizes according to study site and habitat type.

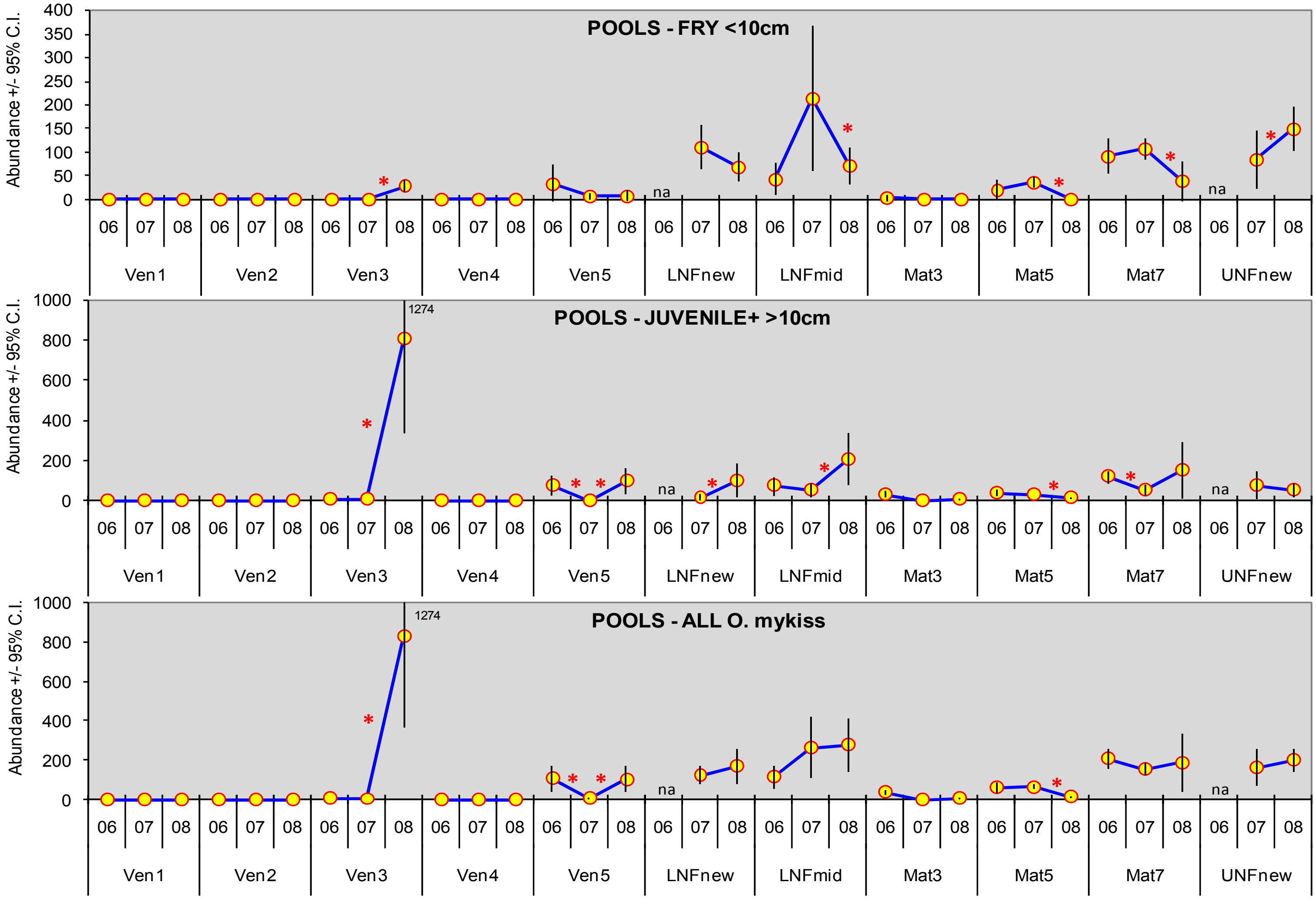

Figure 6. Estimated density (#/100ft^2) of *O. mykiss* fry, juvenile+, and combined sizes in pools according to study site and year. Asterisks indicate statistically significant differences between adjacent years.

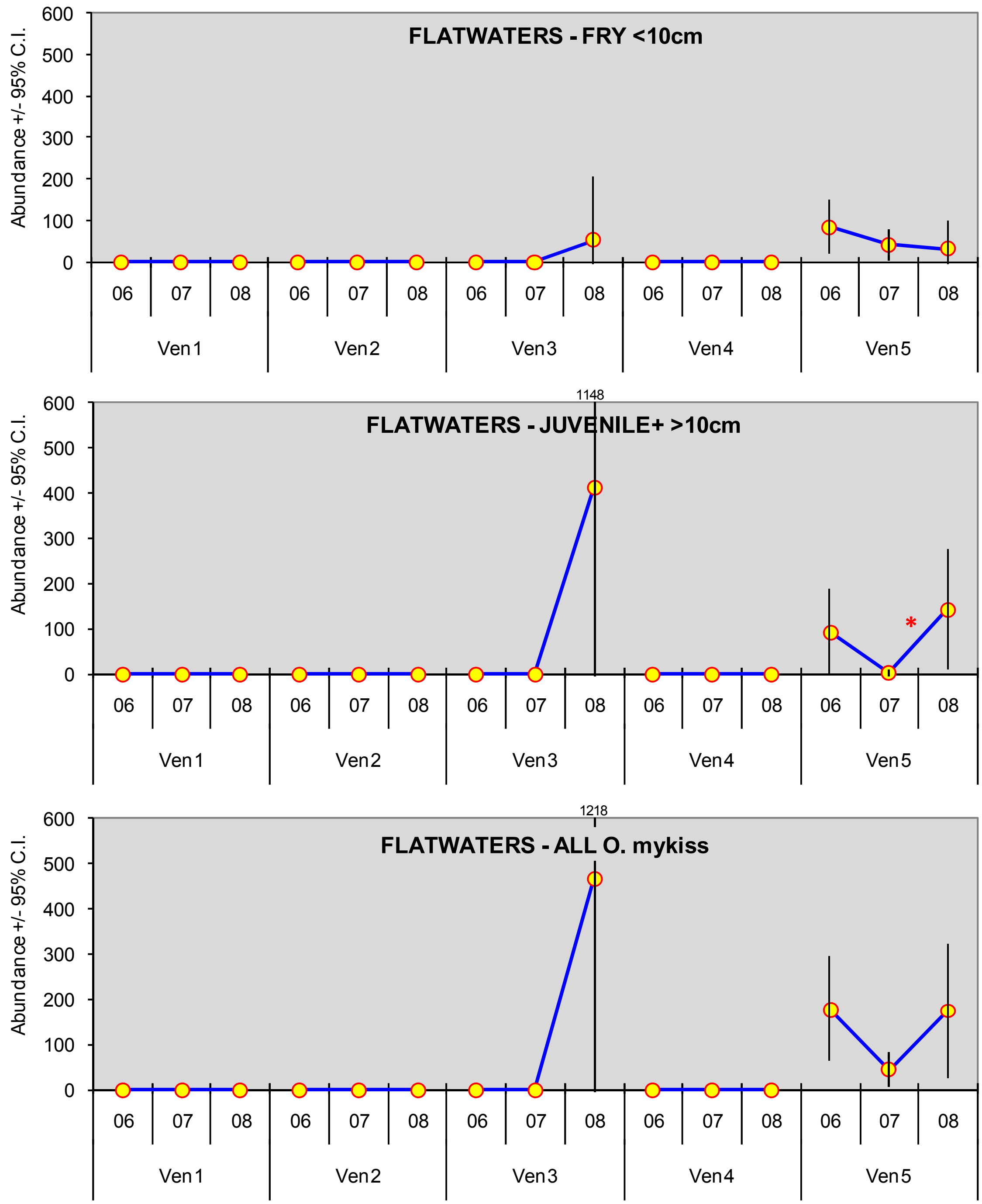

Figure 7. Estimated density (#/100ft^2) of *O. mykiss* fry, juvenile+, and combined sizes in flatwaters according to study site and year (flatwaters only sampled in Ventura River study sites). Asterisks indicate statistically significant differences between adjacent years.

1980). However, recent surveys in 2006 and 2007 suggested very limited rearing with low densities of *O. mykiss* in the Ven 3 study site (TRPA 2008). The 2008 survey, in contrast, revealed that *O. mykiss* were *very* abundant in the Ven 3 reach, particularly among the juvenile+ size class (Table 2). An estimated 28 fry (±13, 95% confidence interval) and 806 juvenile+ (±468) occurred in Ven 3 pool habitats, with 54 (±151) additional fry and 414 (±734) juvenile+ fish in flatwaters (Figure 4). The associated densities (in #/100ft^2) are shown in Figure 5. As noted above, the late timing of the 2008 survey likely resulted in many *O. mykiss* fry (or, young-of-year fish) growing into the juvenile+ size class.

Note that these estimates do not include estimates of fish abundance in riffles, which were not sampled in 2008. In the two prior years when densities were estimated for all three habitat types, riffles contained on average about 50% of the fry population, whereas flatwaters contained about 35% and pools only 15% (Figure 8). Juveniles were more evenly distributed among habitat types, with a slight majority (38%) in pools. These proportions were relatively similar between the high flow year of 2006 and the low flow year of 2007. Consequently, the 2008 estimates listed above do not include a potentially significant number of *O. mykiss* that inhabited Ven 3 riffle habitats.

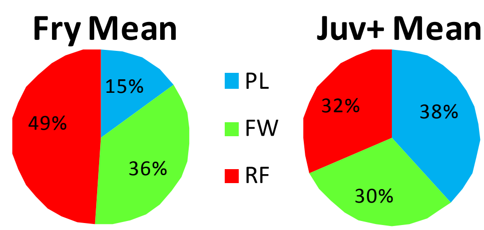

Figure 8. Mean relative proportion of *O. mykiss* fry (<10cm) and juvenile+ (≥10cm) found in pools, flatwaters, and riffles in 2006 and 2007, all study sites combined.

These 2008 abundance estimates were significantly greater than the 2006 and 2007 estimates for both fry and juvenile+ size classes in pool habitats (Figure 6). The estimates of abundance for flatwaters also increased dramatically in 2008 (Figure 7), but high variability in counts produced wide confidence intervals that encompassed zero (although counts were obviously much greater in 2008). The 2008 densities of >2 fish/100ft^2 are similar to historical densities of ~1.7 "wild" *O. mykiss*/100ft^2 estimated in 1977 from the Casitas Springs area, and they greatly exceed the 1978 estimate of <0.1 fish/100ft^2 that followed a significant winter flood (estimates re-calculated from Moore 1980).

The high abundance of *O. mykiss* in the Ven 3 reach is likely influenced by the close proximity of San Antonio Creek, a potentially important spawning and rearing tributary, which enters the Ven 3 study site near its upper boundary. San Antonio Creek was flowing in the summer of 2006 and 2008, but was dry at its mouth in 2007. Qualitative electrofishing in one randomly located section of San Antonio Creek in 2007 revealed no *O. mykiss*. Quantitative dive counts conducted in the same reach in eight pool habitats also resulted in zero counts in 2008, however juvenile *O. mykiss* were relatively abundant (at ~3-4 fish/pool) in pools both upstream of the study site just above Camp Comfort, as well as in pools just upstream of the mouth. Evidently these juveniles were the result of several steelhead redds that had been reported in San Antonio Creek during the previous winter by local fisheries biologists (Mark Capelli, NMFS personal communication).

The influence of San Antonio Creek on *O. mykiss* distribution and abundance in the mainstem Ventura River is further illustrated by the relationship between local fish densities and distance from the creek confluence. Densities were highest in pools and flatwaters <1,000 ft from the confluence, but were much lower in habitats farther away (Figure 9). This spatial trend was also evident in 2006 and 2007, when *O. mykiss* densities were greatest within ½ mile of nearby spawning tributaries in several upstream study sites (TRPA 2008).

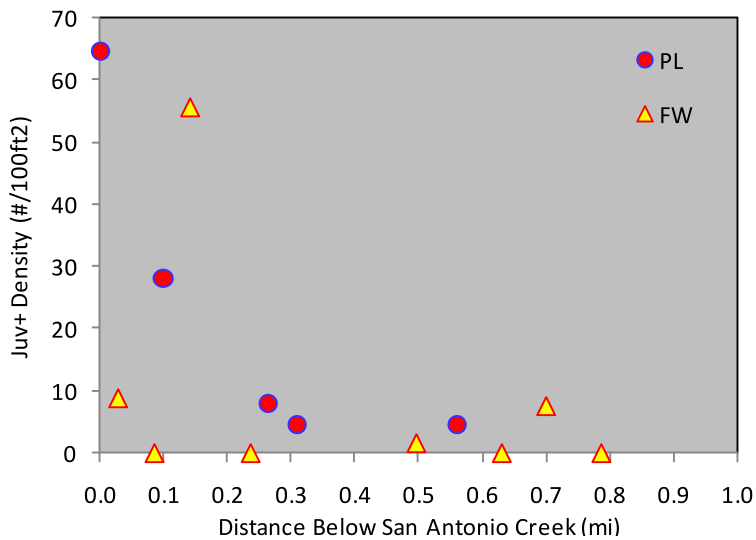

Figure 9. Relationship between distance from mouth of San Antonio Creek and density of juvenile+ *O. mykiss* in Ven 3 pool and flatwater habitat units.

<u>Ven 4</u>. The Ven 4 study site is located about 2,000 ft below the Robles Diversion Dam in the Ojai Valley Conservancy property, and contains large, deep, bedrock pools that were believed to have provided important holding habitat for upstream adult steelhead (Mark Capelli, pers. comm.). This study site occurs at the top of a losing stream reach that perennially goes dry throughout much of the year, as was the case during fish sampling in both 2007 and 2008. In 2006, however, the deep pools were full and many riffles were flowing, although no live *O. mykiss* were captured or observed in that year. Consequently, estimates of abundance in Ven 4 were zero in all three years (Figures 6-7).

<u>Combined Study Sites</u>. The estimated abundance of all *O. mykiss* in all pools throughout the entire lower segment in 2006 and 2007 was zero fry and only 13 to 19 juvenile+ fish; however the combined segment abundance in 2008 for pools increased significantly to 28 (±15) fry (at 0.012 ±0.006 fish/100ft^2) and 806 (±537) juvenile+ (at 0.34 ±0.22 fish/100ft^2) (Figures 10, 11 and 12). Note that the combined study site / basin segment estimates shown in this report represent pools only, whereas prior segment estimates and annual comparisons given in TRPA 2007 and 2008 represented estimates combined from all three habitat types. As stated above, the majority of *O. mykiss* reside in riffle habitats, which were not sampled in 2008; nor were flatwater habitats sampled in 2008 except in the mainstem Ventura River. Consequently, the annual trends displayed by the pools-only data in Figures 10-12 generally show more variable estimates (with wider confidence intervals) and less statistically significant differences between years than did the combined habitat data shown in the 2006 and 2007 reports.

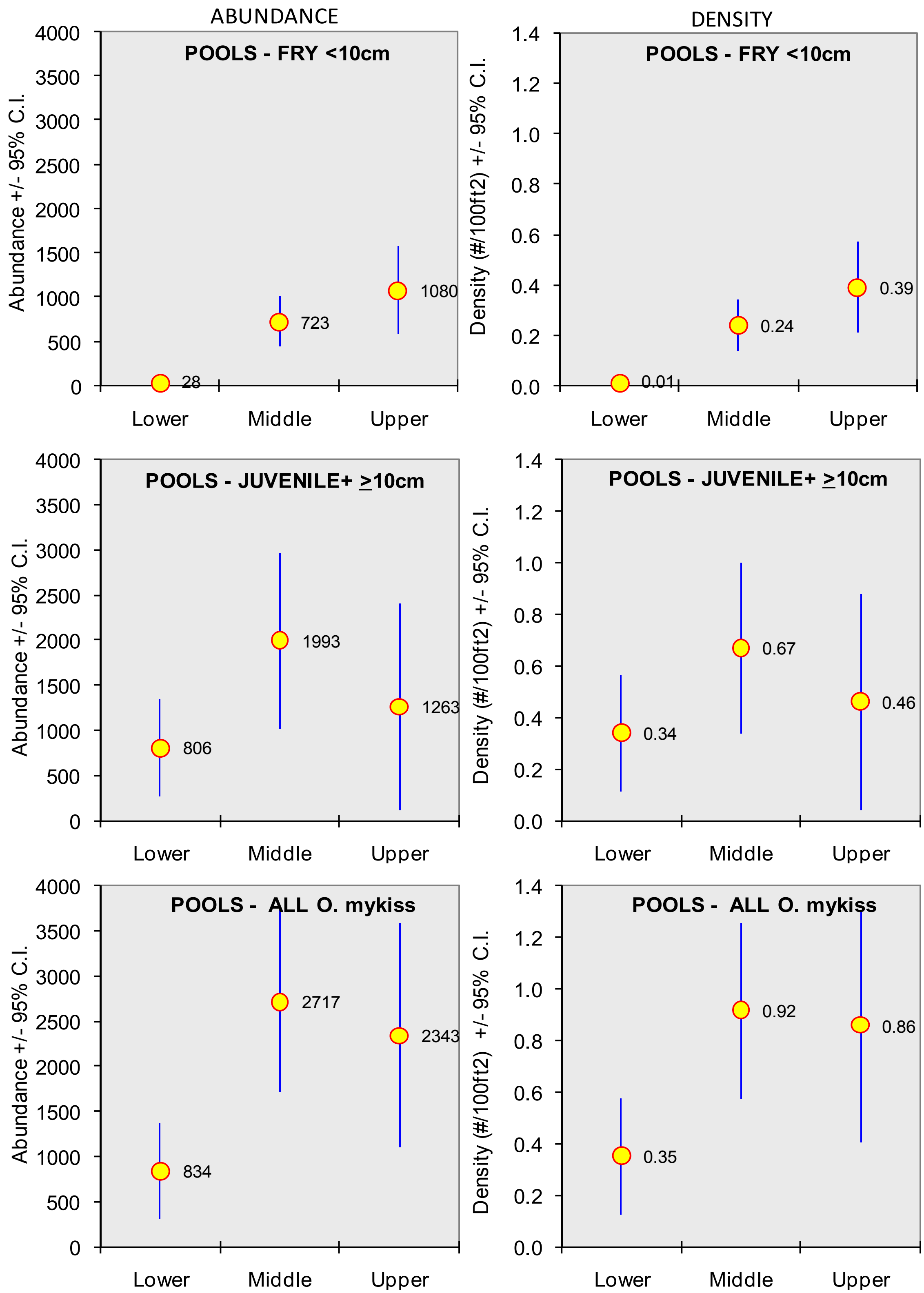

Figure 10. Estimated abundance and density of *O. mykiss* in pool habitats according to study segment in 2008.

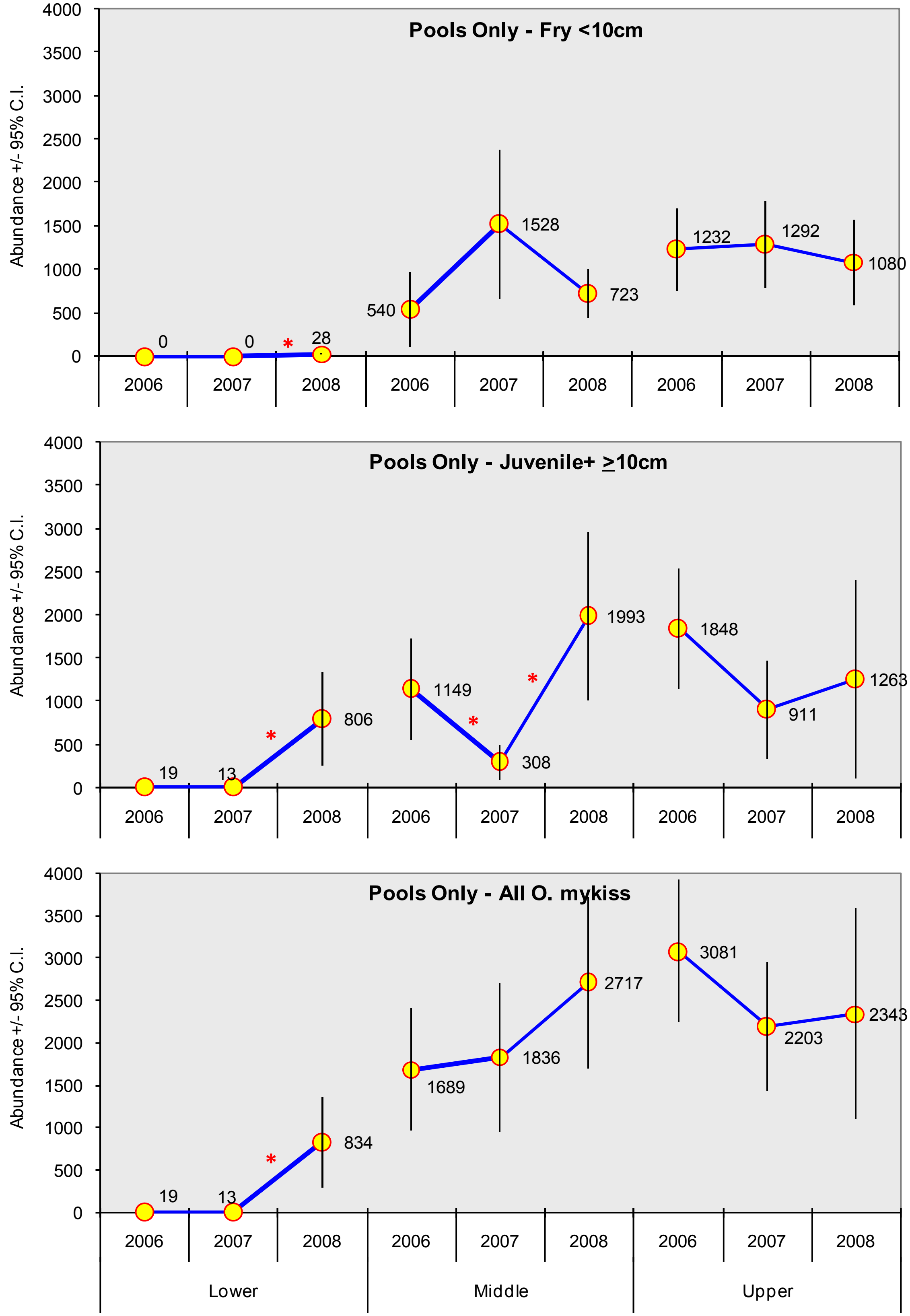

Figure 11. Estimated abundance of *O. mykiss* in pool habitats according to year and study segment. Asterisks indicate statistically significant differences between adjacent years.

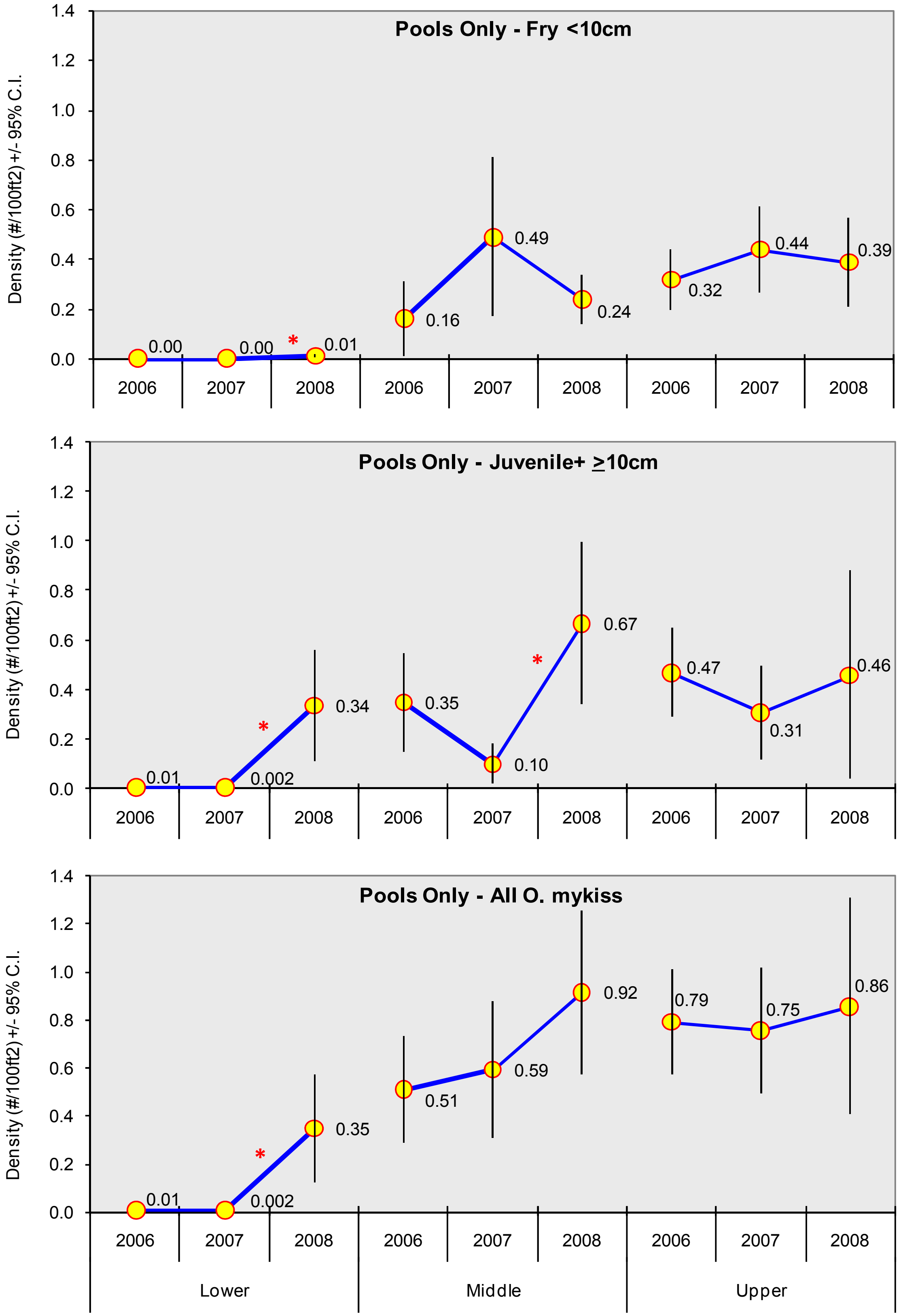

Figure 12. Estimated density (#/100ft^2) of *O. mykiss* in pool habitats according to year and study segment. Asterisks indicate statistically significant differences between adjacent years.

Middle Segment

The middle segment includes three ½ mile study sites upstream of the Robles Diversion Dam, but downstream of Matilija Dam (Figure 1). A new fish ladder at the diversion dam became operational in 2005, and remote cameras have verified passage of several adult steelhead in recent years, including four large *O. mykiss* during the winter and spring of 2006 (CMWD 2006) and six in February 2008 (CMWD 2008). No adult steelhead were observed passing the Robles Diversion Dam during the dry winter and spring of 2007 (Scott Lewis, CMWD, personal communication).

The Ven 5 study site is located on the mainstem Ventura River immediately below the confluence with the lower North Fork (LNF) Matilija Creek, approximately ½ miles below Matilija Dam. The other two study sites (LNF new and LNF mid) are located in the lower North Fork downstream of the passage barrier at Wheeler Springs Campground, but above a recent barrier (since removed) below the Ojai Quarry (Figure 1) that likely prevented steelhead passage into the study sites in 2007 and 2008. Numerous small, resident trout and trout-sized redds were observed in the LNF during the initial habitat mapping in mid-March 2003 (TRPA 2003). Because of the presence of abundant rainbow trout in the LNF and the formation of the quarry barrier in March 2006, many (if not all) of the *O. mykiss* fry captured in 2007, and both fry and juvenile+ fish observed in 2008, were likely offspring of resident trout rather than from anadromous parents, however the parental origin of these fish could not be confirmed. Black spot disease was observed on many *O. mykiss* in LNF pools, as was noted in 2006 (TRPA 2007).

In addition to salmonids, Arroyo chub were observed in virtually every sampled habitat unit in sites Ven 5 and in many pools and flatwaters in the two LNF study sites. Green sunfish (*Lepomis cyanellus*) and largemouth bass (*Micropterus salmoides*), both exotic warmwater species likely recruited from Matilija Reservoir, were also observed in several Ven 5 pools.

Ven 5. *O. mykiss* fry were observed in less than one-half of the sampled pools and one-half of the flatwaters, whereas juvenile+ were observed in most units. The resulting estimates of abundance were low for both size classes, at 8 ±10 fry and 97 ±66 juvenile+ in pools, with 33 ±68 fry and 143 ±132 juvenile+ in flatwaters (Table 2, Figure 4). The corresponding densities were similarly low in both habitat types at $\leq 0.1/100ft^2$ for fry and $<0.5/100ft^2$ for juvenile+ (Figure 5). The estimated abundance of fry was similar to the 2007 estimates in both pools and flatwaters, and about one-half of the 2006 estimate (although not statistically different). In contrast, the estimated abundance and density of juvenile+ *O. mykiss* was significantly greater in 2008 than in 2007 in both pools and flatwaters, and was greater (but not significantly) than the 2006 estimates (Figures 6 and 7). As noted in previous years (Figure 8), the density of *O. mykiss* fry was greater in the shallower/swifter flatwater habitats than in the deeper/slower pool habitats.

LNF new. As noted in 2007 (TRPA 2008), the LNF new study site was again highly altered by swimmers, who constructed many rock dams and formed a series of larger-than-normal pool habitats. Visual evidence also suggested significant angling in this area, in contrast to the LNF mid study site that showed little evidence of recreational use. Perhaps in part for those reasons, the abundance and density of *O. mykiss* was less in the LNF new site than in the LNF mid site, particularly for the juvenile+ size class (Figures 4 and 5). Pool habitats in the LNF new study site contained an estimated 69 (±29) fry and 100 (±84) juvenile+, at densities of 0.33 (±0.14) and 0.48 (±0.40) fish/100ft^2, respectively (Table 2). Sampling was not conducted in flatwaters or riffles in this or any remaining study sites due to insufficient depths for dive counts. The 2008 abundance estimate for fry was about 40% lower than the 2007 estimate (this site was not sampled in 2006), but the difference was not significant (Figure 6). In contrast, the abundance of juvenile+ *O. mykiss* in 2008 was significantly greater than the 2007 estimate.

LNF mid. Abundant spawning activity was observed in the LNF mid study site during the April 2003 HSI study (TRPA 2003), and the 2008 abundance and density of *O. mykiss* fry in pools (70 ±38 fish at 0.58 ±0.32 fish/100ft^2) was higher in this study site than in any other site except for the UNF study site (Table 2, Figures 4 and 5). Similarly, the abundance and density of juvenile+ (208 ±130 fish at 1.73 ±1.08 fish/100ft^2) was second only to the Ven 3 study site. The 2008 abundance estimate for fry in pools was significantly lower than the 2007 estimate, but was relatively similar to the 2006 estimate (Figure 6). Juvenile+ fish, in contrast, were significantly more abundant in 2008 than in 2007. This annual trend is consistent with the trend observed in the downstream Ven 3, Ven 5, and LNF new sites, as well as the trend seen in several of the upstream sites.

Combined Study Sites. Combining data from the three middle segment study sites and expanding the estimates to all pools in the entire segment area (e.g., Robles Diversion Dam upstream to Matilija Dam, including the LNF upstream to the Wheeler Gorge barrier) produced estimates of abundance of 723 (±283) fry and 1,993 (±970) juvenile+, with overall densities of 0.24 (±0.10) fish/100ft^2 and 0.67 (±0.33) fish/100ft^2, respectively (Figure 10). The combined estimate for fry was intermediate between the lower estimates from the lower segment and the higher estimates from the upper segment, but the middle segment estimates for juvenile+ *O. mykiss* were higher than for both lower and upper basin segments. Comparison of annual abundance and density estimates in the middle segment reflects the site-specific results, with a ~50% (but statistically non significant) decrease in fry from 2007 to 2008, but a highly significant 6-7 fold increase in juvenile+ fish (Figures 11 and 12). The 2008 estimates are slightly higher than the 2006 estimates for fry, but are approximately double the 2006 estimates for juvenile+ fish.

Upper Segment

The upper segment lies entirely above Matilija Dam, which has blocked immigration of steelhead into Matilija Creek since 1947. Three study sites occur on the mainstem Matilija Creek, and one study site represents its principal tributary, the Upper North Fork (UNF) Matilija Creek (Figure 1). All four study sites are approximately ½ mile in length.

The lowest mainstem site (Mat 3) was divided (due to private property) into a lower portion that occurs below a major hot spring, and an upper portion that contains some fairly large pools. Evidence of the arundo eradication was apparent along part of the Mat 3 study site, but it did not appear to affect the instream habitat or the riparian vegetation bordering the sampling units. Mat 5 occurs about 1½ miles upstream of Mat 3, but is only a short distance below two sources of *O. mykiss* recruitment: Murietta Creek (~¼ mi upstream) and the UNF (~½ mi upstream). A diversion canal that carries cool water (and presumably contains *O. mykiss*) directly from the UNF enters the Mat 5 study site at its upper boundary. The lower portion of the Mat 5 study site frequently becomes dry or intermittent during the low flow period, which was the case in 2007. In 2008, the channel became dry just below the bottom boundary, but most of the study site was wetted and appeared to contain good water quality. Mat 7 occurs within the upper mainstem canyon and supports perennial flow with a healthy riparian zone and a diverse variety of mesohabitat types. A new study site was selected in the Upper North Fork in 2007 and was again sampled in 2008. This study site is ¾ miles up the North Fork trail and is relatively pristine with heavy riparian growth. The site crosses a transition from a relatively unconfined channel (with low flows) downstream into a bedrock confined channel with increased flow and water depths. Consequently, this new site was expected to better represent the overall length of available habitat in the UNF than did the 2006 site several miles upstream.

Both arroyo chub and stickleback were common in the Mat 3 and Mat 5 study sites, whereas only chub were occasionally observed in the UNF new site and neither species were observed in Mat 7. The exotic largemouth bass was observed in only one Mat 3 pool in 2008, whereas they appeared more abundant (with occasional sunfish) in 2007. The presence of black spot disease was present on many *O. mykiss* observed in the upper segment in 2008, and was commonly seen among fish captured in 2006.

Mat 3. *O. mykiss* fry were not observed in Mat 3 pools in 2008, and only two of the eight pools contained juvenile+ *O. mykiss*, both of which were above the hot springs. This resulted in estimates of zero fry and 5 (±3) juvenile+ fish, at a density of 0.03 (±0.02) fish/100ft^2 (Table 2, Figures 4 and 5). No fry or juvenile+ fish were observed in Mat 3 pools in 2007, but both size classes were observed in low abundance (estimated at 4 fry and 34 juvenile+) under the high flow conditions of 2006 (Figure 6). As noted in the summer of 2007 and also measured in 2008, inflow from the hot springs increases the temperature in lower Mat 3 by 1-2^{o}C in the morning and by 4-5^{o}C in the afternoon. The maximum measured water temperature during the 2008 survey occurred in lower Mat 3 with an afternoon (1435) temperature of 28^{o}C.

Mat 5. Only one *O. mykiss* fry was observed in Mat 5 pools in 2008, but juvenile+ fish were observed (in low numbers) in five of ten sampled pools, producing an estimated abundance of one fry and 12 (±5) juvenile+ fish (Table 2, Figures 4 and 5). The estimated density of the juvenile+ size class was 0.26 (±0.10) fish/100ft^2. The abundance of both fry and juvenile+ *O. mykiss* in Mat 5 pools was significantly less in 2008 than in both 2006 and 2007 (Figure 6). The decreasing trend for juvenile+ fish was contrary to trends seen in most other study sites, which showed increasing abundance of juvenile+

fish in 2008, however abundance estimates in Mat 5 were low (<40 fish) in all three years.

Mat 7. In previous years the abundance of fry and juvenile+ *O. mykiss* in Mat 7 pools was higher than estimates from the Mat 5 study site (although not for flatwaters and riffles). Likewise, the 2008 estimates of abundance of fry (38 ±42) and juvenile+ (151 ±140) exceeded the estimates for the other mainstem study sites - and even exceeded the UNF estimate for juvenile+ fish (Table 2, Figures 4 and 5). Associated densities for fry and juvenile+ *O. mykiss* in Mat 7 pools in 2008 were 0.21 ±0.23 fish/100ft^2 and 0.83 ±0.77 fish/100ft^2, respectively. Like for most other study sites, these 2008 estimates represent a substantial decrease from 2007 estimates for fry and a large increase for juvenile+ fish, with the former being a statistically significant change (Figure 6).

UNF new. Pool habitats in the UNF contained the highest densities of *O. mykiss* fry among all study sites in all three years, including 2008 with 149 (±47) fish (Table 2, Figure 4). For juvenile+ fish, however, the 2008 estimate (52 ±35) was exceeded by several other study sites. The 2008 density of for *O. mykiss* fry was 1.72 (±0.54) fish/100ft^2, again the highest in the basin, with 0.60 (±0.40) fish/100ft^2 for juvenile+ fish (Figure 5). The 2008 abundance of fry was approximately double the 2007 estimate and was statistically significant (Figure 6). In contrast, the estimate for juvenile+ in 2008 was approximately one-half of the 2007 estimate.

Combined Study Sites. The overall estimated abundance of fry and juvenile+ *O. mykiss* in pools throughout the upper segment (excluding Murietta Creek, Old Man Creek, and all reaches above barriers) in the summer of 2008 was 1,080 (±492) fry and 1,263 (±1,143) juvenile+, at densities of 0.39 (±0.18) and 0.46 (±0.42) fish/100ft^2, respectively (Figure 10). The 2008 upper segment estimate for fry was higher than estimates for both downstream segments, but was slightly (and non-significantly) lower than the upper segment estimate from 2007 (Figures 11 and 12). The 2008 combined estimate for juvenile+ fish in upper segment pools was intermediate between the lower segment and the middle segment estimates, but represented a 40-50% (yet statistically non-significant) increase from 2007.

DISCUSSION

Differences in Age-Class Proportions Between Years

The changes of fish abundance estimates between years for each study site (or segment) were discussed above (Figures 6-7 and 11-12). The most consistent and prominent trend was the 2008 decline in abundance of fry and the concomitant increase in juvenile+ *O. mykiss*. These opposing trends are both likely dependent in part to the lateness of the 2008 sampling in comparison to previous years (6-8 weeks later). Because of the delayed sampling in 2008, a much higher proportion of young-of-year fish probably recruited from the fry size class (at <10cm) into the juvenile+ size class (at ≥10cm) than was the case in 2006 and 2007. Consequently, an unknown (but potentially substantial) amount of the decrease in fry abundance (and increase in juvenile+ abundance) in 2008 may be due to mischaracterization of young-of-year (or, 0+) fish vs. older fish (i.e., 1+ or older).

It is not possible, without age analysis, to determine the proportion of 0+ or 1++ fish in the 2008 dive counts, or how that proportion differs from previous years data. In 2006 and 2007 it was possible, through the length-frequency distributions derived from capture of *O. mykiss* by electrofishing, to generally evaluate the proportion of fish classified as fry that were more than one year old, and similarly to assess how many fish classified as juvenile+ were likely to be less than a year old. The length-frequency distributions from 2007, which were dominated by strong recruitment of fry, suggested that the vast majority of fish <10cm were probably young-of-year fish, and that a small proportion of fish >10cm were likely to be less than one year in age. *O. mykiss* captured during a similar time period in 2006, however, showed a higher proportion of older, larger fish, and also suggested that a significant proportion of young-of-year may have been larger than the 10cm length criteria for fry, particularly in warmer, mainstem study sites.

This qualitative analysis was not possible for the 2008 data since only dive counts were conducted that partitioned all observed *O. mykiss* into two size classes based on the 10cm criteria. However, the large number of juvenile+ fish observed in the Ven 3 study site was believed by local biologists to be the result of that years spawning of steelhead in San Antonio Creek (Scott Lewis, CMWD, and Mark Capelli, NMFS, personal communications), which supports the assumption that the delayed sampling in 2008 resulted in greater misclassification of *O. mykiss* age classes. Yet previous surveys, which included sampling in all three habitat types, showed strong and statistically significant increases in abundance of fry from 2006 and 2007 (TRPA 2008). Consequently it is likely that the increases observed in juvenile+ fish in 2008 are due to both the carryover of strong fry recruitment in 2007 as well as additional growth of fry beyond 10cm in the 2008 survey.

Given this uncertainty in the size-age relationship among years, a cursory analysis of the total number of *O. mykiss* observed over the years may be warranted. When the fry and juvenile+ size classes were combined, the estimated abundance of all *O. mykiss* in pool habitats (and for flatwaters in mainstem Ventura study sites) showed an increase in abundance in all study sites except Mat 5 (Figures 6 and 7). The increases in 2008 were statistically significant for the Ven 3 and Ven 5 study sites, as well as for the decrease observed in the Mat 5 study site. When the data from individual study sites were combined into basin segments, the overall change from 2007 to 2008 was positive in all three segments, although only the increase in the lower segment (thanks to the Ven 3 results) was statistically significant (Figures 11 and 12).

<u>Correlations Between Abundance and Habitat Unit Length</u>

The estimates of abundance of *O. mykiss* in each study site are based on the MBC estimators, which may (or may not) include habitat unit size as an auxiliary variable (Mohr and Hankin, *in press*). When the number of fish in a habitat unit is positively correlated with the size of the habitat unit (expressed as unit length in this study), the use of the auxiliary variable can increase the accuracy and precision of the abundance estimates, which could then lead to improved distinction of changes between years. When the correlation is low or non-existent, the auxiliary variable does not contribute to the quality of the estimates.

In several other *O. mykiss* studies conducted by TRPA, moderate to high correlations between unit length (or in some cases unit depth or volume) and fish abundance have provided significant benefits to the resulting estimates (e.g., Upper Sacramento River [TRPA 2005], NF Feather River [TRPA 2007c], San Luis Obispo Creek [TRPA 2004b], San Luisito Creek [TRPA 2007b], Morro Bay [TRPA 2001]); however in streams containing low densities of fish the unit:abundance correlations may be too low to provide such benefits. In this study, estimates of abundance were calculated both with and without the auxiliary variable, and the most precise result (i.e., that estimate having the smallest variance relative to the abundance) was selected to represent abundance in this study. Over the past three years of sampling in the Ventura/Matilija Basin, the Pearson product-moment correlations between unit length and *O. mykiss* abundance have been typically positive and useful for estimation for those study sites where *O. mykiss* were well distributed among sampled habitat units, but the correlations were weak where abundance was low or the distribution was patchy. Consequently, the estimator using an auxiliary variable was not used in most Ventura River and lower mainstem Matilija Creek study sites, whereas auxiliary variables were typically included in estimates for headwater study sites where higher densities resulted in better correlations with unit length.

For those study sites were *O. mykiss* were consistently observed each year, the overall mean correlations were higher in 2006 (at r=0.33) than in the subsequent years (at r's=0.17), with relatively little difference between size class or habitat type (Table 3). Sixty-three of the 85 correlation coefficients (74%) were positive, but only 13 were statistically significant at P<0.05. None of the 21 negative correlations were significant.

<u>Correlations In Abundance Between Years</u>

Correlations may also provide a significant benefit when estimating the difference in abundance between years. The Sampling on Repeated Occasions design (Cochran 1977) utilizes correlations in fish counts in individual sampling units between time intervals to improve the most recent abundance estimates and to minimize the variance in the difference estimates, which increases the ability to detect significant changes between years. The correlation in counts within pools between 2007 and 2008, for those study sites where *O. mykiss* were observed both years, were generally good except in the Mat 5 study site which was becoming intermittent during sampling in both years. Correlations in the other study sites were mostly between 0.4 and 0.7 (Table 4). The increased ability to detect statistically significant annual changes due to the use of the difference equations can be seen in the significant changes in fry abundance, despite overlapping confidence intervals, from 2007 to 2008 in the LNF mid, Mat 7, and UNF study sites; and also for juvenile+ *O. mykiss* in the LNF new and Mat 7 study sites (Figure 6).

Table 3. Correlation coefficients (*r*) between *O. mykiss* abundance (first-pass counts) and habitat unit length. Significant *r* values are shown in bold type.

Study Site	Hab Type (n's)	Size Class	2006 *r*	2007 *r*	2008 *r*	mean *r*'s
Ven 5	PL	Fry	0.51	0.49	-0.50	0.17
	n=8	Juv+	0.24	-	-0.68	-0.22
	FW	Fry	0.17	-0.05	-0.02	0.04
	n=8	Juv+	0.22	0.38	0.07	0.23
	RF	Fry	0.00	-0.16	-	-0.08
	n=8	Juv+	0.10	0.13	-	0.11
LNF low/	PL	Fry	0.57	0.09	**0.82**	0.49
new	n=8	Juv+	-0.40	0.43	**0.72**	0.25
	FW	Fry	0.39	-0.64	-	-0.12
	n=8	Juv+	0.16	-0.23	-	-0.04
	RF	Fry	0.52	-0.18	-	0.17
	n=8	Juv+	0.57	**0.76**	-	0.66
LNF mid	PL	Fry	**0.81**	**0.79**	-0.04	0.52
	n=8	Juv+	-0.66	0.29	-0.35	-0.24
	FW	Fry	**0.77**	0.66	-	0.71
	n=8	Juv+	0.33	0.25	-	0.29
	RF	Fry	0.04	0.15	-	0.10
	n=8	Juv+	-0.13	-0.38	-	-0.26
Mat 5	PL	Fry	-0.19	-0.32	0.19	-0.11
	n=9,7,10	Juv+	**0.89**	-0.32	0.27	0.28
	FW	Fry	0.20	-0.39	-	-0.09
	n=8,6,-	Juv+	0.06	-0.36	-	-0.15
	RF	Fry	0.17	-0.13	-	0.02
	n=8,4,-	Juv+	0.30	0.17	-	0.23
Mat 7	PL	Fry	0.42	0.02	0.27	0.24
	n=9,8,9	Juv+	**0.79**	0.61	0.41	0.60
	FW	Fry	0.53	0.21	-	0.37
	n=8,7,-	Juv+	**0.87**	**0.86**	-	0.87
	RF	Fry	**0.77**	-0.03	-	0.37
	n=8,7,-	Juv+	0.34	-	-	0.34
UNF up/	PL	Fry	0.54	0.57	**0.83**	0.65
new	n=8	Juv+	0.18	0.64	0.45	0.43
	FW	Fry	0.67	0.14	-	0.41
	n=8	Juv+	0.03	0.29	-	0.16
	RF	Fry	0.44	0.35	-	0.40
	n=8	Juv+	**0.76**	0.69	-	0.73
		mean *r*'s:	0.33	0.17	0.17	

As noted in 2006-2007, the 2008 data again showed a significant correlation ($r = 0.65$, $P<0.05$) between the overall abundance of *O. mykiss* fry in each study site between the last two years (Figure 13). The correlation was low and non-significant, however, for juvenile+ fish, in part because of the high density of *O. mykiss* in the Ven 3 study site in 2008, whereas densities were near zero in 2006 and 2007.

Table 4. Correlations in first-pass counts of *O. mykiss* in individual pool habitat units between 2007 and 2008.

Study Site	Hab Type	Size Class	Correl
LNF new	PL	Fry	0.47
		Juv+	0.55
LNF mid	PL	Fry	0.47
		Juv+	0.21
Mat 5	PL	Fry	-0.38
		Juv+	-0.52
Mat 7	PL	Fry	0.44
		Juv+	0.68
UNF new	PL	Fry	0.62
		Juv+	0.60

The high inter-annual correlations among study sites that were exhibited for both fry and juvenile+ fish in 2006 and 2007 (TRPA 2008) suggested that those factors that affect local fish densities (e.g., fry recruitment, habitat quality or availability) appeared to operate similarly throughout the basin, but that annual differences in escapement of adult steelhead could lead to annual changes in the relative density of fish among reaches. Such was illustrated in 2008 with the high density of *O. mykiss* in the Ven 3 site, which degraded the correlation for the juvenile+ size class (although most of the observed fish were thought to be young-of-year that grew out of the "fry" size class). The 2008 results support historical information (e.g., Moore 1980) that portions of the mainstem Ventura River may be capable of rearing significant numbers of juvenile steelhead, given adequate recruitment of adult spawners.

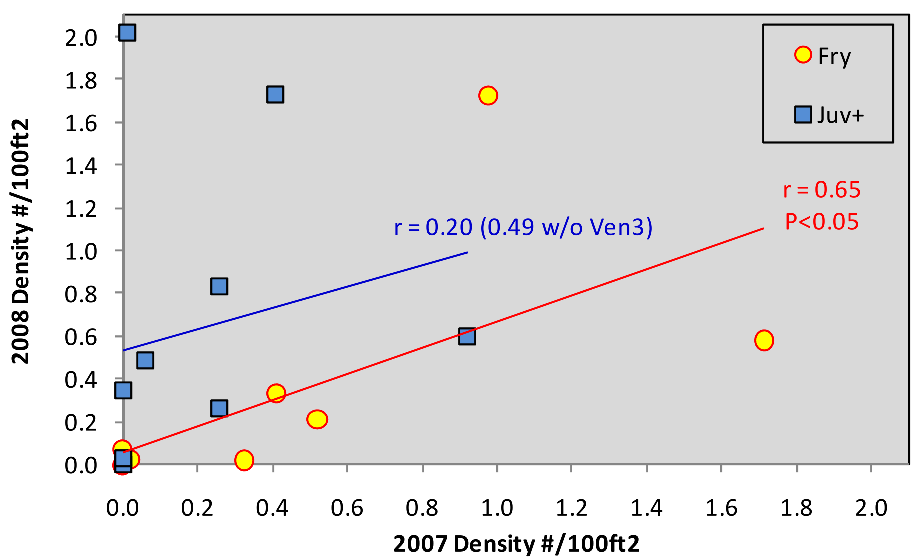

Figure 13. Correlation (*r*) in annual densities of *O. mykiss* by study site and size class.

In addition to the strong relationship in fish densities between years for a single size class, the data again (similar to 2007) showed a strong relationship between size classes of *O. mykiss*. For example, the 2007 estimated densities of fry, which were presumed to be mostly young-of-year fish, were highly correlated with the 2008 densities of juvenile+ fish, many of which were assumed to be 1+ fish (Figure 14). A regression model that utilized the 2007 density of fry to explain the 2008 density of juvenile+ was highly significant (R^2=0.87, P<0.001), if the Ven 3 results are omitted.

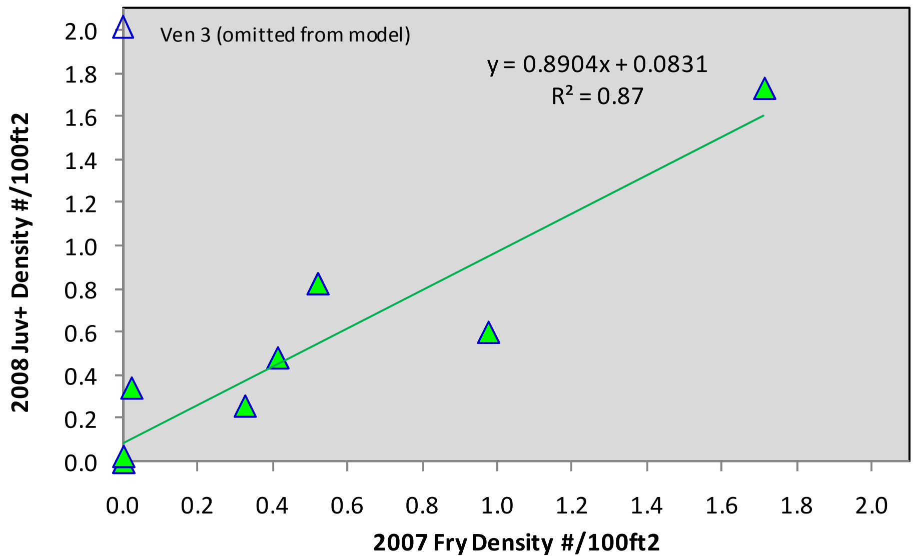

Figure 14. Relationship between densities of *O. mykiss* fry in 2007 and juvenile+ the following year, according to study site.

A more thorough analysis of cohort relationships, such as that between fry (0+) and first-year (1+) juveniles the following year, or between adult (spawning aged) fish and fry the following year, would require a more precise assessment of age distributions, such as through scale analysis and an assessment of age-at-maturity. In smaller headwater streams, resident *O. mykiss* are known to mature and spawn by their second year of life at age 1+ (Moyle 2002), but the proportion of mature spawners in the juvenile+ size class used in this study is unknown. Also unknown is the proportion of 0+ *O. mykiss* "fry" that had grown into the larger juvenile+ size class in 2008, which was likely significant in the warmer mainstem study sites given the late timing of sampling (September). In addition, extreme environmental conditions, such as flood flows or drought conditions, can override such cohort-related effects on year-class strengths.

Large-magnitude changes in the abundance of salmonid fry and juveniles such as seen in the Ventura/Matilija Basin in 2006 through 2008 are common in fisheries literature (Benson 1960, Seegrist and Gard 1972, House 1995, Lattrell et al. 1998, Spina et al. 2005), and may be related to changes in abundance of adult spawners, survival of incubating eggs, or summer/winter rearing conditions for fry and juveniles. For anadromous populations, changes in ocean conditions or instream passage conditions can lead to significant annual differences in adult spawner escapement. Winter or early spring flood events can lead to mortality of adult spawners of anadromous and resident populations, and late spring flooding can scour developing eggs or cause displacement-related mortality of newly emerged fry. Also, this study and other studies show that the success or failure of the fry year-class can directly translate into abundance of fish in subsequent years (Hanson and Waters 1974, Lamberti et al. 1991, Nehring and Anderson 1993, Spina 2001, TRPA 2005). The dramatic change in abundance of *O. mykiss* in the Ven 3 study site, from near zero density in 2006 and 2007, to the highest density of all study sites in 2008 (both size classes combined), illustrates how variable the annual rearing densities can be in Southern California watersheds, and how long-term studies are needed to both document the extent of natural variation, and to adequately describe "baseline" conditions prior to any major restoration projects.

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