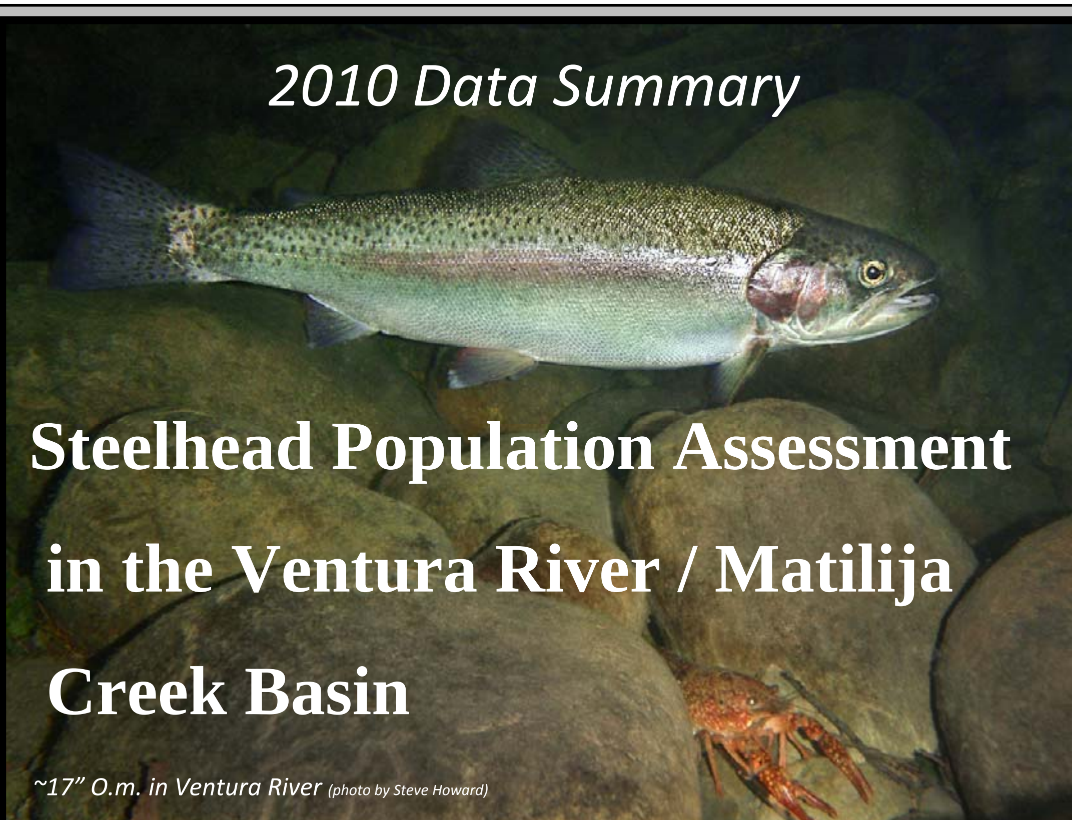

2010 Data Summary

Steelhead Population Assessment in the Ventura River / Matilija Creek Basin

~17" O.m. in Ventura River (photo by Steve Howard)

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Steelhead Population Assessment in the Ventura River / Matilija Creek Basin – *2010 Data Summary*

Introduction

Field sampling to assess the distribution and abundance of *O. mykiss* in the Ventura/Matilija Basin by Thomas R. Payne & Associates (TRPA) was funded in 2010 by a Fisheries Restoration Grant administered by the California Department of Fish & Game (DFG). The primary objectives of the 2010 field surveys were to re-assess the distribution and abundance of *O. mykiss* throughout the Ventura River Basin, and compare 2010 results from similar surveys conducted in 2006-2009. The 2010 abundance estimates add to existing data to help assess the level of natural variation in *O. mykiss* population characteristics, and to establish a more robust assessment of baseline population conditions in the Ventura River Basin prior to the anticipated removal of Matilija Dam. See prior reports for details regarding the 2006-2009 data (TRPA 2007, 2008, 2009, 2010). TRPA 2008 contains detailed descriptions of sampling protocols, as well as an assessment of a Habitat Suitability Index (HSI) model developed for the Ventura Basin.

Study Sites

The July and August 2010 sampling encompassed 12 stream reaches (Figure 1). Eleven of the original twelve study reaches were sampled in 2010 (one land owner denied access to the upper mainstem Matilija Creek), plus one new location was sampled on San Antonio Creek. The sampling locations consisted of five stream reaches in the mainstem Ventura River, two reaches in San Antonio Creek, two reaches in the Lower North Fork Matilija Creek, two reaches in mainstem Matilija Creek, and one site in the Upper North Fork Matilija Creek. Ven 1 and Ven 2 are in the lower river Ventura River. The one-mile long Ven 3 study site occurs in the “living reach” of Casitas Springs, where groundwater emerges from the long dry channel below Robles Diversion Dam, and includes the habitats surrounding the San Antonio Creek confluence. Ven 4 is in the Ojai Land Conservancy property immediately below the diversion dam, where surface flows often cease during the summer months. The Ven 5 study site extends ½ -mile below the confluence of the Lower North Fork Matilija Creek (LNF). The two LNF sites are ½ -mile in length, with the LNF “new” site located immediately above the Ojai Quarry, and the LNF “mid” study site just downstream of Wheeler Gorge. Mat 3 is in the mainstem Matilija Creek above Matilija Dam in the vicinity of the hot springs, and Mat 5 is at the end of the public part of Forest Road 5N24. The UNF “new” site is approximately one mile upstream of the confluence with Matilija Creek. Two sites were sampled in San Antonio Creek in 2010. The upper site was

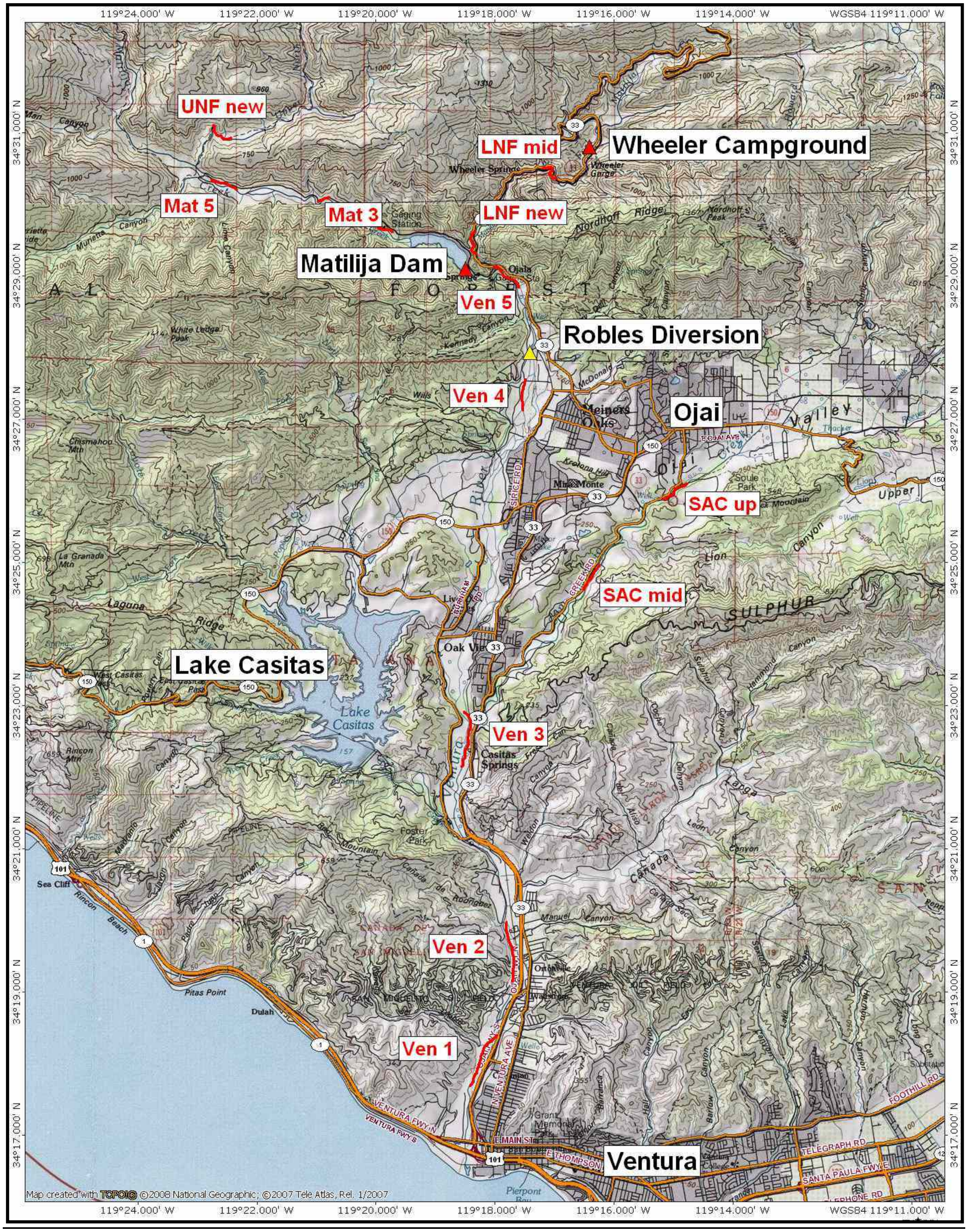

Figure 1. Map of Ventura/Matilija Basin showing study reaches (red lines) and landmarks.

located about 0.85 miles upstream of Camp Comfort, while the second site (referred to as the middle site) was located about 1.3 miles downstream of Camp Comfort. Appendix A contains GPS coordinates for top and bottom boundaries for each of the 12 study sites.

Methods

For this study, sampling by direct observation (snorkeling) was the preferred methodology and was used in those habitats where diving was feasible. Water depths in all study reaches were sufficient to allow direct observation in pool habitat units, but electrofishing was employed in all of the shallower flatwater and riffle habitats. Abundance estimates using snorkel counts were derived according to the Method of Bounded Counts (MBC) within randomly selected sampling units stratified by reach and habitat type. Multiple-pass electrofishing was employed for sampling in all riffles and flatwaters. Electrofishing surveys were conducted by trained personnel using procedures consistent with guidelines established by NOAA Fisheries for protecting listed species of salmonids (NMFS 2000), except that electrofishing was conducted at stream temperatures higher than the maximum recommended temperature of 18^{o}C, and at conductivities higher than 350µS/cm. See TRPA 2007, 2008, 2009, and 2010 for detailed descriptions of the study sites, sampling design, abundance estimators, and field methodologies.

The separation of *O. mykiss* into "fry" (<10 cm FL) and "juvenile+" size classes was intended to approximate the proportions of *O. mykiss* represented by young-of-year (age 0+) vs. older age classes (age 1+ and older). Basin-wide sampling in July-August of 2006 and 2007 suggested that the 10cm size criterion was reasonably successful in separating 0+ from older age classes for fish inhabiting tributary streams, but that some 0+ trout in the warmer mainstem study sites likely exceeded 10 cm by mid-summer. The later sampling in 2009 (early to mid-Aug) and especially in 2008 (early to mid-Sept) undoubtedly resulted in a much higher proportion of 0+ *O. mykiss* that exceeded the 10 cm length criterion, and were thus classified by divers as "juvenile+" fish. Consequently, these differences in sampling periodicity and spatial/temporal growth rates are expected to somewhat confound the size-specific comparisons of annual abundance. The annual abundance estimates for the "All *O. mykiss*" (e.g., combined size classes) are therefore also included in order to control for this effect.

See TRPA (2008) for a more detailed description of field sampling methodologies and abundance estimation. Prior reports are generally available for download at www.matilijadam.org or at http://matilija-coalition.org/publications.htm.

Results

Physical Habitat Conditions. Stream flow and water temperature are important environmental parameters that affect fish habitat. The gage at Foster Park (USGS 11118500 - Ventura River near Ventura) that measures flow in the Ventura River provided the means to compare the river flow for the years 2003-2010 (Figure 2). While the highest summertime flows occurred in 2005 and 2006; summer flows in 2003, 2008 and 2010 were also higher than the historical median flow from 1959 to 2009. Streamflows estimated at each sampling site in 2010 ranged from a maximum of about 15 cfs in the lower Ventura River to a minimum of about ½ cfs in the uppermost tributary (UNF new).

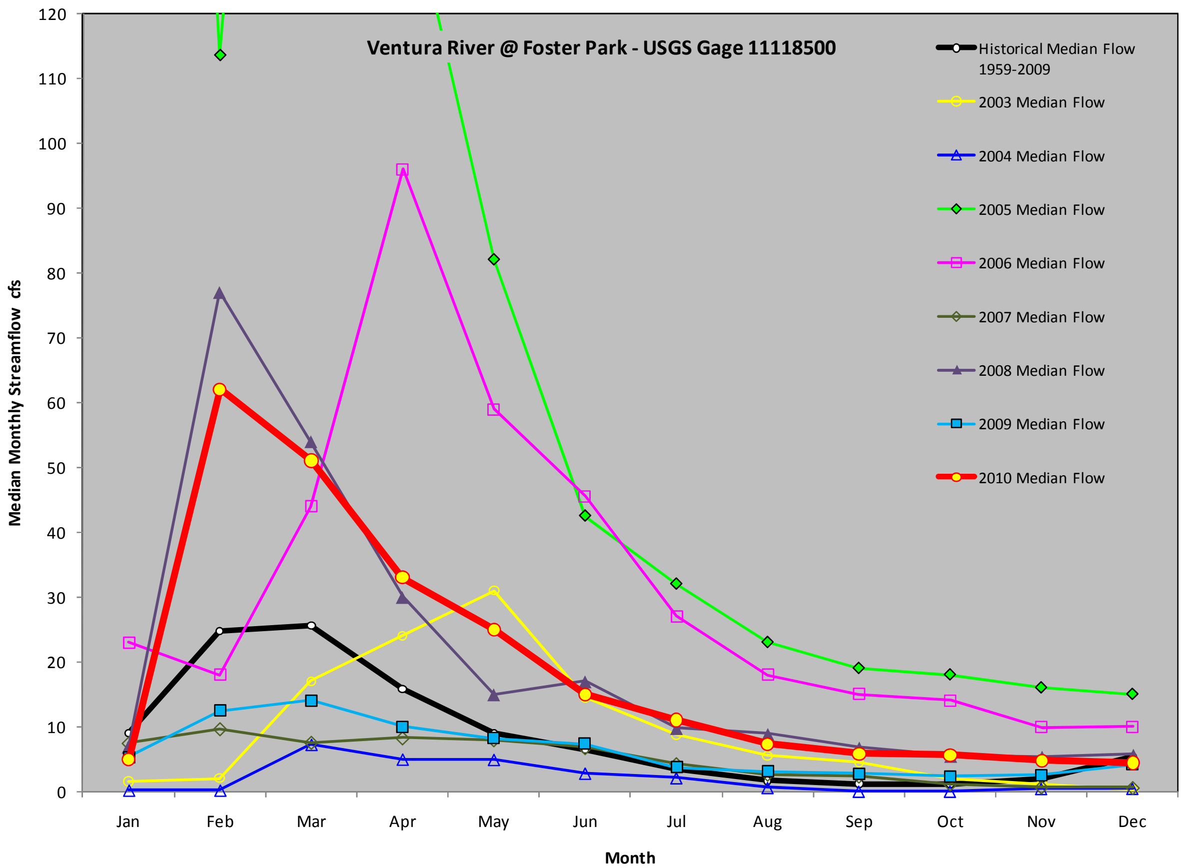

Figure 2. Median monthly flows for the Ventura River at Foster Park Gage (revised for 1959-2009).

Stream temperature data loggers were deployed at seven locations in the Ventura River watershed during 2010 (Figure 1). Water temperatures were recorded every 30 minutes to ensure recording the daily maximum and minimum water temperatures. The mean daily temperatures are presented in Figure 3. The highest daily mean temperatures occurred in the Mat 3 and Ven 5 reaches, likely due to the influence of numerous hot springs and open channel (Mat 3), and due to warming in the Matilija Reservoir pool (upstream of Ven 5). The lowest daily mean temperatures occurred in the Upper North Fork reach, which is located in a relatively high elevation (~1,700 ft msl), shaded canyon area of the watershed. The daily mean temperatures peaked in mid-July and again in late-August at all sites, with temperatures above 76 degrees Fahrenheit (°F) (24.5°C) in the warmest reaches (Mat 3 and Ven 5), while the mean daily temperatures during these same periods peaked at levels less than 68°F (20°C) in the Ven3 and San Antonio Creek reaches. These lower mean daily temperatures can be explained by the presence of cool springs and thick riparian zone in the San Antonio Creek reach, and by the dominance of upwelling ground-water in the Ven 3 reach (which is just downstream of the summer dry channel). The significant amount of warming (~4°F or 2.2°C) from the Ven 3 temperature logger to the Ven 2 logger 3½ miles downstream is clearly evident; however the Ven 2 temperatures remained well below temperatures observed upstream in Ven 5 and Mat 3.

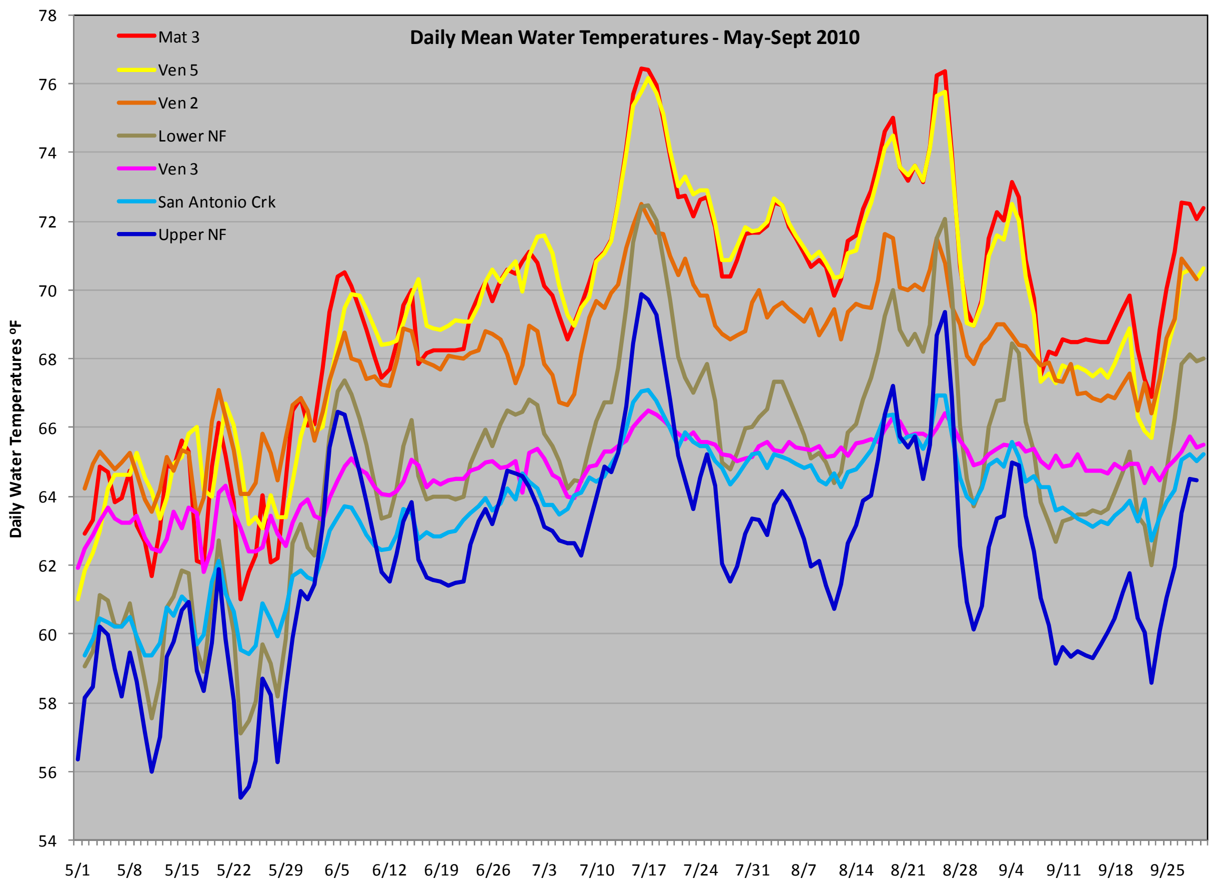

Figure 3. Mean daily water temperature in the Ventura River watershed from May through September
2010.

The relative stability of daily and seasonal (spring to fall) temperatures in the groundwater influenced Ven 3 reach is immediately evident in comparison to the more highly fluctuating daily temperatures in the other reaches (Figure 4). Daily temperature fluctuations in Ven 3, as well as in the coastal, marine-influenced Ven 2 and the heavily shaded Upper North Fork and San Antonio Creek sites, were typically 10°F (5.6°C) or less. In contrast, Mat 3 had the greatest range of daily temperatures, fluctuating approximately 15°F (8.3°C) during late-July and most of August, when daily highs exceeded 80°F (26.6°C).

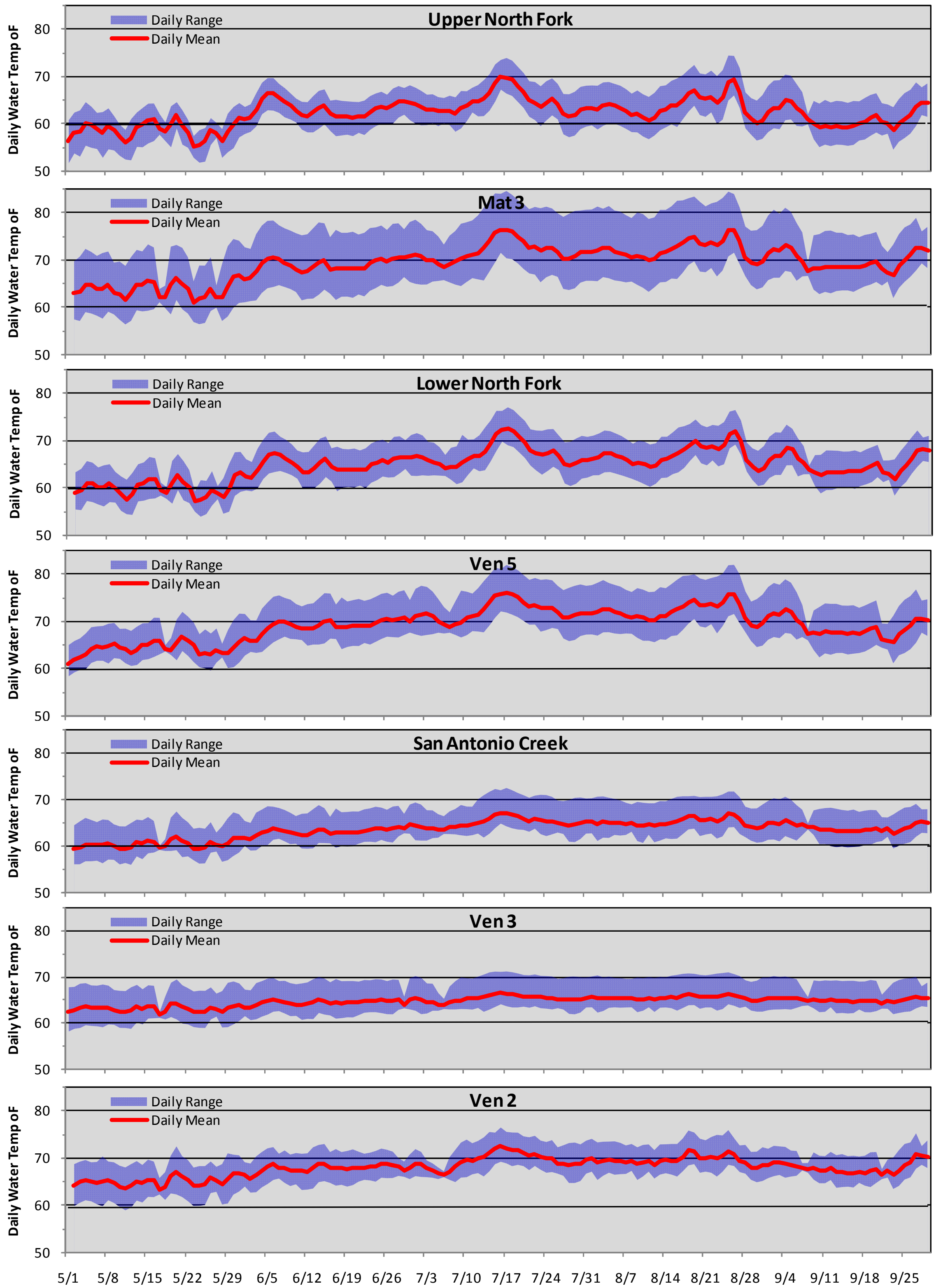

Figure 4. The daily range and daily mean temperatures at seven sites in the Ventura River watershed, May through September 2010.

Fish Sampling. The fish abundance surveys were conducted in the Ventura/Matilija basin over an eight week period between 7 July and 26 August 2010 and generally progressed in an upstream progression (Table 1). A total of 242 habitat units were sampled using snorkel counts in pool habitats and electrofishing in the flatwater and riffle habitats. Due to permitting issues, no electrofishing was conducted in either San Antonio Creek reach, where only pools were sampled. A total of 1,313 *O. mykiss* (696 fry and 617 juvenile+) were counted or captured during this sampling. Over 70 percent of the total *O. mykiss* (923 trout) surveyed came from the anadromous zone below Matilija Dam.

Table 1. General sampling statistics for the 2010 survey.

Basin Segment	Fish Zone *	HSI Reach	Sampling Dates	# Sampling Units Pools	Flatwaters	Riffles	Est Flow cfs	# O. mykiss (cm) ** <10	10+
Upper	Resident	UNF new	21,26 Aug	8	8	8	0.5	64	23
above		Mat 7	*access denied*	0	0	0	n/a	n/a	n/a
Matilija		Mat 5	20,24-25 Aug	11	8	8	2.9	177	69
Dam		Mat 3	20-23 Aug	8	8	8	5.0	15	42
Middle	Anadromous	LNF mid	3-5 Aug	8	8	8	1.4	136	39
between		LNF new	3-4 Aug	8	8	8	2.0	101	42
dams		Ven 5	31 July-2 Aug	8	8	8	11.3	81	95
Lower	Anadromous	Ven 4	13-14 July	5	6	8	1.8	7	15
below		San Ant up	6-Aug	8	0	0	1.5	2	25
Robles		San Ant mid	21-Aug	8	0	0	~2	0	0
Diversion		Ven 3	15-16,29-30 July	6	8	8	13.0	113	258
Dam		Ven 2	10-12 July	0***	8	8	n/a	0	7
		Ven 1	7-9 July	6	8	8	14.7	0	2

* Anadromous zones also contain resident life-forms
** total captured by electrofishing + 1st-pass dive counts
*** water visibility was insufficient for pool dive counts

Length Frequencies (2006-2010). Length frequency analysis used only the measured fork length data for fish captured during electrofishing. Since electrofishing was not conducted in 2009, no data from that year is included. The relative frequencies shown in the following figures are the ratio of number of fish in a size category to the total number captured in the location.

In the lower basin (Reaches Ven 1, 2, 3, and 4) only two *O. mykiss* were captured prior to 2010, while 200 *O. mykiss* were captured and measured in 2010 (Figure 5). Meaningful length frequency comparisons are thus limited to the reaches sampled in 2010. In the lower two reaches, Ven 1 and Ven 2, only juvenile + *O mykiss* were captured. The lengths of these trout ranged from 120 cm to 179 mm, with the two *O. mykiss* from the lower reach at the shorter end of the range. In the lower basin, most of the trout (n=188, or 94% of the lower basin total) were captured in Ven 3. Both fry and juvenile+ trout were captured and the modal length frequency ranged between 110 and 139 mm fork length, thus suggesting a mixture of young-of-year (fry) and older juvenile trout. Only three fish were captured in Ven 4, two fry and one juvenile+. Streamflow in Ven 4 was low and declining at the time of sampling; several sites sampled on one day were completely dry by the next day. Snorkel observations revealed

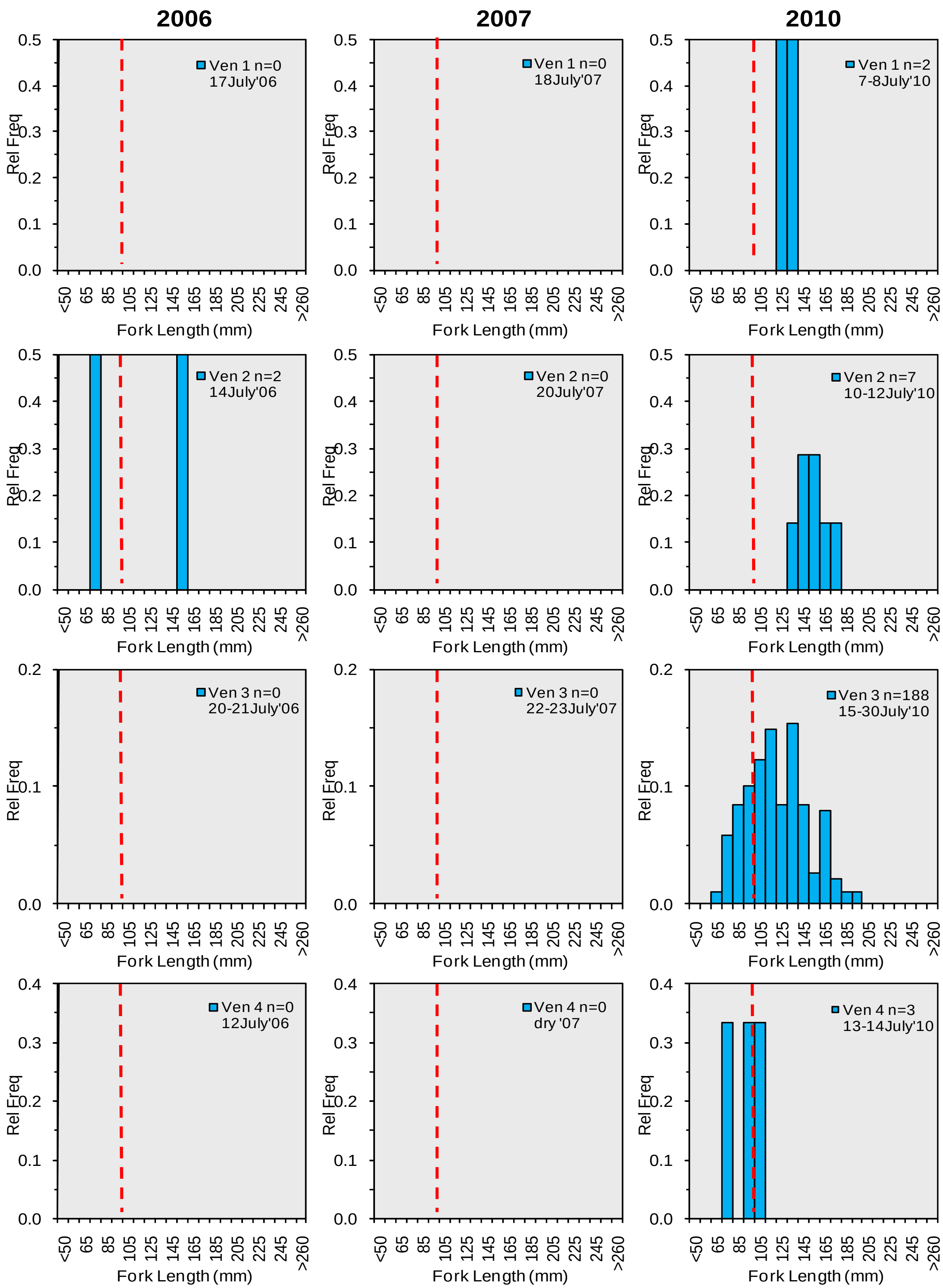

Figure 5. Relative length frequencies of *O. mykiss* captured by electrofishing in the in the Lower Basin Segment of the Ventura River in 2006, 2007, and 2010.

the presence of *O. mykiss* in the residual pool habitats, where the last remaining surface flow was evident in this reach.

Unlike the lower basin reaches, *O. mykiss* have been relatively abundant in the middle basin segments of the Ventura watershed in each of the three survey years (Figure 6). In Ven 5, above Robles Diversion Dam, more and larger fish were captured in 2010 than in previous years. The mode of the length frequency also moved to longer length class (90 to 99 mm interval) in 2010 compared to 2007 (50-59 mm interval), but was similar to the 2006 modal length (100-109 mm interval) mode in 2006. The unimodal length frequency distribution in 2010 suggests that young-of-year trout dominated the catch, and that many of those trout exceeded the 10cm size criteria used in the dive counts to represent fry (red line on graph). At both the Lower North Fork sites, all length frequency modes were in the fry range in all years, but with larger fish in both 2006 (when sampling occurred in late-August) and in 2010.

In the upper basin reaches, the numbers captured and length frequency data was very similar in 2010 compared to 2006 (Figure 7). No definite modal length frequency was present in Mat 3 in either 2006 or 2010, but both years suggested that fry frequently exceeded 10cm in length. During 2007, and in all years in Mat 5, the modal length frequency occurred in the fry range, with a secondary peak (perhaps 1+ trout) in the 150-200cm range. Access through private property to Mat 7 was denied in 2010 and no sampling was conducted in this reach. At the Upper North Fork site, the modal length frequency was consistently in the fry range for all years, suggesting slower growth (or later emergence) of young-of-year in that reach.

<u>Pool Dive Count Length Categories</u>. *O. mykiss* counted in the pool surveys were categorized by a binary size threshold: trout less 10 cm (fry) and trout larger than 10 cm (juvenile+). The dive count size estimates were examined by study reach over the five years of available data (Figure 8). As noted above, in several reaches the 10cm size criteria appeared too short to separate young-of-year (fry) from older trout, particularly in the larger, warmer mainstem reaches. Nevertheless, the length class pies may give an approximate assessment of changes in year-class strength over time.

In the lower basin, only data from Ven 3 is presented. Juvenile and older trout have dominated the pool counts in Ven 3 over the period of record, though relatively large numbers of trout <10cm were counted in this reach in 2010. In the Ven 5 study reach, juvenile+ *O. mykiss* dominated the counts in each year when trout were abundant, which suggests either rapid growth of fry into the juvenile+ size-class, or a relative lack of spawning habitat (verified by the HSI study, TRPA 2008) and a population dominated by juvenile recruits from the Lower North Fork, which enters the Ventura River at the top of the Ven 5 reach. Size-class trends in the two Lower North Fork reaches were highly similar between reaches, but variable between years. Juvenile+ trout dominated the pool dive counts in 2006 and 2008, whereas fry were more abundant in 2007

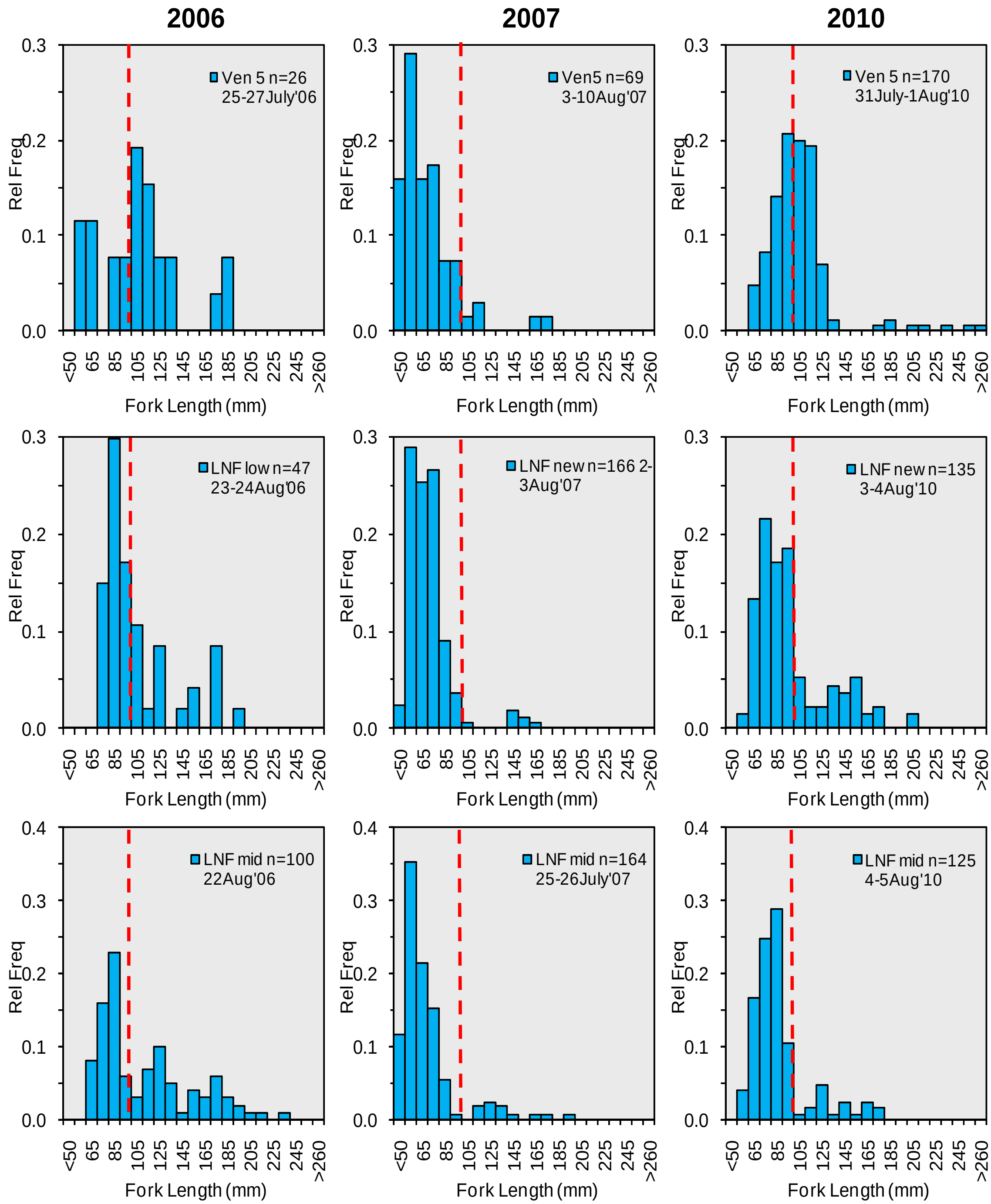

Figure 6. Relative length frequencies of *O. mykiss* captured by electrofishing in the in the Middle Basin Segment of the Ventura River in 2006, 2007, and 2010.

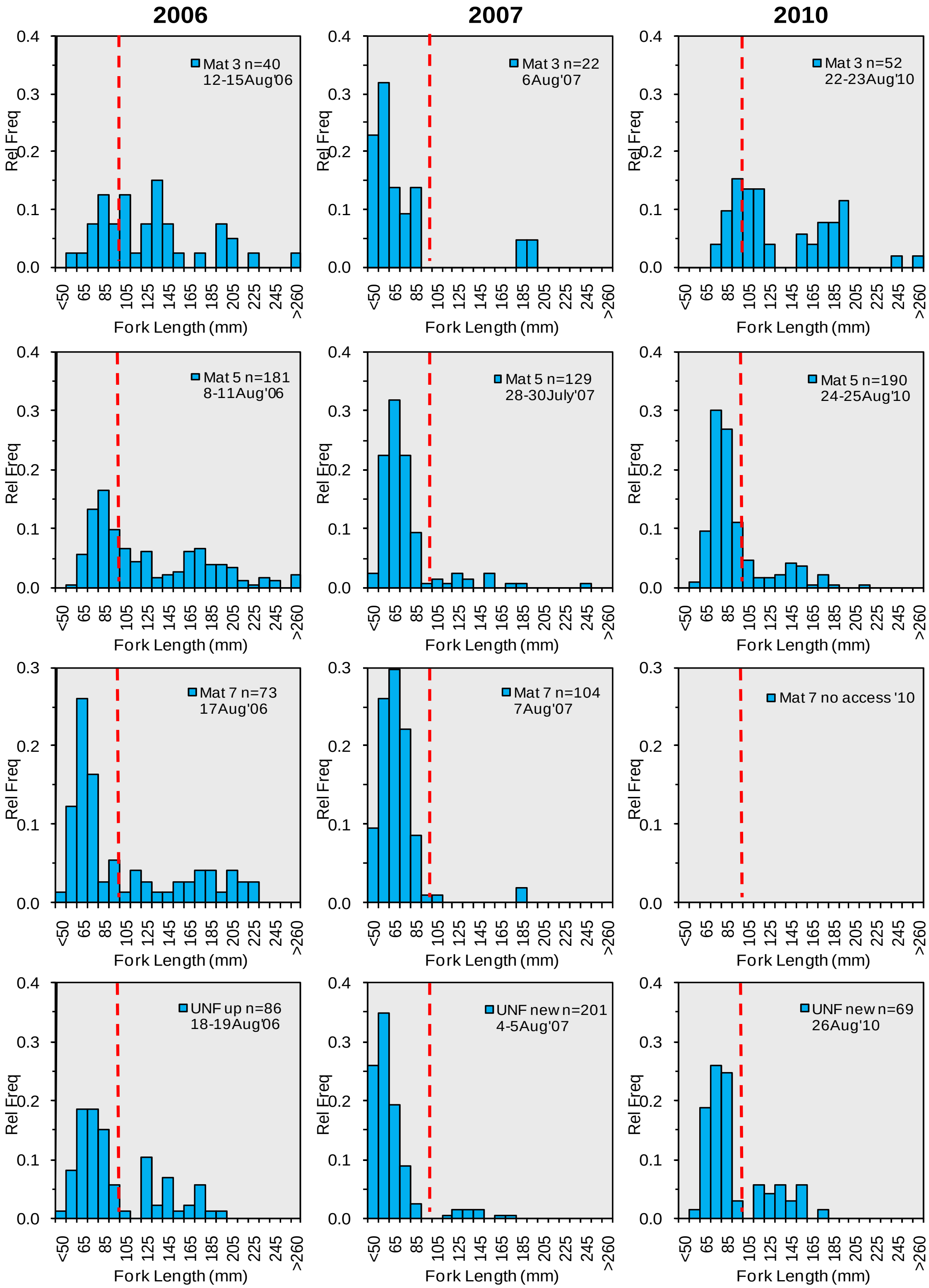

Figure 7. Relative length frequencies of *O. mykiss* captured by electrofishing in the in the Upper Basin Segment of the Ventura River in 2006, 2007, and 2010.

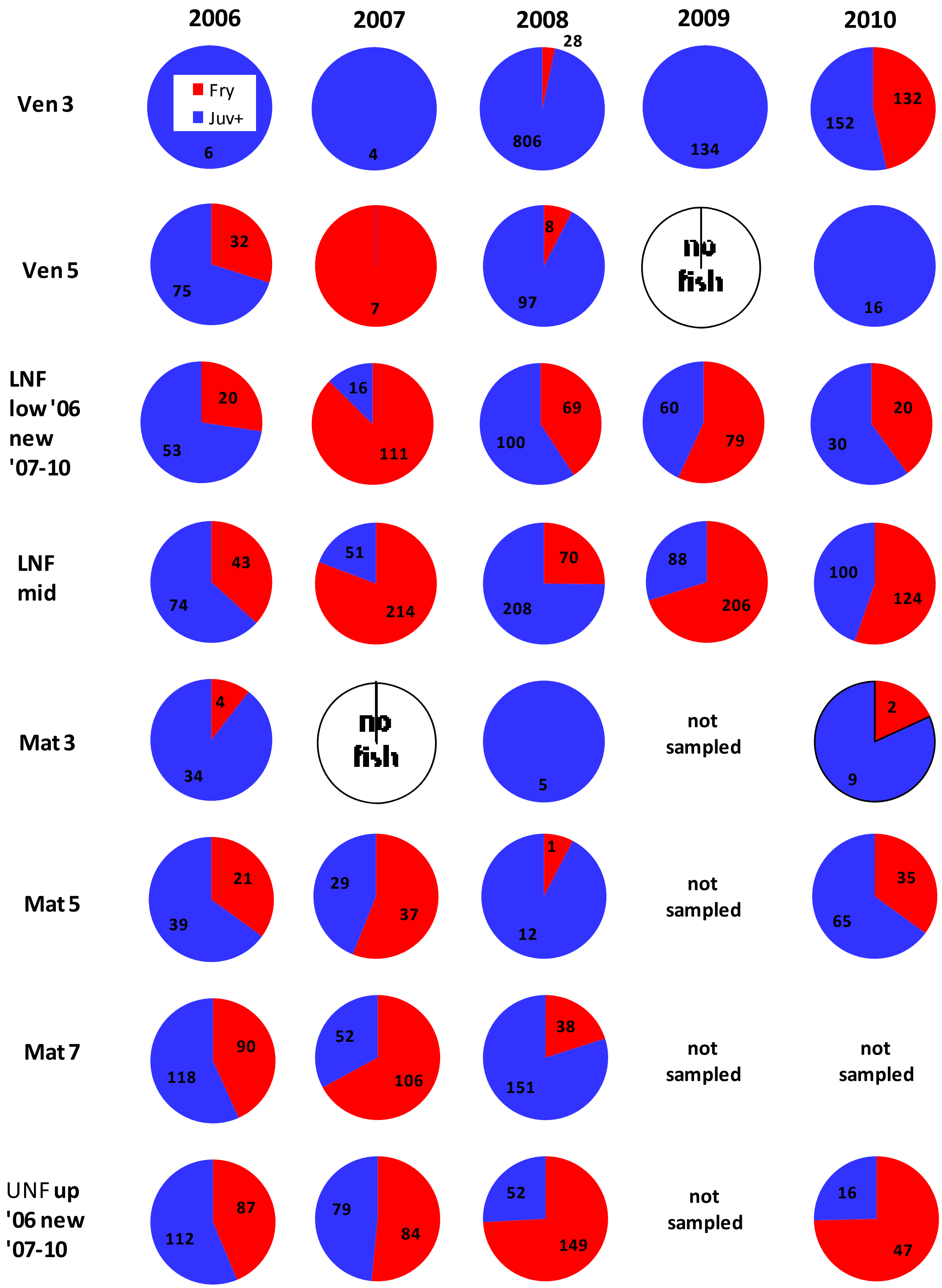

Figure 8. Relative proportion of *O. mykiss* fry (< 10 cm) and juvenile + (> 10 cm) from pool dive counts by year and study reach, 2006-2010. Numbers indicate actual first pass fish counts.

and 2009. Relative frequencies of fry and juvenile+ were fairly similar in 2010. Examination of the upper basin reaches (Mat 3, Mat 5, Mat 7, and Upper North Fork) pool count data suggests variable patterns of trout size distribution across sites and years. In 2006, *O. mykiss* juvenile + tended to dominate the count data, while in 2007 *O. mykiss* fry were relatively more abundant in the pool counts. In both 2008 and 2010, juvenile+ trout dominated the pool count data in mainstem Matilija reaches, while trout fry dominated the pool counts in the Upper North Fork site. There were no pool dive counts conducted in any of the upper basin sites in 2009. Likewise, no pool counts were made in the upper Matilija Creek site (Mat 7) in 2010 due to lack of access.

The length-frequency and size-class frequency distributions both suggest successful spawning and good recruitment of fry in 2007 and 2009 (pool data only), with a relatively strong fry year-class in 2010.

2010 Abundance and Density Estimates. The 2010 sampling results and associated statistics for *O. mykiss* abundance (total # fish) and density estimates (# fish/mile and # fish/100 ft^2) are presented in Table 2. The estimated abundance of *O. mykiss* fry across all habitats was highest in the Ven 3, LNF mid, and Mat 5 sites (Table 2 and Figure 9). Fry abundance was generally very low in the lower basin study reaches, except for Ven 3 where most fry occurred in pools and flatwaters. The Ven 3 site is just downstream of the San Antonio Creek confluence, which likely contributes to the higher abundance in this lower basin reach. Among the two San Antonio Creek study sites, no *O. mykiss* were observed in the middle site (as in 2009), but fry were present in low numbers in the upper site. Fry abundance was relatively high in all three of the middle basin sites (Ven 5, LNF new, LNF mid), with the highest abundances generally in the flatwater and riffle habitats. In the three upper basin sites surveyed in 2010, estimated fry abundance was highest in Mat 5, moderate in UNF new, and low in Mat 3. In the Mat 5 and UNF new reaches, fry abundance was highest in the flatwater habitats and lowest in pools.

Examination of the 2010 trout fry density estimates (# fish/100ft^2) across all habitats revealed the highest fry densities occurred in the LNF mid and UNF new sites, with intermediate densities in the Mat 5 and LNF new sites, and relatively low densities at the remaining sites (Table 2 and Figure 10). The highest fry densities occurred in the riffle habitats, with the lowest densities were in the pools.

The highest abundance estimate for *O. mykiss* juvenile+ during the 2010 survey occurred in the mainstem Ven 3 study site (Table 2 and Figure 11), with 2x to 7x the number of fish in most other reaches (although note the Ven 3 reach is one mile in length, whereas the Ven 4, San Antonio Creek, and all middle basin and upper basin reaches are ½ mile in length). As previously stated, Ven 3 is located just downstream of the San Antonio Creek confluence, which likely contributed toward the high trout abundance. Juvenile *O. mykiss* were only occasionally

Table 2. 2010 *O. mykiss* abundance and density estimates for the Ventura watershed by size class, habitat type, and study site.

Size Class	Habitat Type	Statistic	Ven 1	Ven 2	Ven 3	Ven 4	SAC mid	SAC up	Ven 5	LNF new	LNF mid	Mat 3	Mat 5	Mat 7*	UNF new
Fry <10cm	Pools	# Units Sampled	6	0	6	5	8	8	8	8	8	8	11	0	8
		Abundance	0	0	132	5	0	4	0	20	124	2	35	-	47
		Variance	0	0	30	0	0	0	0	264	394	1	18	-	246
		95% C.I.	0	0	14	1	0	0	0	38	47	2	9	-	37
		Density (#/mi)	0.0	0.0	511.0	51.0	0	70	0.0	89.0	586.0	19.0	265	-	285
		Variance (#/mi)	0.00	0.00	454.00	25.00	0	0	0.00	5,215.00	8,834.00	66.00	1,020	-	9,159
		95% C.I. (#/mi)	0.0	0.0	55.0	14.0	0	0	0.0	171.0	222.0	19.0	71	-	226
		Density (#/100ft^2)	0.00	0.00	0.31	0.02	0.00	0.10	0.00	0.10	1.06	0.01	0.17	-	0.59
		Variance (#/100ft^2)	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0068	0.0287	0.00002	0.0004	-	0.0397
		95% C.I. (#/100ft^2)	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.19	0.40	0.01	0.04	-	0.47
	Flatwaters	# Units Sampled	8	8	8	6	0	0	8	8	8	8	8	0	8
		Abundance	0	0	143	0	-	-	101	55	142	15	216	-	81
		Variance	0	0	10417	0	-	-	997	151	431	69	1378	-	136
		95% C.I.	0	0	241	0	-	-	75	29	49	20	88	-	28
		Density (#/mi)	0.0	0.0	297.0	0.0	-	-	423	538	954	57.0	920	-	523
		Variance (#/mi)	0.00	0.00	44,838.00	0.00	-	-	17,568	14,320	19,380	984.00	25,057	-	5,608
		95% C.I. (#/mi)	0.0	0.0	501.0	0.0	-	-	313	283	329	74.0	374	-	177
		Density (#/100ft^2)	0.00	0.00	0.21	0.00	-	-	0.26	0.71	1.84	0.03	0.72	-	1.22
		Variance (#/100ft^2)	0.0000	0.0000	0.0234	0.0000	-	-	0.0066	0.0248	0.0724	0.0003	0.0155	-	0.0307
		95% C.I. (#/100ft^2)	0.00	0.00	0.36	0.00	-	-	0.19	0.37	0.64	0.04	0.29	-	0.41
	Riffles	# Units Sampled	8	8	8	8	0	0	8	8	8	8	8	0	8
		Abundance	0	0	56	5	-	-	111	84	76	11	109	-	58
		Variance	0	0	331	2	-	-	418	105	17	6	387	-	60
		95% C.I.	0	0	43	3	-	-	48	24	10	6	47	-	18
		Density (#/mi)	0.0	0.0	288.0	38.0	-	-	1,110	1,256	1,488	125.0	1,498	-	823
		Variance (#/mi)	0.00	0.00	8,825.00	113.00	-	-	42,131	23,545	6,639	780.00	73,614	-	12,118
		95% C.I. (#/mi)	0.0	0.0	222.0	25.0	-	-	485	363	193	66.0	642	-	260
		Density (#/100ft^2)	0.00	0.00	0.22	0.02	-	-	0.77	1.82	3.17	0.08	0.77	-	1.56
		Variance (#/100ft^2)	0.0000	0.0000	0.0050	0.00003	-	-	0.0203	0.0492	0.0301	0.0003	0.0194	-	0.0435
		95% C.I. (#/100ft^2)	0.00	0.00	0.17	0.01	-	-	0.30	0.52	0.41	0.04	0.33	-	0.49
Fry <10cm	All Habitats	# Units Sampled	22	16	22	19	0	0	24	24	24	24	27	0	24
		Abundance	0	0	330	10	-	-	211	159	342	28	360	-	186
		Variance	0	0	10778	2	-	-	1415	520	842	76	1783	-	442
		95% C.I.	0	0	217	3	-	-	78	47	60	18	87	-	44
		Density (#/mi)	0.0	0.0	354.0	17.0	-	-	396	403	831	61	817	-	477
		Variance (#/mi)	0.00	0.00	12,388.00	6.00	-	-	4,973	3,341	4,983	345	9,211	-	2,907
		95% C.I. (#/mi)	0.0	0.0	233.0	5.0	-	-	147	120	147	39	198	-	112
		Density (#/100ft^2)	0.00	0.00	0.25	0.01	-	-	0.24	0.49	1.57	0.04	0.55	-	1.02
		Variance (#/100ft^2)	0.0000	0.0000	0.0060	0.0000	-	-	0.0018	0.0050	0.0177	0.0001	0.0042	-	0.0133
		95% C.I. (#/100ft^2)	0.00	0.00	0.16	0.003	-	-	0.09	0.15	0.28	0.02	0.13	-	0.24

Table 2. (continued)

Size Class	Habitat Type	Statistic	Ven 1	Ven 2	Ven 3	Ven 4	SAC mid	SAC up	Ven 5	LNF new	LNF mid	Mat 3	Mat 5	Mat 7*	UNF new
Juv+ ≥10cm	Pools	# Units Sampled	6	0	6	5	8	8	8	8	8	8	11	0	8
		Abundance	0	0	152	19	0	47	16	30	100	9	65	-	16
		Variance	0	0	12	1	0	11	30	110	292	9	134	-	34
		95% C.I.	0	0	9	2	0	8	13	25	40	7	26	-	14
		Density (#/mi)	8	0.0	589.0	196.0	0	822	82.0	133	472	77.0	488	-	95
		Variance (#/mi)	0	0.00	180.00	85.00	0	3,318	780.00	2,182	6,539	669.00	7,608	-	1,273
		95% C.I. (#/mi)	0	0.0	34.0	26.0	0	136	66.0	110	191	61.0	194	-	84
		Density (#/100ft^2)	0.00	0.00	0.36	0.08	0.00	1.19	0.04	0.15	0.85	0.05	0.31	-	0.20
		Variance (#/100ft^2)	0.0000	0.0000	0.0001	0.0000	0.0000	0.0069	0.0002	0.0028	0.0213	0.0003	0.0030	-	0.0055
		95% C.I. (#/100ft^2)	0.00	0.00	0.02	0.01	0.00	0.20	0.04	0.13	0.34	0.04	0.12	-	0.18
	Flatwaters	# Units Sampled	8	8	8	6	0	0	8	8	8	8	8	0	8
		Abundance	3	0	244	0	-	-	133	26	28	55	75	-	54
		Variance	7	0	4562	0	-	-	1231	12	49	657	394	-	114
		95% C.I.	6	0	160	0	-	-	83	8	17	61	47	-	25
		Density (#/mi)	7.0	0.0	506.0	0.0	-	-	559	253	191	207	319	-	349
		Variance (#/mi)	37.00	0.00	19,635	0.00	-	-	21,690	1,102	2,207	9,377	7,172	-	4,697
		95% C.I. (#/mi)	14.0	0.0	331.0	0.0	-	-	348	78	111	229	200	-	162
		Density (#/100ft^2)	0.01	0.00	0.37	0.00	-	-	0.34	0.33	0.37	0.12	0.25	-	0.82
		Variance (#/100ft^2)	0.00004	0.0000	0.0103	0.0000	-	-	0.0081	0.0019	0.0082	0.0032	0.0044	-	0.0257
		95% C.I. (#/100ft^2)	0.014	0.00	0.24	0.00	-	-	0.21	0.10	0.21	0.13	0.16	-	0.38
Juv+ ≥10cm	Riffles	# Units Sampled	8	8	8	8	0	0	8	8	8	8	8	0	8
		Abundance	2	15	165	0	-	-	101	29	12	19	21	-	7
		Variance	2	32	2396	0	-	-	342	23	0	0	10	-	1
		95% C.I.	3	13	116	0	-	-	44	11	2	0	8	-	3
		Density (#/mi)	11.0	59.0	854.0	0.0	-	-	1,009	431	240	217	288	-	106
		Variance (#/mi)	60.00	490.00	63,952.00	0.00	-	-	34,442	5,143	194	0	1,969	-	260
		95% C.I. (#/mi)	18.0	52.0	598.0	0.0	-	-	439	170	33	0	105	-	38
		Density (#/100ft^2)	0.010	0.04	0.65	0.00	-	-	0.70	0.62	0.51	0.14	0.15	-	0.20
		Variance (#/100ft^2)	0.00005	0.0002	0.0365	0.0000	-	-	0.0166	0.0107	0.0009	0.0000	0.0005	-	0.0009
		95% C.I. (#/100ft^2)	0.016	0.03	0.45	0.00	-	-	0.30	0.25	0.07	0.00	0.05	-	0.07
	All Habitats	# Units Sampled	22	16	22	19	0	0	24	24	24	24	27	0	24
		Abundance	5	15	561	19	-	-	250	85	140	83	161	-	77
		Variance	9	32	6970	1	-	-	1603	145	341	666	539	-	149
		95% C.I.	6	12	175	2	-	-	83	25	38	54	48	-	25
		Density (#/mi)	6.0	14.7	601.0	32.5	-	-	468	215	341	176	1,208	-	198
		Variance (#/mi)	13	30.00	8,010.80	2.30	-	-	5,631	932	2,020	3,031	30,499	-	982
		95% C.I. (#/mi)	8	11.8	187.3	3.2	-	-	156	63	93	114	360	-	65
		Density (#/100ft^2)	0.005	0.008	0.42	0.02	-	-	0.280	0.26	0.64	0.11	0.25	-	0.42
		Variance (#/100ft^2)	0.00001	0.00001	0.0040	0.0000	-	-	0.0020	0.0014	0.0072	0.0011	0.0013	-	0.0045
		95% C.I. (#/100ft^2)	0.007	0.007	0.13	0.002	-	-	0.090	0.08	0.18	0.07	0.07	-	0.14

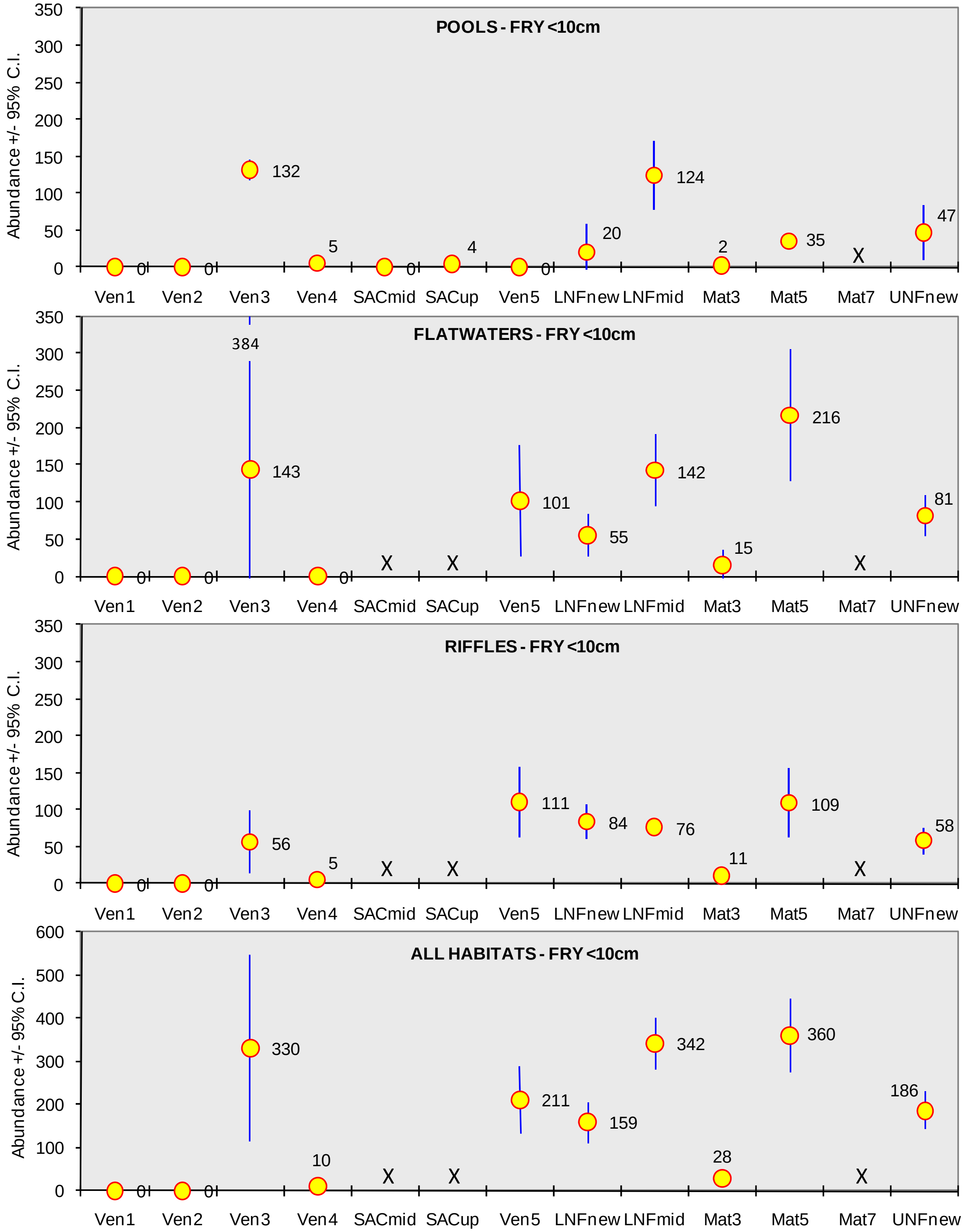

Figure 9. 2010 abundance estimates for *O. mykiss* fry by habitat type and study site.

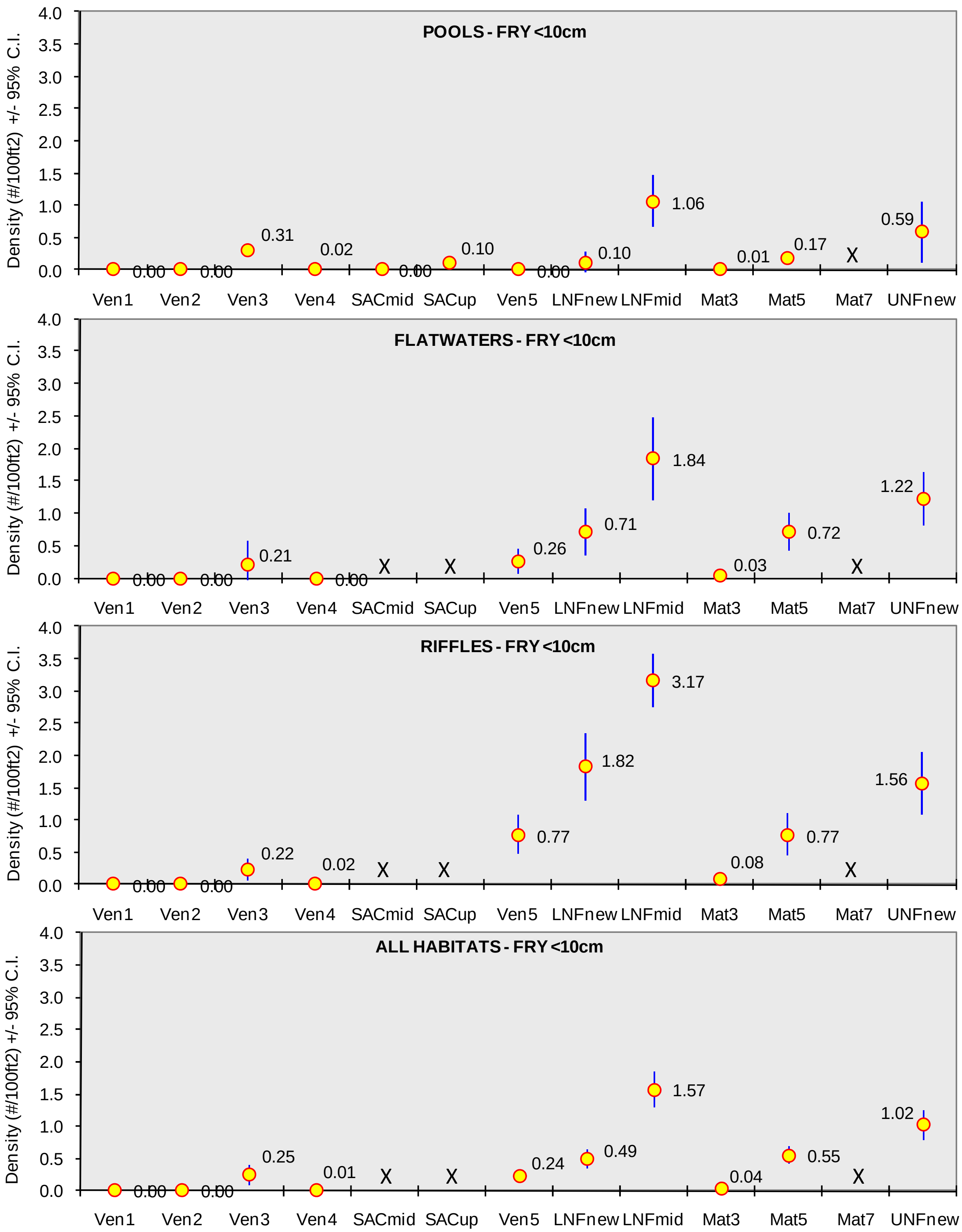

Figure 10. 2010 density estimates for *O. mykiss* fry by habitat type and study site.

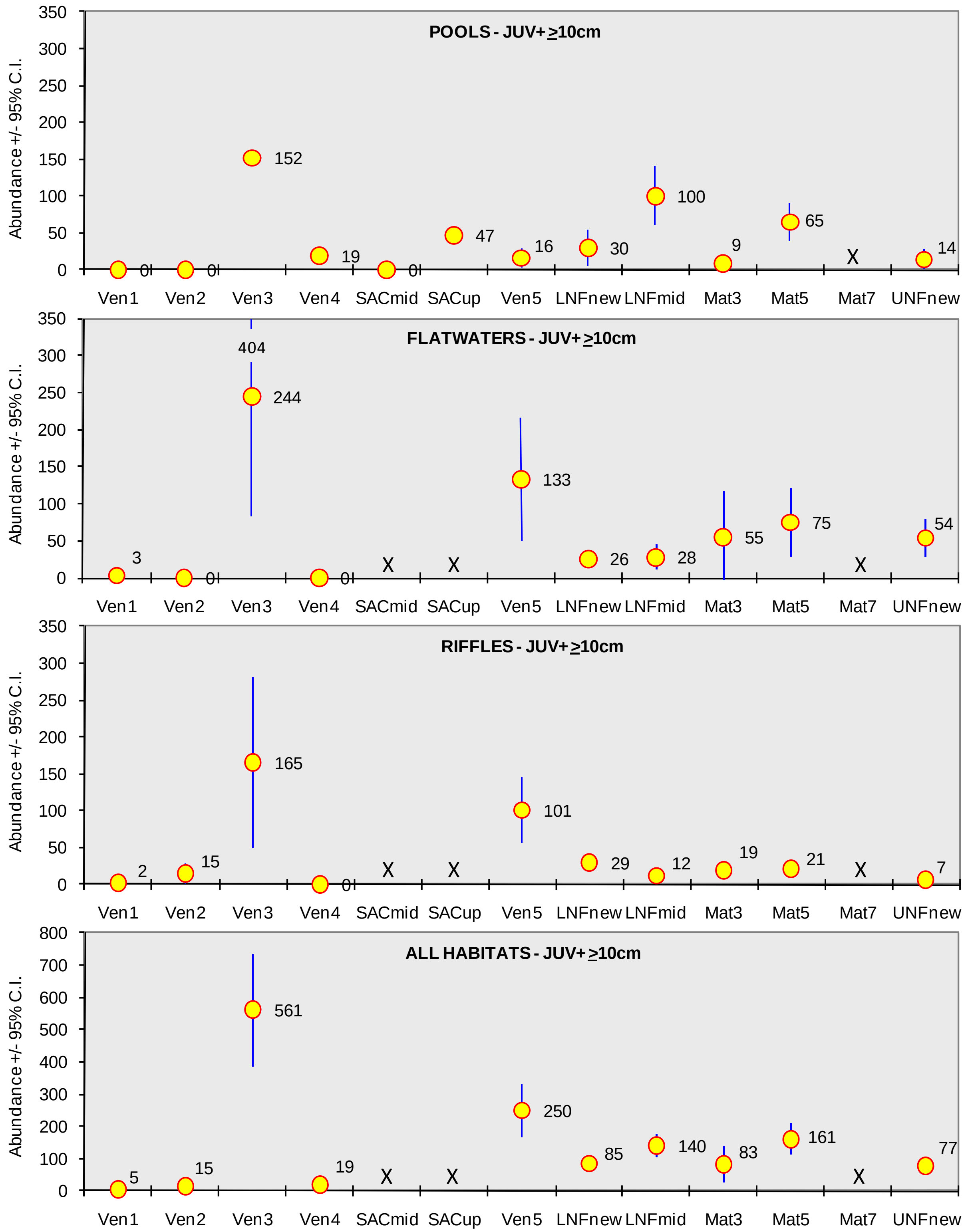

Figure 11. 2010 abundance estimates for *O. mykiss* juvenile+ by habitat type and study site.

observed in the Ven 4 study site, but were observed in five of the eight pools sampled in the upper San Antonio Creek site. Relatively high juvenile abundance was also noted in the Ven 5 reach, with intermediate juvenile+ abundances in the remaining middle and upper basin sites. Except for the LNF mid site, where the highest juvenile+ trout abundances occurred in the pools, the highest juvenile abundances in the middle and upper basin reaches typically occurred in the flatwater habitats.

Examination of the 2010 juvenile+ trout density estimates across all habitats revealed the highest densities occurred in the Ven 3, LNF mid and UNF new sites, with intermediate densities in the Ven 5, LNF new, and Mat 5 sites and relatively low densities at the remaining sites (Table 2 and Figure 12). Among pools only, the upper San Antonio Creek study site had the highest density of juvenile+ trout, followed by the LNF mid study site. Juvenile+ densities in pools in those two study sites were significantly greater than comparative pool densities in all other study sites. During 2010 there was no clear pattern of juvenile+ density within specific habitat types. In some reaches the highest densities occurred in pools (LNF mid, Mat 5), while in others the highest densities were noted in riffles (Ven 3, Ven 5, LNF new) or flatwaters (UNF new).

Annual Trends in Abundance. A comparison of annual *O. mykiss* fry and juvenile abundance estimates over five years (2006 to 2010) by habitat type is shown for the lower basin sites (Figures 13 and 14), the middle basin sites (Figures 15 and 16) and the upper basin sites (Figure 17 and 18). Annual trends are not available for either of the two San Antonio Creek study sites since they were only surveyed in a quantitative manner in 2010.

In the lower Ventura River basin sites, *O. mykiss* fry and juveniles have only been commonly observed in the Ven 3 reach, except for isolated observations in Ven 2 riffles in 2006 and in Ven 4 pools and riffles in 2010. Although *O. mykiss* fry were not observed in Ven 3 in 2006, 2007, or 2009, they were moderately abundant in 2008 and very abundant in 2010 (Figure 13). Large annual changes in fry abundance were observed in both pools and flatwaters in Ven 3, but only the changes in pool habitats were statistically significant (based on non-overlap of the 95% confidence intervals). The abundance of *O. mykiss* juvenile+ in Ven 3 pools and flatwater habitat exhibited large increases in 2008 followed by a decline in 2009 (Figure 14). In Ven 3 pool habitats the juvenile abundance remained virtually unchanged from 2009 through 2010, but in flatwaters the abundance increased significantly in 2010. Juvenile+ trout abundance estimates in the remaining lower basin sites have remained consistently low (zero or near zero) over the entire five year period.

In the middle Ventura River basin sites, *O. mykiss* fry and juvenile+ abundance estimates exhibit variable temporal patterns (Figures 15 and 16). In Ven 5 trout fry abundance generally declined in pools and flatwaters from 2006 through 2009 (Figure 15). The 2010 Ven 5 estimates continued to show low fry abundance in pools, but a significant increase in fry abundance in the flatwater habitats. 2010 fry abundance estimates in Ven 5 riffles appears to be similar to levels

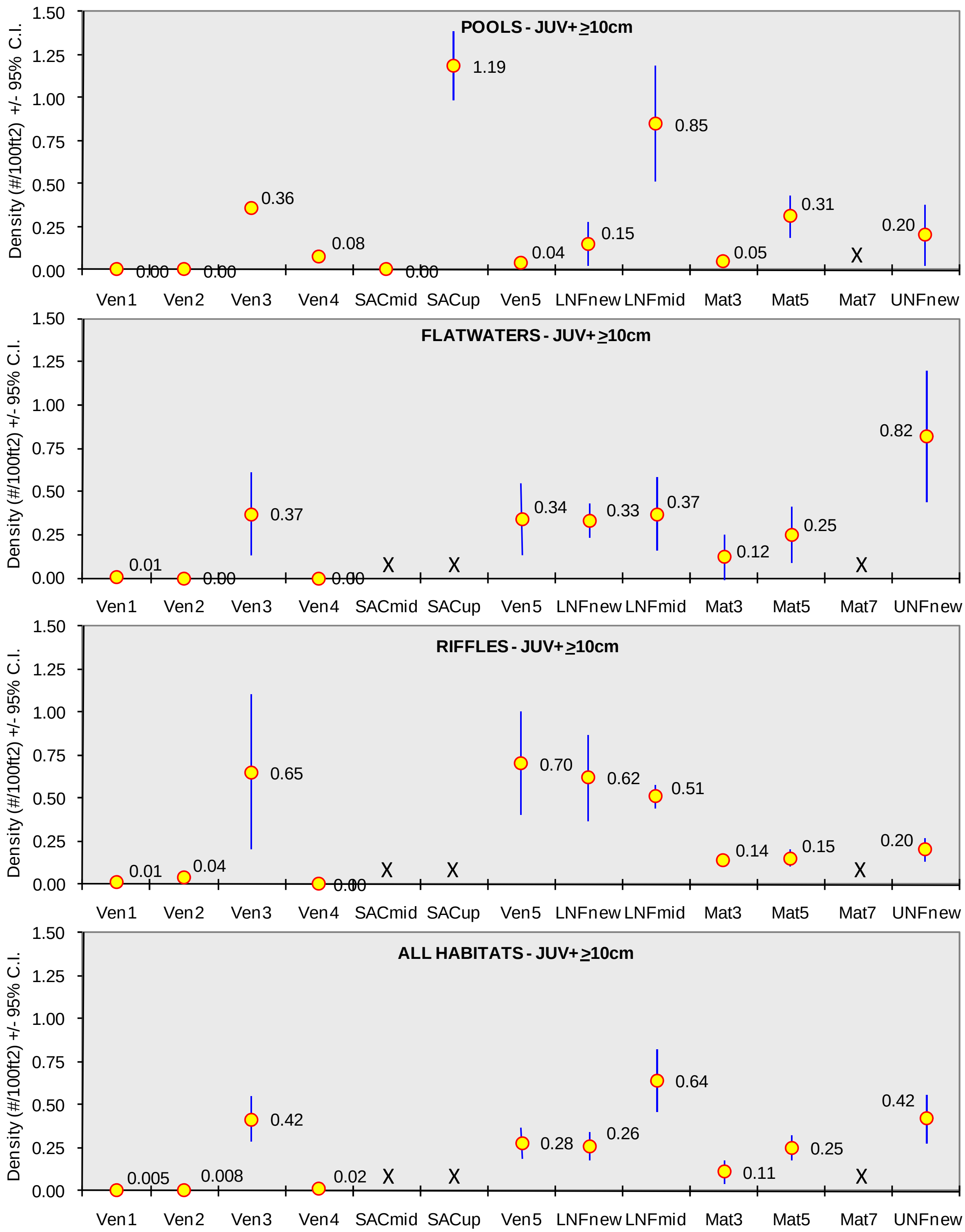

Figure 12. 2010 density estimates for *O. mykiss* juvenile+ by habitat type and study site.

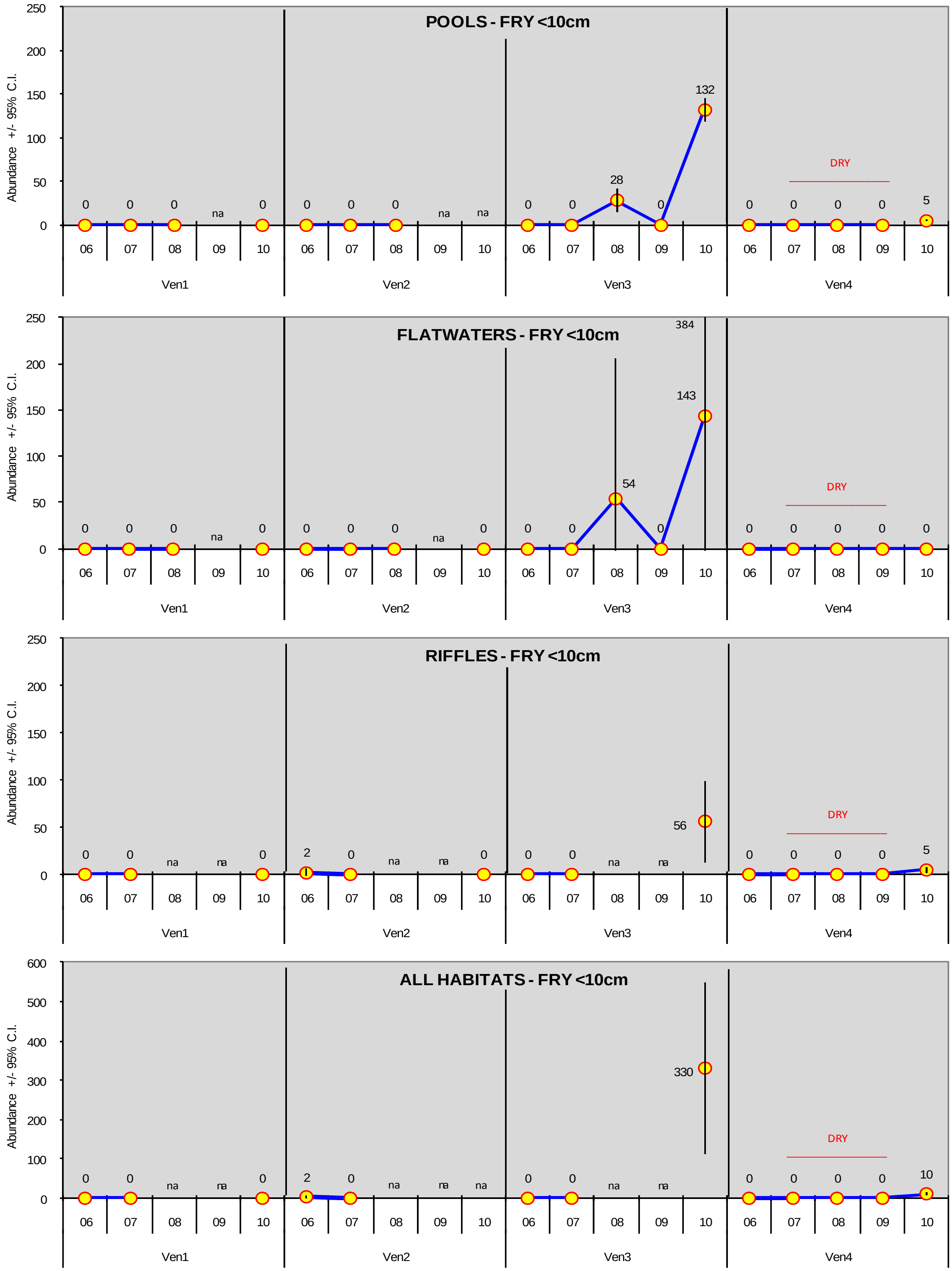

Figure 13. Abundance estimates for *O. mykiss* fry in lower Ventura River basin by year, habitat type, and study site.

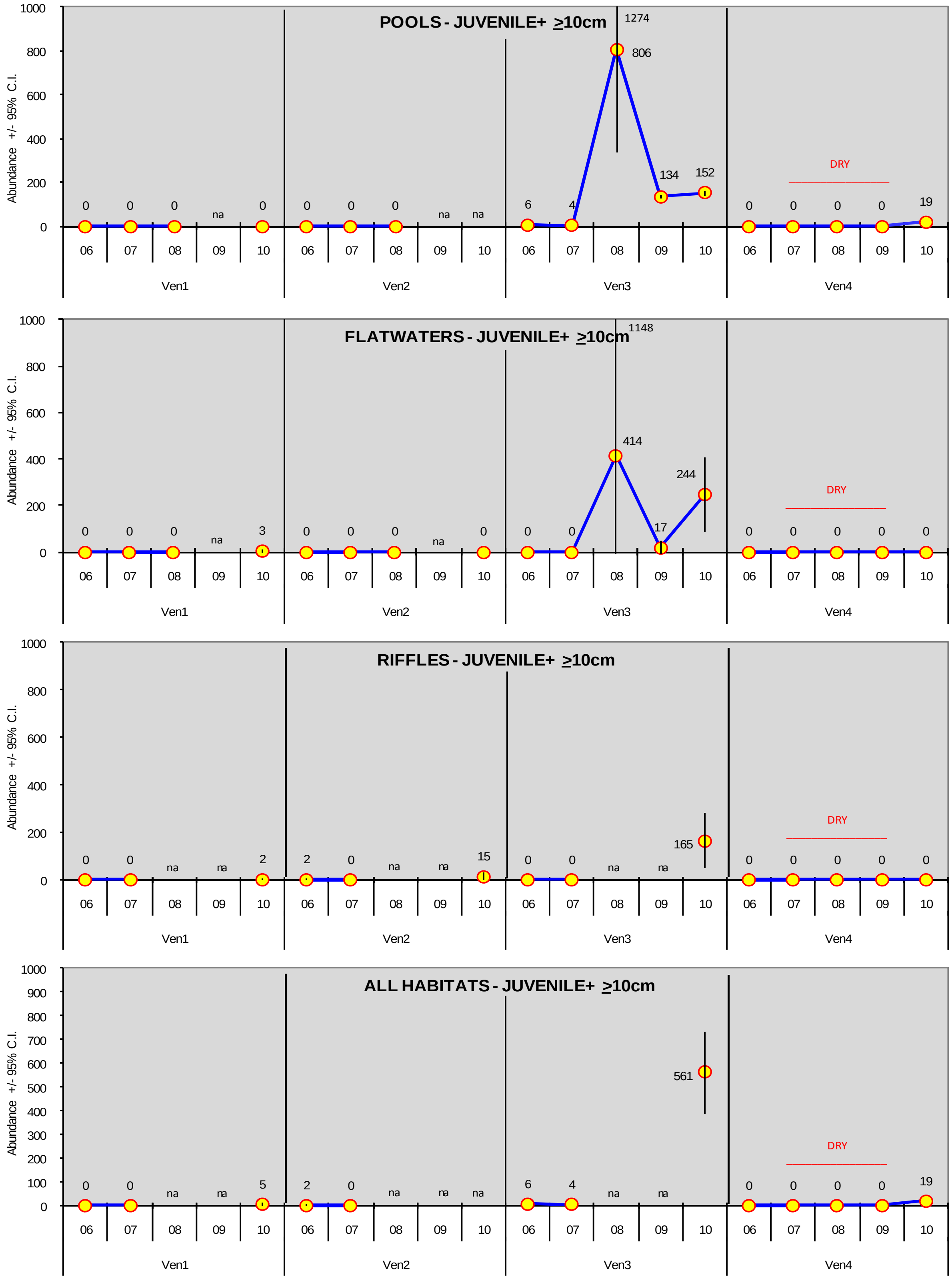

Figure 14. Abundance estimates for *O. mykiss* juvenile+ in lower Ventura River basin by year, habitat type, and study site.

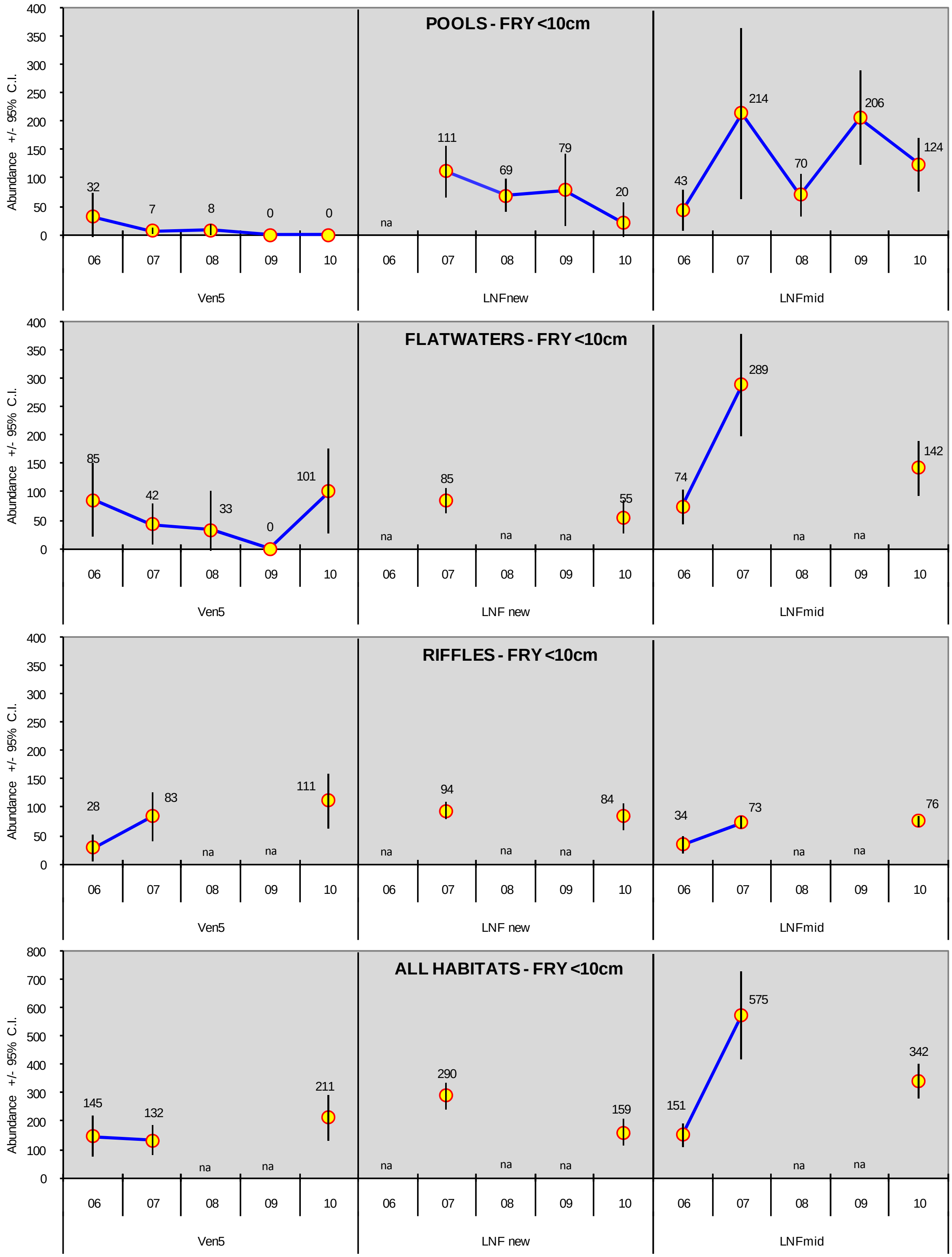

Figure 15. Abundance estimates for *O. mykiss* fry in middle Ventura River basin by year, habitat type, and study site.

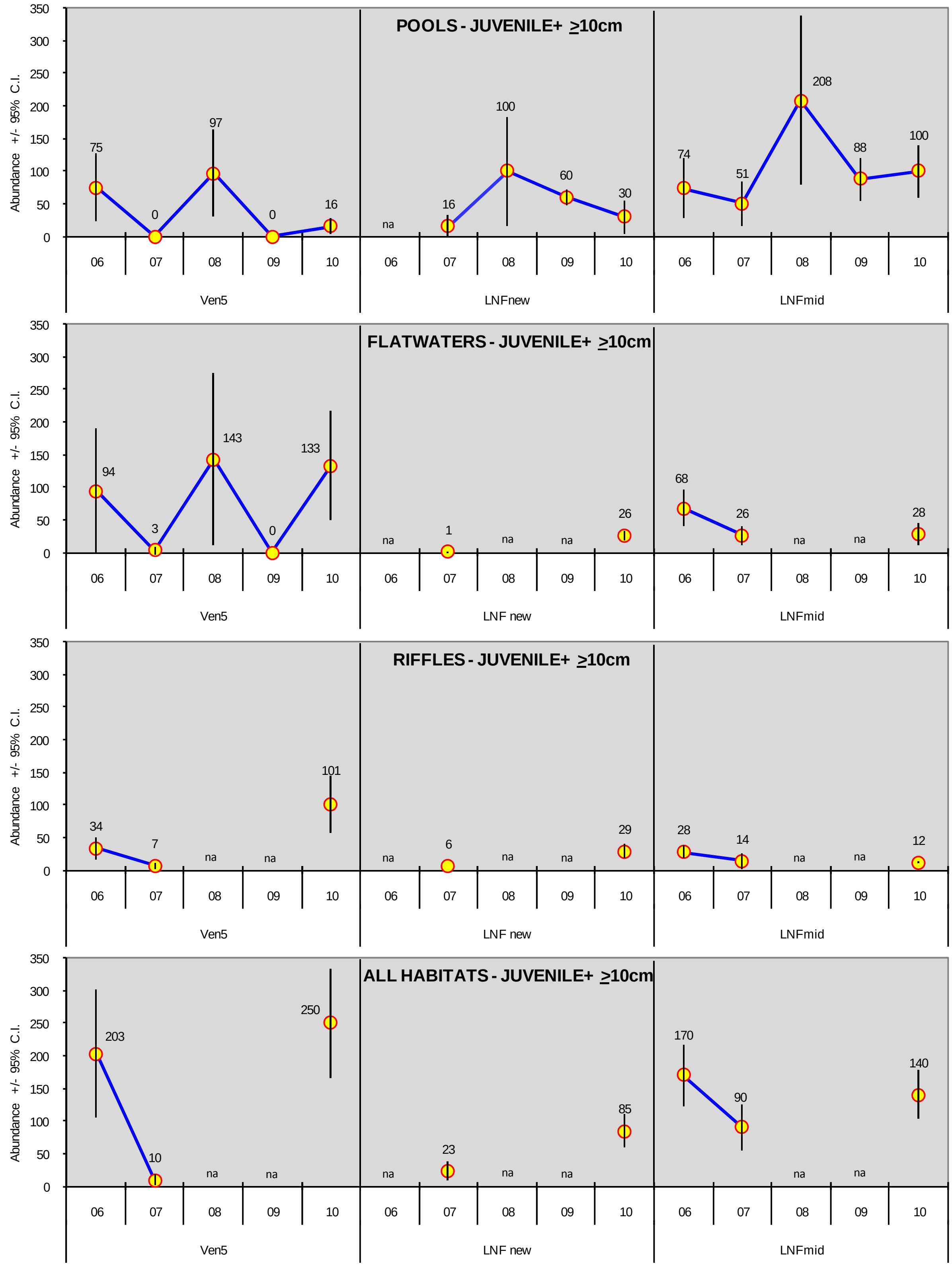

Figure 16. Abundance estimates for *O. mykiss* juvenile+ in middle Ventura River basin by year, habitat type, and study site.

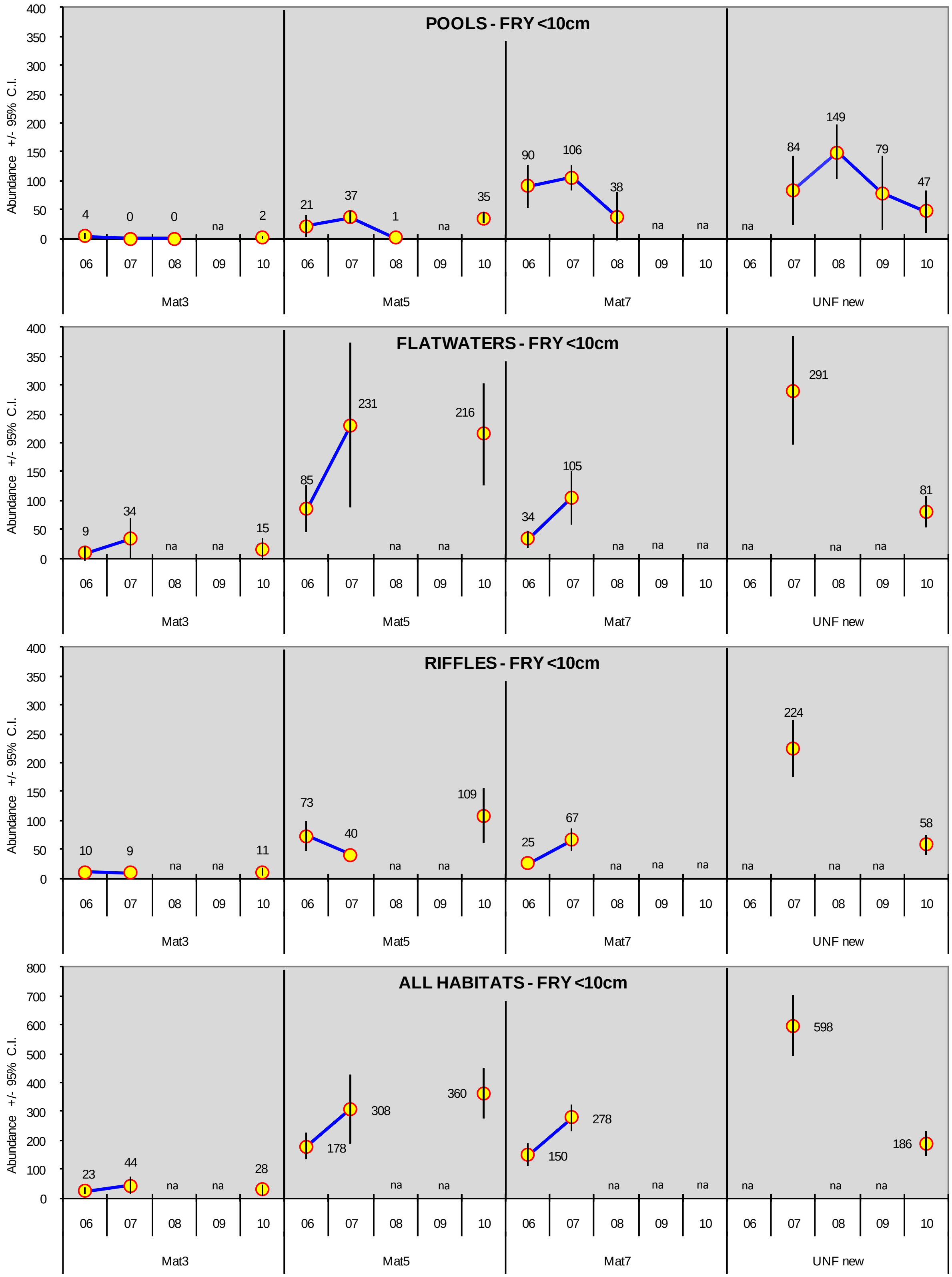

Figure 17. Abundance estimates for *O. mykiss* fry in upper Ventura River basin by year, habitat type, and study site.

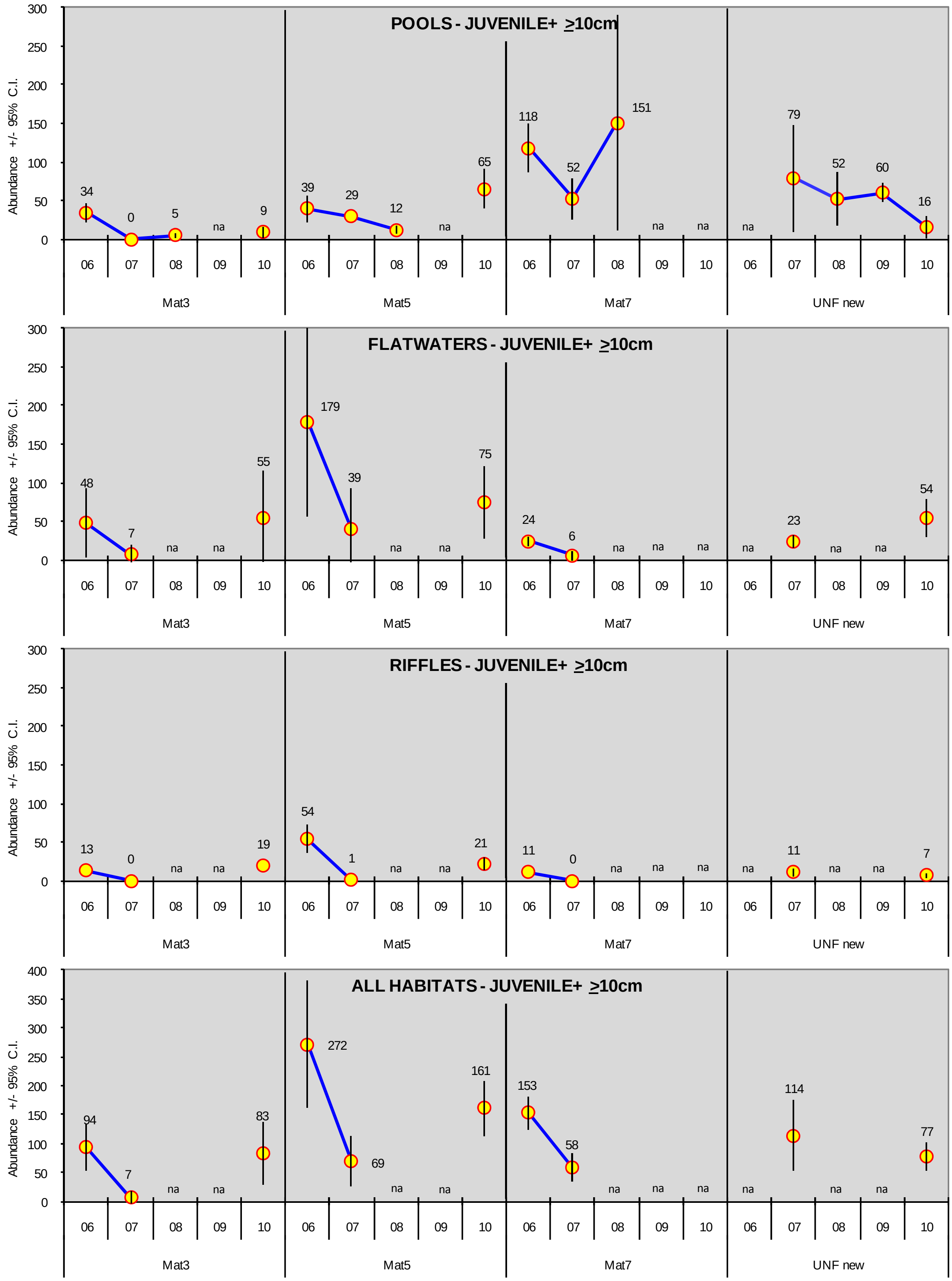

Figure 18. Abundance estimates for *O. mykiss* juvenile+ in upper Ventura River basin by year, habitat type, and study site.

noted in 2007, the last year for which comparable data is available. In the LNF new site, the 2010 estimate of fry abundance in pools was significantly less than in 2007, whereas 2007 and 2010 estimates in flatwaters and riffles were not significantly different. In the LNF mid site, fry abundance estimates are quite variable from year to year. The pool estimates for trout fry in this reach show a fluctuating pattern of increasing and decreasing abundances over the period of record. Lack of estimates in LNF mid flatwater and riffle habitat for 2008 and 2009 make annual comparisons impossible, but in general, 2010 fry abundances were approximately double the estimates from 2006.

For larger juvenile+ trout, abundance estimates in Ven 5 pools and flatwaters also show a sequential pattern of decreasing and increasing abundances over the period of record (Figure 16), with zero or near zero abundance in 2007 and 2009. This sequence exhibits a one-year lag from the fluctuations observed in fry abundance, which is likely due in part to the carryover of strong fry year classes from one year (e.g., 2007 and 2009, Figure 15) to high abundance of juvenile+ trout the following year (e.g., 2008 and 2010). This relationship between fry and juvenile+ size classes was noted and described more fully in previous reports (see TRPA 2009). In the LNF new site, temporal pattern of juvenile+ trout abundance estimates in pools showed a decline since 2008, however the 2010 estimates remained higher than equivalent estimates from 2007 in all three habitat types and, as in Ven 5, was significantly greater in the combined estimate. The abundance estimates for juvenile+ in LNF mid habitats generally followed the same pattern as for the lower study sites, with a decrease in abundance from 2006 to 2007, maximum abundance in 2008, and 2010 estimates somewhat greater than the 2007 minima.

In the upper Ventura River basin sites, *O. mykiss* fry abundance was typically highest in the 2007, according to the combined habitat estimates (Figure 17). Within pool habitats, abundance estimates were lowest in 2008 in both the Mat 5 and the Mat 7 reaches, whereas the UNF reach showed the highest estimate in 2008. Like for fry in the middle basin sites, the 2010 abundance estimates for fry were lower in than in 2007, with statistically significant differences in flatwaters, riffles, and combined habitat types. The opposite abundance pattern was noted for juvenile+ *O. mykiss* abundance in the upper basin sites (Figure 18), that is the lowest abundances tended to occur in 2007 (perhaps following a year of poor fry recruitment). The exception to this pattern was for the UNF new site, where abundance of juvenile+ trout was lower still (though not significantly so) in 2010. In general, however, the 2010 abundance estimates for juvenile+ trout in the upper basin reaches in 2007 and 2010 were relatively similar.

<u>Basin Segment Abundance Estimates</u>. The abundance estimates for *O. mykiss* fry and juvenile+ were pooled within basin segments (lower, middle, and upper) to show annual trends in a more simplified manner. Because electrofishing in flatwaters and riffles was not conducted in 2008 or 2009 (due to budget and permitting limitations), comparisons showing total abundance combined across all three habitat types is only available for three of the five study years. In contrast, pools were sampled each of the five years (except in the upper basin); thus the basin segment

comparisons for pools only are shown separately. Note that the basin segment estimates are expanded estimates that account for study reaches not represented by a study site, and consequently they are greater than the sum of the individual study site estimates. This expansion is intended to generate abundance estimates that represent all available habitat below impassable waterfall barriers in the mainstem Ventura River and Matilija Creek as well as in the Lower North Fork Matilija Creek and Upper North Fork Matilija Creek, but does not account for habitat in other tributaries (e.g., San Antonio Creek, Murietta Creek, etc.).

For the estimates combined across all three habitat types (pools, flatwaters, and riffles) in 2006, 2007, and 2010 (Figure 19), the highest fry abundance estimates in the lower basin occurred in 2010 at 709 fry. Prior to 2010, estimated fry abundance in the lower basin was near zero. The highest trout fry abundances in the middle and upper basins occurred in 2007. In each of three years with comparable data, *O. mykiss* fry abundance increased in an "upstream direction". In other words, each year, the lowest trout fry abundances occurred in the lower basin, intermediate trout fry abundances occurred in the middle basin and the highest trout fry abundances occurred in the upper basin. The increases from 2006 to 2007 were statistically significant in the middle and upper basin segments, but the 2010 estimates were not significantly different from either of the previous year's estimates, although the 2010 middle basin estimate was almost double the 2006 estimate. The 2010 fry estimate in the middle basin (3,357 fish) was approximately 80% of the maximum estimate in 2007 (4,250 fry), whereas in the upper basin the 2010 estimate (3,713 fry) was only 60% of the 2007 value of 6,294 fry.

Similar to the fry data, the highest juvenile+ abundance estimates in the lower basin segment occurred in 2010 at 1,250 fish, which was significantly greater than the 2006 and 2007 estimates, which were less than 25 trout (Figure 19). The highest trout juvenile+ abundances in the middle and upper basin segments occurred in 2006, at 2,269 trout and 4,703 trout, respectively. The 2010 estimated abundance of juvenile+ fish in the middle basin (2,240 trout) was essentially identical to the 2006 estimate, whereas the 2010 estimate in the upper basin was significantly less (at 2,082 trout) than the 2006 estimate. The 2010 estimates were both greater than the 2007 estimates, although only the difference in the middle reach was statistically significant. The pattern of increasing trout abundance in the upstream direction noted for fry was also evident for juvenile+ trout, except for the middle and upper basin estimates in 2010 which were similar.

Five years of comparative data are available when comparing pool-only data, except for 2009 when sampling did not occur in the upper basin (Figure 20). The pool data showed generally similar trends as the combined habitat data for 2006 and 2007, with the addition of the marked decrease in abundance of fry in 2008 followed by an equally marked increase in 2009 (for fry), and opposite trends (increases in 2008 followed by decreases in 2009) for juvenile+. These opposing trends for fry and juvenile+ are likely to be due in part to the carryover of strong or weak fry year-classes into the juvenile+ size class the following year, as previously described.

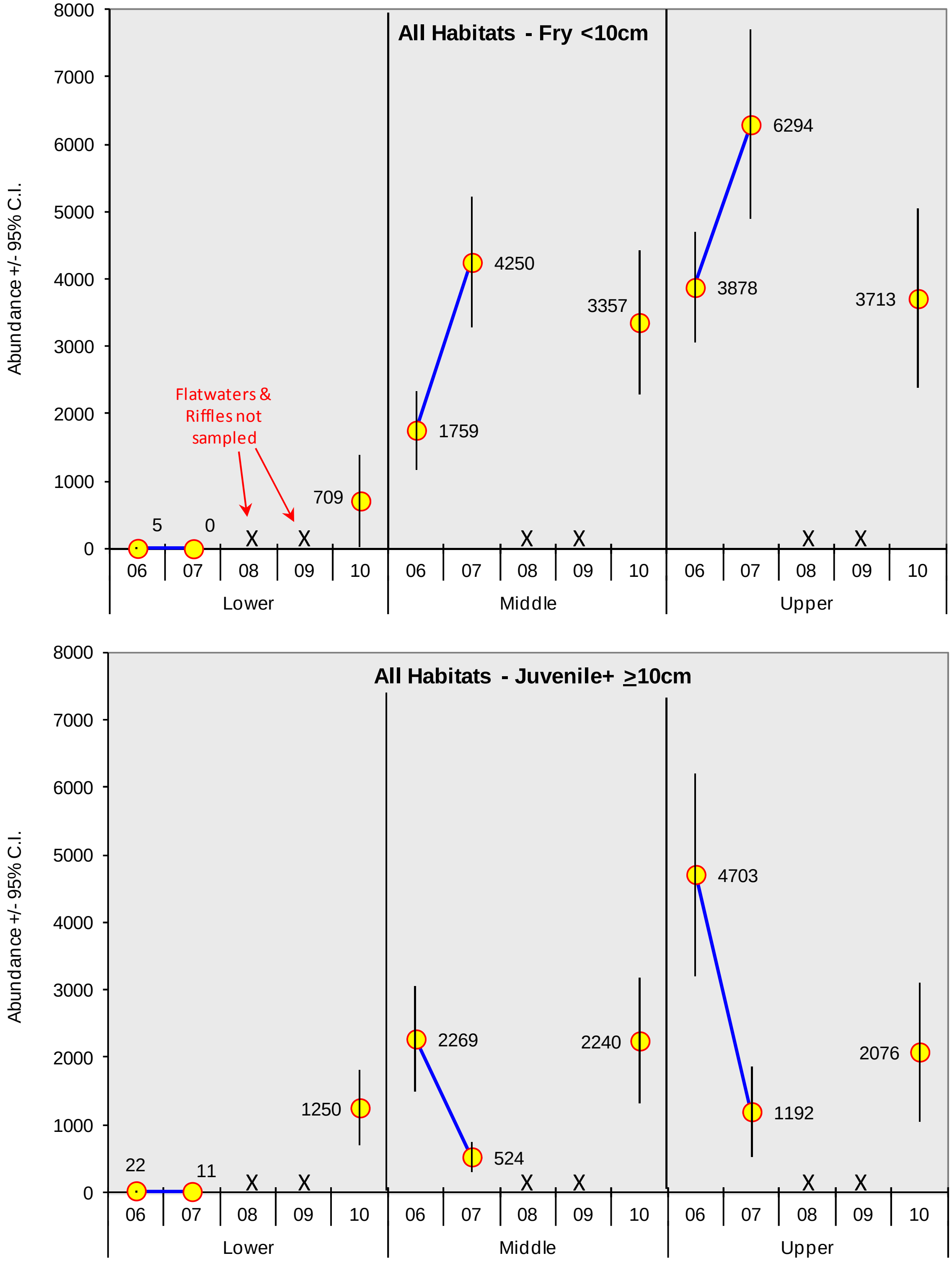

Figure 19. Abundance estimates for *O. mykiss* fry (top) and juvenile+ (bottom) across all habitat types in the lower, middle, and upper Ventura River basin by year. Lower=below Robles Diversion Dam, Middle=between Robles and Matilija Dams, Upper=above Matilija Dam.

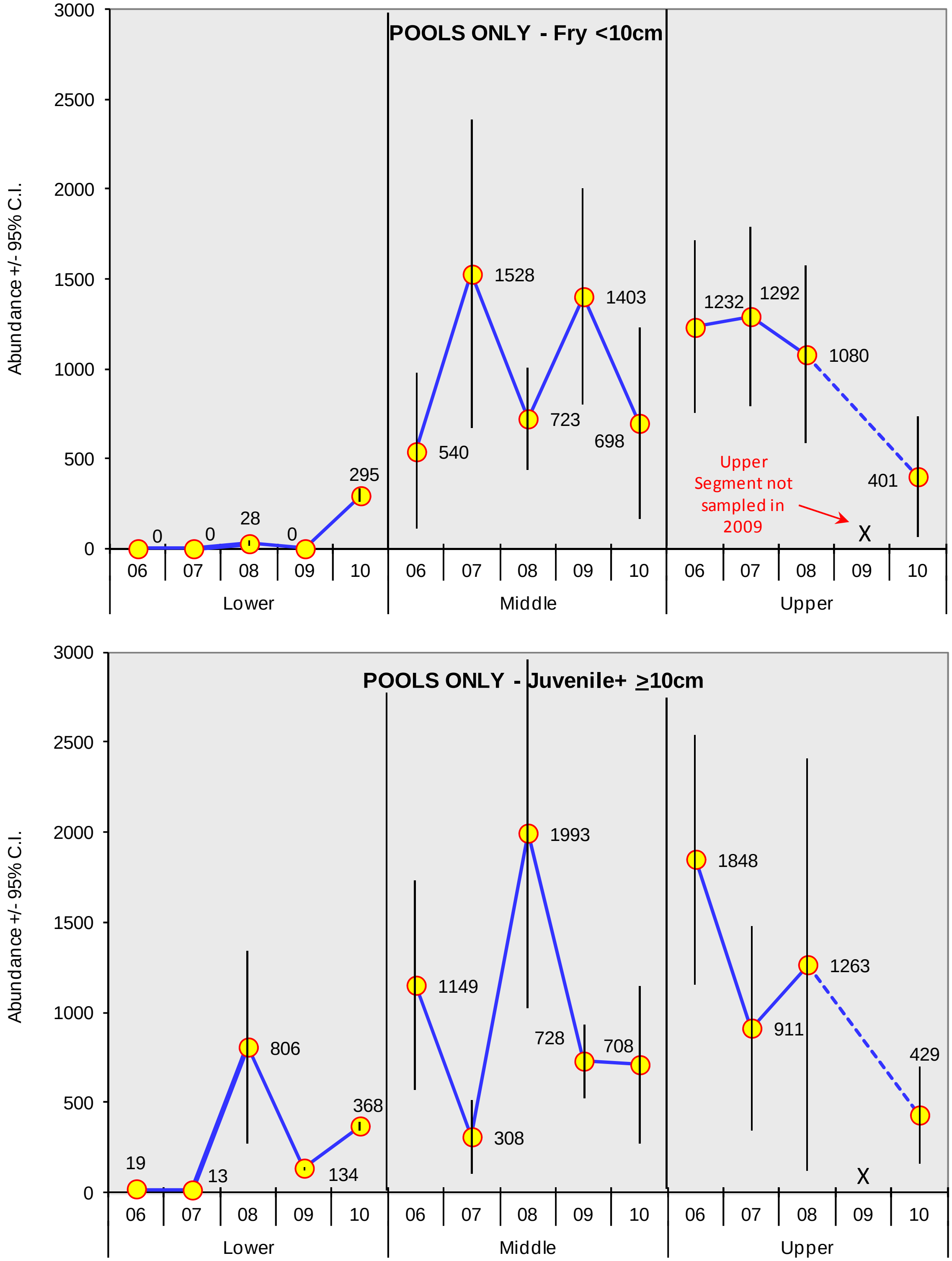

Figure 20. Abundance estimates for *O. mykiss* fry (top) and juvenile+ (bottom) within pool habitats in the lower, middle, and upper Ventura River basin by year. Lower=below Robles Diversion Dam, Middle=between Robles and Matilija Dams, Upper=above Matilija Dam.

Although the pool-only data contains a longer time series of trend data, the combined habitat estimates should be a more accurate representation of actual annual changes, particularly for fry which are generally much more abundant in flatwaters and riffles than in pools. Consequently, the most likely scenario is that the 2010 abundance of fry and juvenile+ *O. mykiss* is greater than all previous estimates in the lower basin segment, is similar to the maximum observed abundance in the middle basin segment, but is lower than maximum estimates in the upper basin segment.

The annual changes in the relative density (#/100ft^2) of trout according to habitat type is further shown in Figure 21, where the high density of fry in riffles relative to the low density in pools is evident in most reaches and years. Combined across all study sites, the densities of fry averaged 3*X* greater in riffles (at 1.32 fry/100ft^2) than in pools (0.37 fry/100ft^2), with intermediate densities in flatwaters (0.97 fry/100ft^2). Given the high relative density of fry in riffles and low density in pools in the Ventura River Basin, utilizing pool-only data to assess annual trends of small *O. mykiss* (e.g., Figure 20) may not be valid. In contrast to fry, juvenile+ trout tended to use all three habitat types more equitably, where overall mean densities were slightly higher in pools (at 0.32 juvenile+/100ft^2) than in flatwaters (0.29 fish/100ft^2) and riffles (0.29 fish/100ft^2).

<u>Conclusions and Additional Observations</u>

In most previous years, overall abundance was highest in the upper basin segment above Matilija Dam, intermediate in the middle basin segment between Robles Diversion Dam and Matilija Dam, and much lower in the lower basin segment. However in 2010, overall abundance was relatively similar between the middle basin and upper basin segments, and the lower basin segment contained over 20% of the basin-wide abundance of juvenile+ *O. mykiss* (not including San Antonio Creek).

The 2010 data again illustrated the importance of the mainstem Ventura River near the San Antonio Creek confluence for rearing *O. mykiss*. Although intensive sampling in 2006 and 2007 did not reveal significant densities in this lower basin study reach, subsequent sampling in 2008, 2009, and 2010 showed significant rearing of juvenile+ *O. mykiss*, along with large numbers of fry in 2010. The relative importance of downstream recruitment from San Antonio Creek, recruitment from upstream locations (e.g., the Lower North Fork), or from spawning within the Ven 3 mainstem itself is unknown, but recent observations of spawning in San Antonio Creek and nearby mainstem areas suggest that multiple sources may contribute to these mainstem densities. The 2010 dive counts in the Ven 3 reach also revealed a sizable number of large *O. mykiss*, including over one dozen fish estimated to be 30-40cm+ in length (e.g., see cover photo).

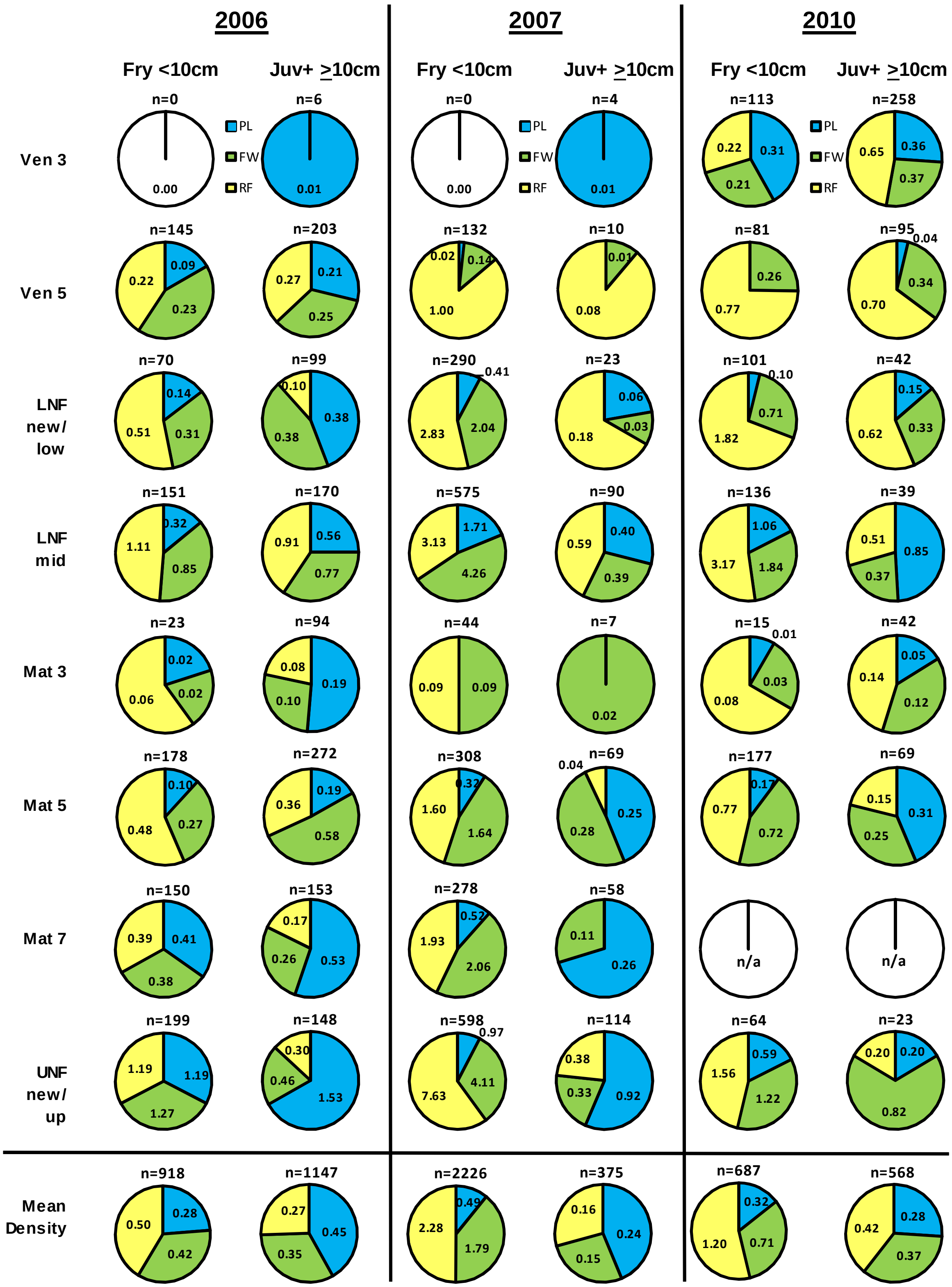

Figure 21. Relative proportion of *O. mykiss* fry and juvenile+ density estimates (#/100ft^2) by habitat type and study site in 2006, 2007 and 2010.

Although unverified by scale analysis, these fish appeared to be large resident trout rather than holdover steelhead, and likely contributed to the good recruitment of fry in that reach.

Abundance estimates from pool habitats in the middle basin study sites in 2010 were considerably lower than in some previous years, however estimates combined across all habitat types showed that overall abundance in 2010 was in fact comparable to maximum estimates from 2006 (for juvenile+) and from 2007 (for fry). This discrepancy illustrates the potential difficulties in interpreting abundance data from a single habitat type. As in previous years, densities of *O. mykiss* fry were highest in the LNF mid site, whereas juvenile+ were most abundant in the LNF mid and the Ven 5 study sites.

Estimates based on upper basin study sites above Matilija Dam, using both combined habitat and pools only, showed that the abundance of fry and juvenile+ *O. mykiss* in 2010 was much lower than the maximum levels observed in prior years, but were similar to or greater than minimum estimates from 2006 (for fry) and 2007 (for juvenile+). Most prior years showed the highest abundance of both fry and juvenile+ in the UNF study site, however in 2010 abundance was higher in the Mat 5 study site, which contains little spawning habitat but is thought to receive recruits from the UNF and Murietta Creek, both of which enter the mainstem Matilija Creek just upstream of the Mat 5 boundary.

Also observed in 2010 was the continued heavy infestation of black-spot disease on *O. mykiss* fry and juveniles in the middle and upper basin study sites. Black-spot disease (caused by a sub-dermal parasite) is relatively common in southern and central California streams and was previously noted in the Ven 5 study site, the LNF study sites, and in most of the Matilija Creek study sites above Matilija Dam (except in the Upper NF Matilija Creek) in the 2006-2008 surveys. As also noted in prior reports (see TRPA 2008, 2010), riparian vegetation continued to show rapid growth following the scouring effects of the 2005 flood events. This continued recovery of the riparian can be expected to increase shading to help cool water temperatures, and also serve to lessen algal growth. The increased density of grasses and shrubs would also enhance allochthonous input, including drop of invertebrate prey into the stream.

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Appendix A. GPS coordinates (NAD83) for top and bottom boundaries of study sites.

Study Site	Deg N	Min N	Deg W	Min W
LNFmid Btm	34	30.499	-119	17.197
LNFmid Top	34	30.359	-119	16.989
LNFnew Btm	34	29.327	-119	18.341
LNFnew Top	34	29.606	-119	18.327
Mat3(low) Btm	34	29.624	-119	19.713
Mat3 (low) Top	34	29.696	-119	19.976
Mat3 (up) Btm	34	30.097	-119	20.796
Mat3 (up) Top	34	30.021	-119	20.966
Mat5 Btm	34	30.197	-119	22.335
Mat5 Top	34	30.336	-119	22.767
SACmid Btm	34	24.734	-119	16.439
SACmid Top	34	24.979	-119	16.251
SACup Btm	34	25.889	-119	15.194
SACup Top	34	26.106	-119	14.777
UNF Btm	34	31.083	-119	22.723
UNF Top	34	30.919	-119	22.444
Ven1 Btm	34	17.697	-119	18.412
Ven1 Top	34	18.369	-119	18.007
Ven2 Btm	34	19.150	-119	17.717
Ven2 Top	34	20.000	-119	17.817
Ven3 Btm	34	22.141	-119	18.555
Ven3 Top	34	22.901	-119	18.539
Ven4 Btm	34	27.035	-119	17.609
Ven4 Top	34	27.531	-119	17.497
Ven5 Btm	34	28.833	-119	17.600
Ven5 Top	34	29.117	-119	17.999