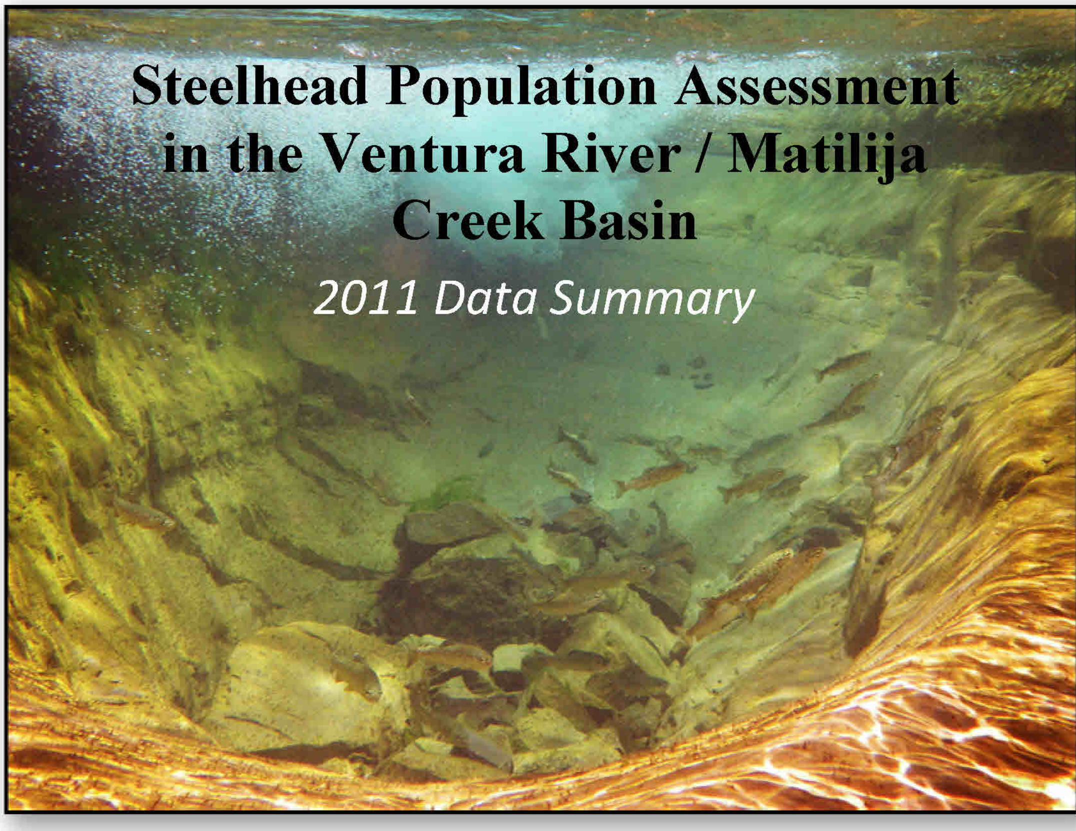

Steelhead Population Assessment in the Ventura River / Matilija Creek Basin

2011 Data Summary

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Introduction

Field sampling to assess the distribution and abundance of *O. mykiss* in the Ventura/Matilija Basin by Normandeau Associates (NAI) was funded in 2010 by a Fisheries Restoration Grant administered by the California Department of Fish & Game (DFG). The primary objectives of the 2011 field surveys were to re-assess the distribution and abundance of *O. mykiss* throughout the Ventura River Basin, and compare 2011 results from similar surveys conducted in 2006-20010. The 2011 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 2006-2010 data (TRPA 2007, 2008, 2009, 2010, NAI 2011). 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 2011 sampling encompassed 13 study sites and the Ventura River lagoon (Figure 1). The sampling locations represented five stream reaches in the mainstem Ventura River (Ven), two reaches in San Antonio Creek (SAC), two reaches in the Lower North Fork Matilija Creek (LNF), three reaches in mainstem Matilija Creek (Mat), and one site in the Upper North Fork Matilija Creek (UNF). Eleven of the thirteen study sites were sampled in previous years, but one site (Ven 1) was moved upstream in 2011 due to expansion of a homeless community into the previous site. A second site (Mat 7) was not sampled in 2010 due to restricted access; therefore a new site (Mat 7b) was selected immediately upstream on public land.

Ven 1, Ven 2, and Ven 3 were one-mile long study sites in the lower mainstem Ventura River. The Ven 3 study site occurred at Casitas Springs, where groundwater emerges from the long dry channel below Robles Diversion Dam, and included the habitat surrounding the San Antonio Creek confluence. Ven 4 was a ½ -mile site in the Ojai Land Conservancy property immediately below the diversion dam where mainstem surface flows cease during many summers, and consequently sampling in Ven 4 only occurred in three of the six years of study. The mainstem Ven 5 study site extended ½ -mile below the confluence of the LNF. The two LNF sites were ½ -mile in length, with the LNF *new* site located immediately above the Ojai Quarry, and the

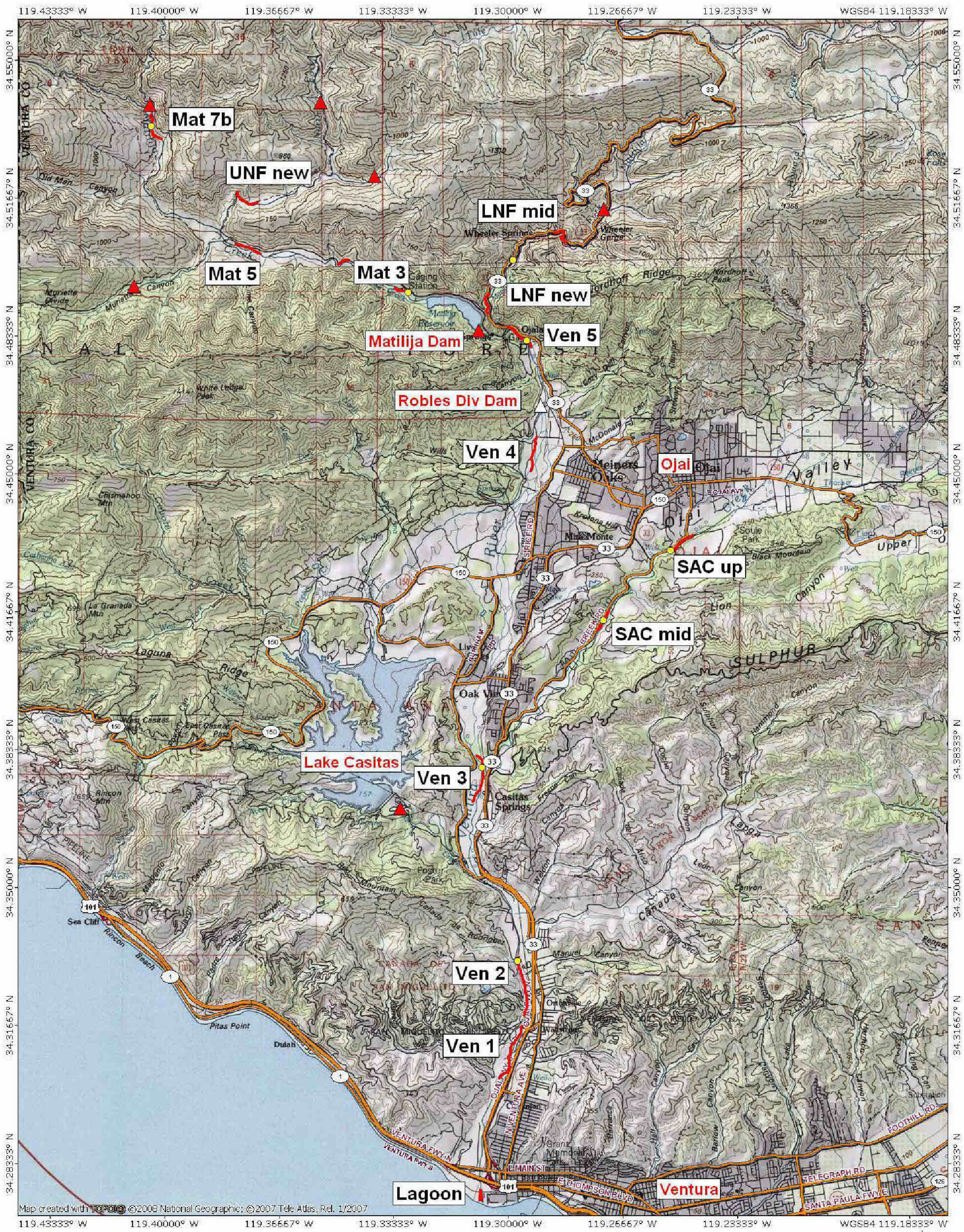

Figure 1. Map of Ventura/Matilija Basin showing study reaches (red lines), barriers (red triangles), water temperature data loggers (yellow dots), and landmarks.

LNF *mid* study site just downstream of Wheeler Gorge. Two ½ -mile study sites were sampled in San Antonio Creek (SAC) in 2011. The SAC *mid* site was located approximately 0.5 mi downstream of the Lion Canyon confluence, whereas the upper site (SAC *up*) was above Camp Comfort approximately 1.25 mi upstream of Lion Canyon. All study sites above Matilija Dam were also ½ mile in length. Mat 3 was in the mainstem Matilija Creek above Matilija Dam in the vicinity of the hot springs, and Mat 5 was at the end of the public part of Forest Road 5N24. The UNF *new* site was approximately one mile upstream of the confluence with Matilija Creek. Appendix A contains GPS coordinates for top and bottom boundaries for each of the 13 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 shallow depths required the use of backpack electrofishing in all riffle habitats. Flatwater habitats were sampled by snorkeling in all mainstem Ventura River and Matilija Creek study sites, and by electrofishing in all tributary study sites. Abundance estimates were derived according to the Method of Bounded Counts (MBC), using four repeat counts in a subsample of snorkeled habitats, and multiple-pass electrofishing in all shallow-water habitats. 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°C, and at conductivities higher than 350µS/cm. See TRPA 2007, 2008, 2009, 2010, and 2011 for detailed descriptions of the study sites, sampling design, MBC 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 a 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.

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 USGS streamflow gage at Foster Park (#11118500) provided a means to compare the river flow for the years 2003-2011 (Figure 2). Summertime flows occurred in 2005, 2006, and 2011 were notably higher than the median flow as well as all previous sample year flows. Summer flows during 2004, 2007, and 2009 were at or below median flows, whereas flows in 2003, 2008, and 2010 were intermediate to the high flow years and the low flow years. Streamflows estimated at each sampling site in 2011 ranged from a maximum of about 46 cfs in the lower Ventura River to a minimum of 2-3 cfs in the smallest tributary study sites (Table 1).

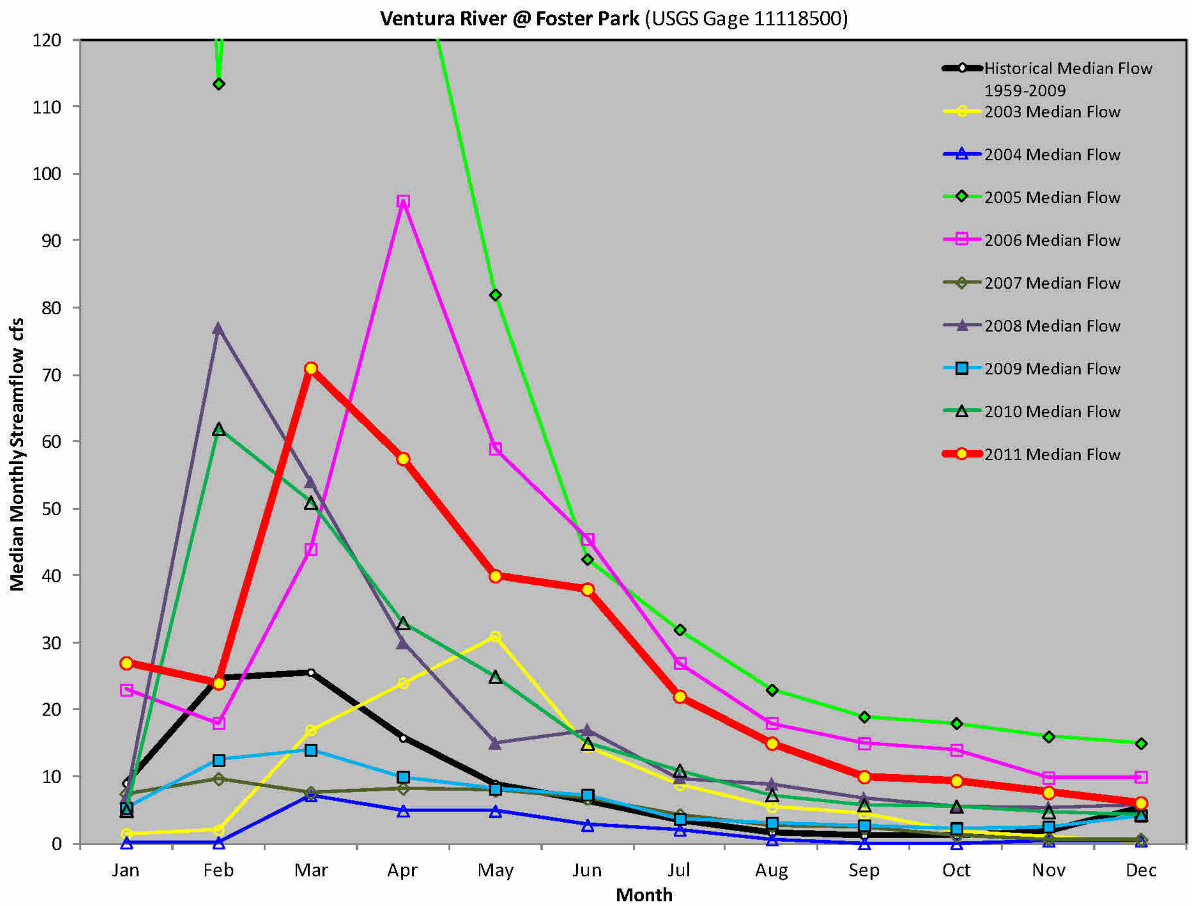

Figure 2. Median monthly flows for the Ventura River at Foster Park Gage (revised for 1959-2009).

Stream temperature data loggers were deployed at eight locations in the Ventura River watershed during 2011 (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 study sites, 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 highest mainstem Matilija site (Mat 7b), which was located in a steep canyon and was the highest elevation of all study sites (~2,300 ft msl). The daily mean temperatures peaked in early-July and again in late-August and early September at all sites, with temperatures above 70 degrees Fahrenheit (°F) (21°C) in the warmest reaches (Mat 3 and Ven 5) throughout most of July and August, while temperatures mostly remained below 67°F (19.5°C) in the Ven 3 and Mat 7b study sites. The significant amount of warming (avg 3.4°F or 1.9°C) from the Ven 3 temperature logger to the Ven 2 logger 3½ miles downstream is clearly evident; as is the 2.4°F (1.3°C) of warming from the SAC *up* study site to the SAC *mid* site only 1.75 mi downstream.

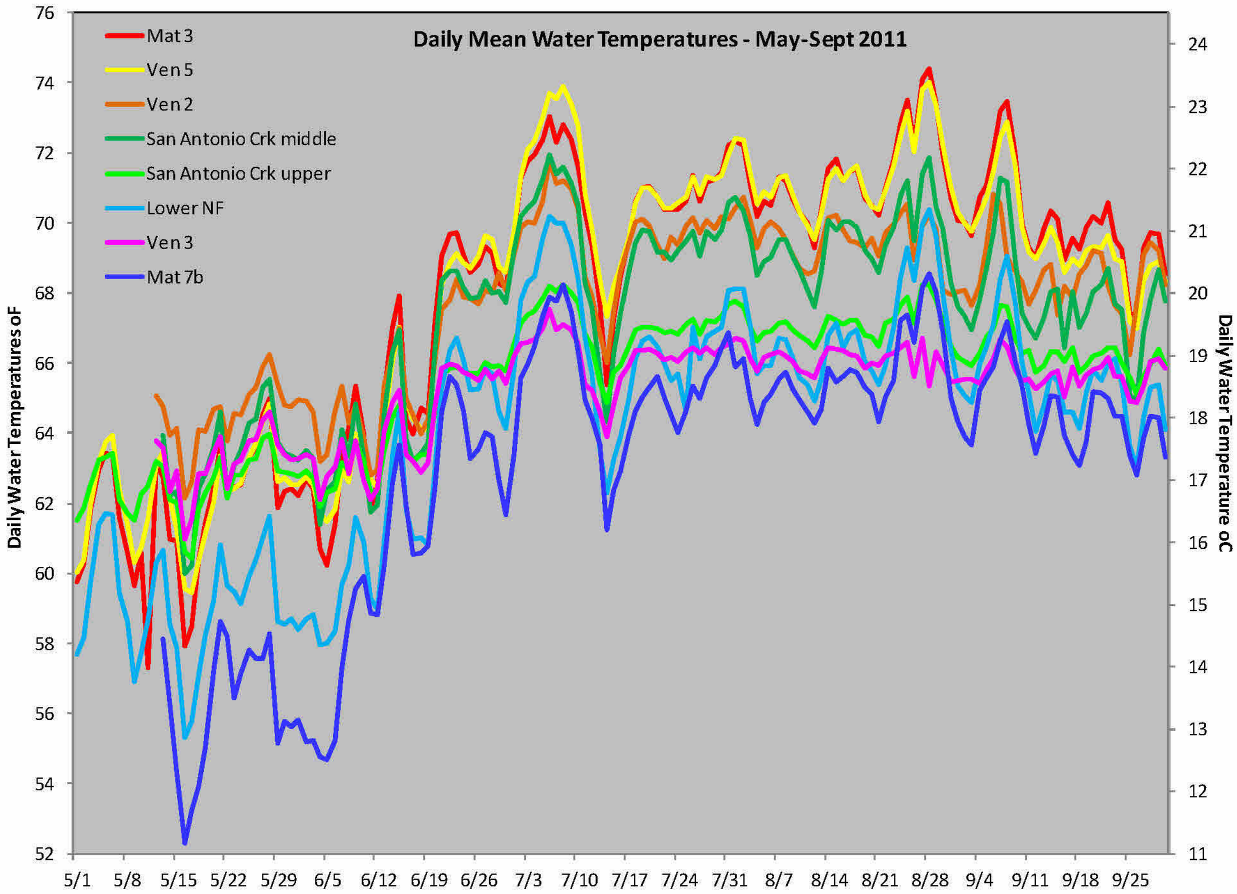

Figure 3. Mean daily water temperature in the Ventura River watershed from May through September 2011.

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 Lower North Fork and upper San Antonio Creek sites, were typically 10°F (5.6°C) or less. In contrast, Mat 3 and the

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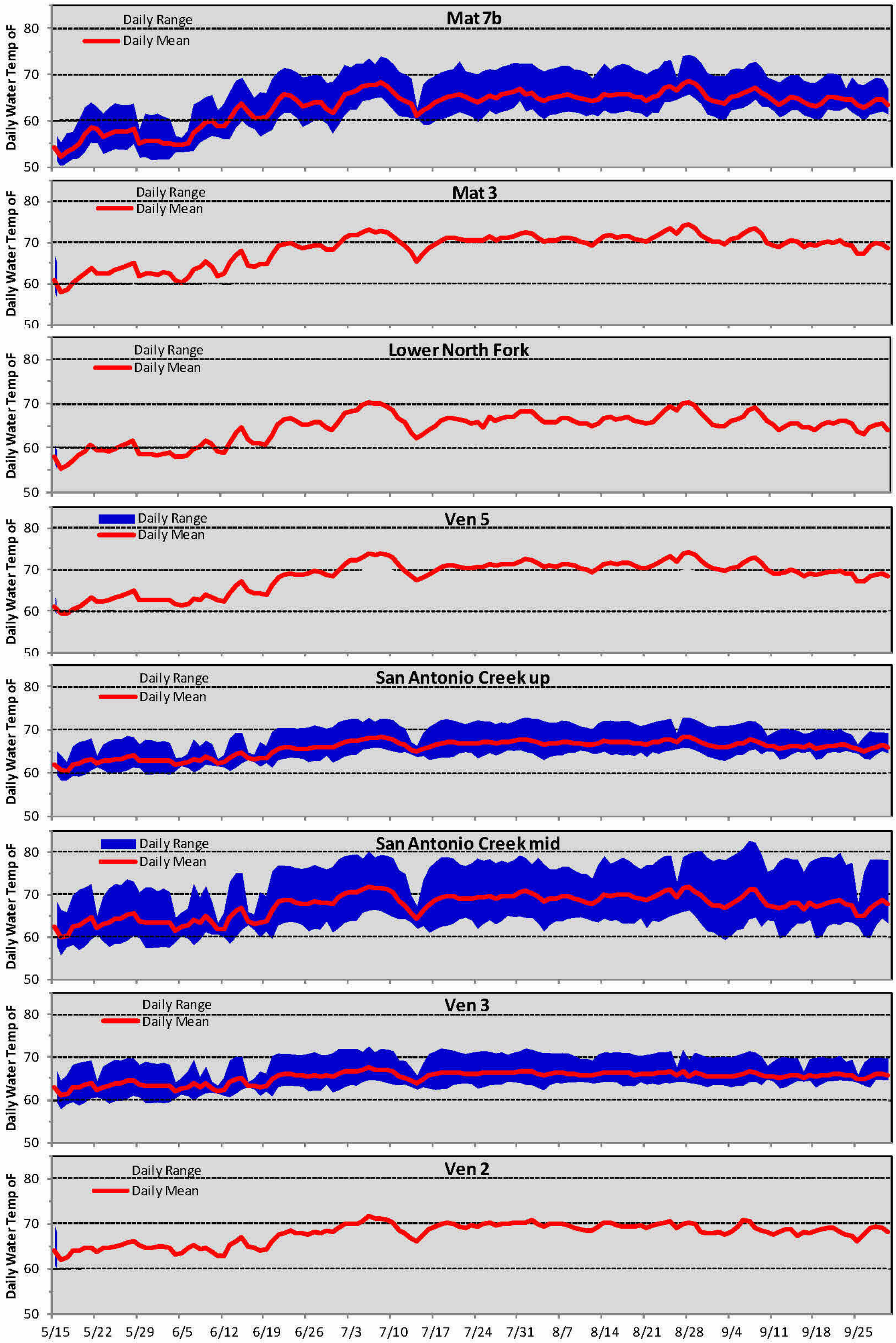


Figure 4. The daily range and daily mean temperatures at eight study sites in the Ventura River watershed, May through September 2011.

lower San Antonio Creek sites had the greatest range of daily temperatures, with daily fluctuations in summer of 10-15°F (5.6-8.3°C) in Mat 3 and up to 19°F (10.6°C) in SAC mid. The Mat 3 and SAC mid study sites also showed the highest maximum daily temperatures of up to 82°F (27.8°C). The SAC mid study site occurred below an open channel area possessing little riparian coverage, and the Mat 3 temperature logger was downstream of a substantial inflow of hot springs. Spot checks in prior years suggested that the hot springs may elevate mainstem water temperatures in the lower portion of Mat 3 by up to 7-9oF (4-5oC) (TRPA 2009).

Fish Sampling. The fish abundance surveys were conducted in the Ventura/Matilija basin over an eight week period between 21 June and 11 August 2011 and generally progressed in an upstream progression (Table 1). A total of 308 habitat units were sampled using either snorkel counts or backpack electrofishing. A total of 1,241 *O. mykiss* (395 fry and 846 juvenile+) were counted or captured during this sampling. Sixty percent of the total *O. mykiss* (740 trout) surveyed came from the anadromous zone below Matilija Dam.

Table 1. General sampling statistics for the 2011 survey.

Basin Segment	O. mykiss Zone *	HSI Study Site	Sampling Dates	# Sampling Units Pools	Flatwaters	Riffles	Est Flow cfs	# O. mykiss (cm) ** <10	10+
Lower	Anadromous	Ven 1	6/22-26	7	8	8	46.0	1	4
below		Ven 2	6/23-28	7	8	8	n/a	0	31
Robles		Ven 3	6/28-7/12	8	8	8	25.6	1	331
Diversion		San Ant mid	7/20-21	8	8	8	9.6	0	13
Dam		San Ant up	7/19-20	7	8	8	6.7	3	29
		Ven 4	6/21-24	8	8	8	n/a	1	7
Middle	Anadromous	Ven 5	7/16-18	8	8	8	25.4	63	84
between		LNF new	7/14-19	8	8	8	3.7	39	62
dams		LNF mid	7/15-19	8	8	8	2.5	36	35
Upper	Resident	Mat 3	8/2-8	8	8	8	11.8	23	28
above		Mat 5	8/2-9	8	8	8	5.6	25	68
Matilija		Mat 7b	8/4-10	8	8	8	4.4	105	126
Dam		UNF new	8/3-11	8	7	8	3.2	98	28
* Anadromous zones also contain resident life-forms				101	103	104		395	846

** total captured by electrofishing + 1st-pass dive counts

Length Frequencies (2006-2010). Length frequency analysis used only the measured fork length data for fish captured during electrofishing. Electrofishing was not conducted in 2008 or 2009 (only dive counts), consequently detailed length frequency data are not available for those years. 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 study sites (Ven 1, 2, 3, 4 [not shown], and the two San Antonio Creek sites), *O. mykiss* were rarely captured prior to 2010, while 200 *O. mykiss* were captured and measured in 2010, mostly in the Ven 3 study site (Figure 5). In 2011, most of the *O. mykiss* in Ven 3 were observed by diving and relatively few fish (n=7) were captured in riffles. Meaningful length frequency comparisons are thus limited to the 2010 data, which shows that most *O. mykiss*

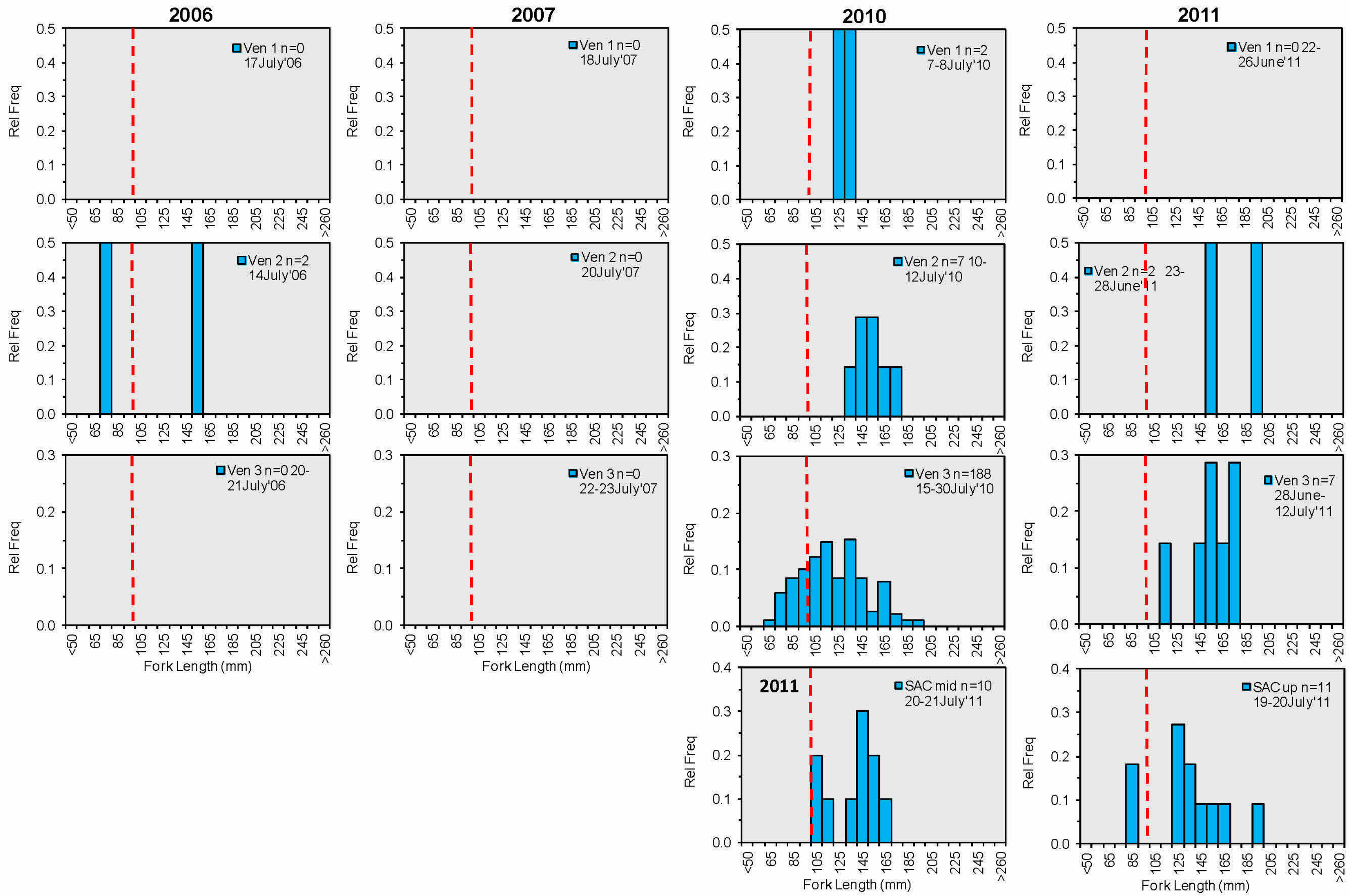


Figure 5. Relative length frequencies of *O. mykiss* in the lower segment of the Ventura River Basin in 2006, 2007, 2010, and 2011.

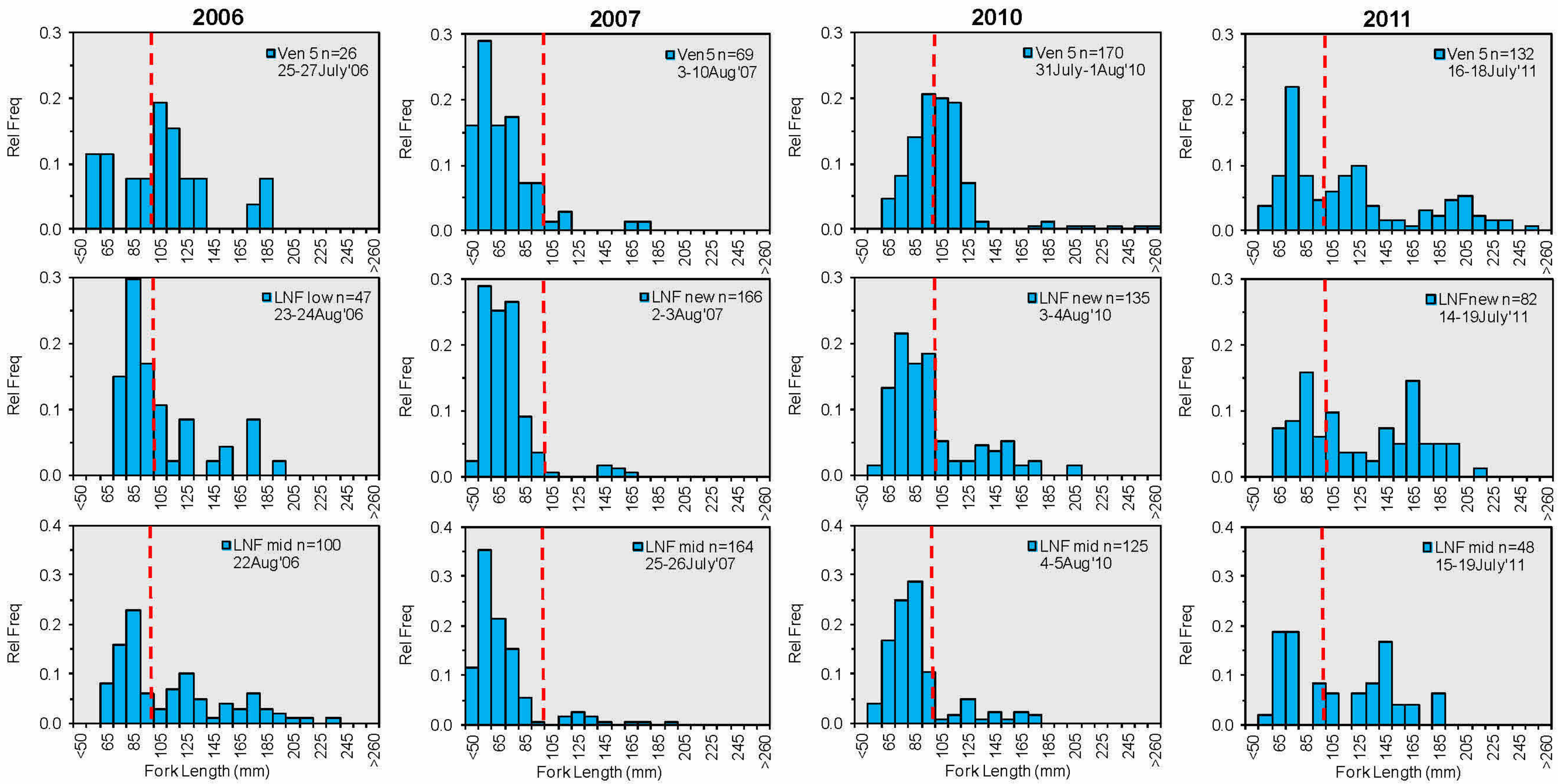


Figure 6. Relative length frequencies of *O. mykiss* in the middle segment of the Ventura River Basin in 2006, 2007, 2010, and 2011.

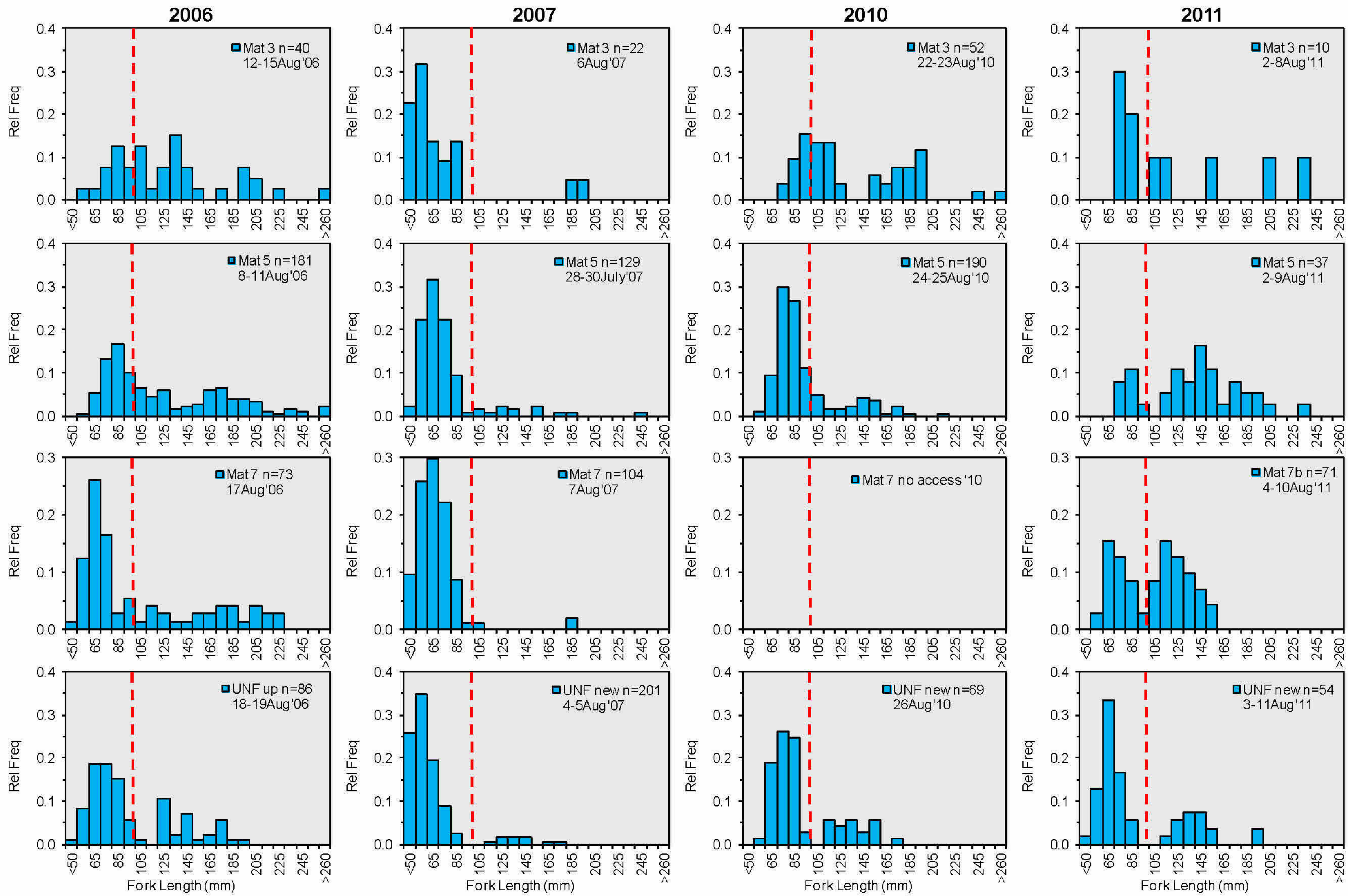


Figure 7. Relative length frequencies of *O. mykiss* in the upper segment of the Ventura River Basin in 2006, 2007, 2010, and 2011.

the lower segment were larger individuals that exceeded 10 cm in length. Although unverified by scale analysis, it is expected that the larger channel and warmer water in the mainstem Ventura River results in fairly rapid growth and that many of the *O. mykiss* >10 cm in length are young-of-year (fry) that grew out of the <10 cm fry size class. Limited data from the two San Antonio Creek study sites also suggest that *O. mykiss* up to 12 cm in length may represent young-of-year fish.

Unlike the lower basin reaches, *O. mykiss* have been relatively abundant in the middle basin segments of the Ventura watershed in each survey year (Figure 6). In Ven 5 above Robles Diversion Dam, length distributions showed a single dominant mode in 2007 and in 2010, but in 2011 three distinct modes were observed which may represent 0+, 1+, and 2+ fish. Because spawning habitat is limited in Ven 5, it is expected that many of the observed *O. mykiss* are immigrants from the Lower North Fork, which enters the mainstem at the top of the Ven 5 study site. Similar to Ven 5, the length frequency distributions from both LNF study sites in 2007 and 2010 were dominated by a single mode, presumably representing young-of-year *O. mykiss*, whereas the 2011 distribution shows a larger proportion of older fish. The 10 cm size class criterion appears to be relatively successful at separating young-of-year (0+) *O. mykiss* from 1+ juvenile/adult fish in the two tributary study sites.

In the upper basin reaches, the length frequency distributions showed a clear dominance of a younger age class of *O. mykiss* in 2007 and (except for Mat 3) 2010, whereas a greater proportion of larger fish were captured in 2006 and 2011 (Figure 7). The 10 cm size class criteria appears to be adequate to separate 0+ fry and 1+ juvenile/adult *O. mykiss* for most distributions, particularly for the tributary study sites or the mainstem sites sampled by early August.

<u>Dive Count Length Categories</u>. *O. mykiss* counted by divers were categorized by a binary size threshold: trout less 10 cm (fry) and trout larger than 10 cm (juvenile+). The relative proportions of each size class are based on the estimated abundance of each size class in pool habitats by study site over the six 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.

Juvenile+ *O. mykiss* have dominated the pool abundance estimates in most of the mainstem Ventura River (Ven 3 and Ven 5) and Matilija Creek study sites (Mat 3 and Mat 5) (Figure 8). In contrast, *O. mykiss* fry <10 cm in length have comprised a large proportion, if not the dominant proportion, of abundance estimates in the tributary study sites and in the upper Matilija Creek site (Mat 7/7b). In tributary sites, strong year classes of fry are apparent in 2007, 2009, 2010, and 2011, whereas juvenile+ *O. mykiss* dominated most pool estimates in 2006 and 2008.

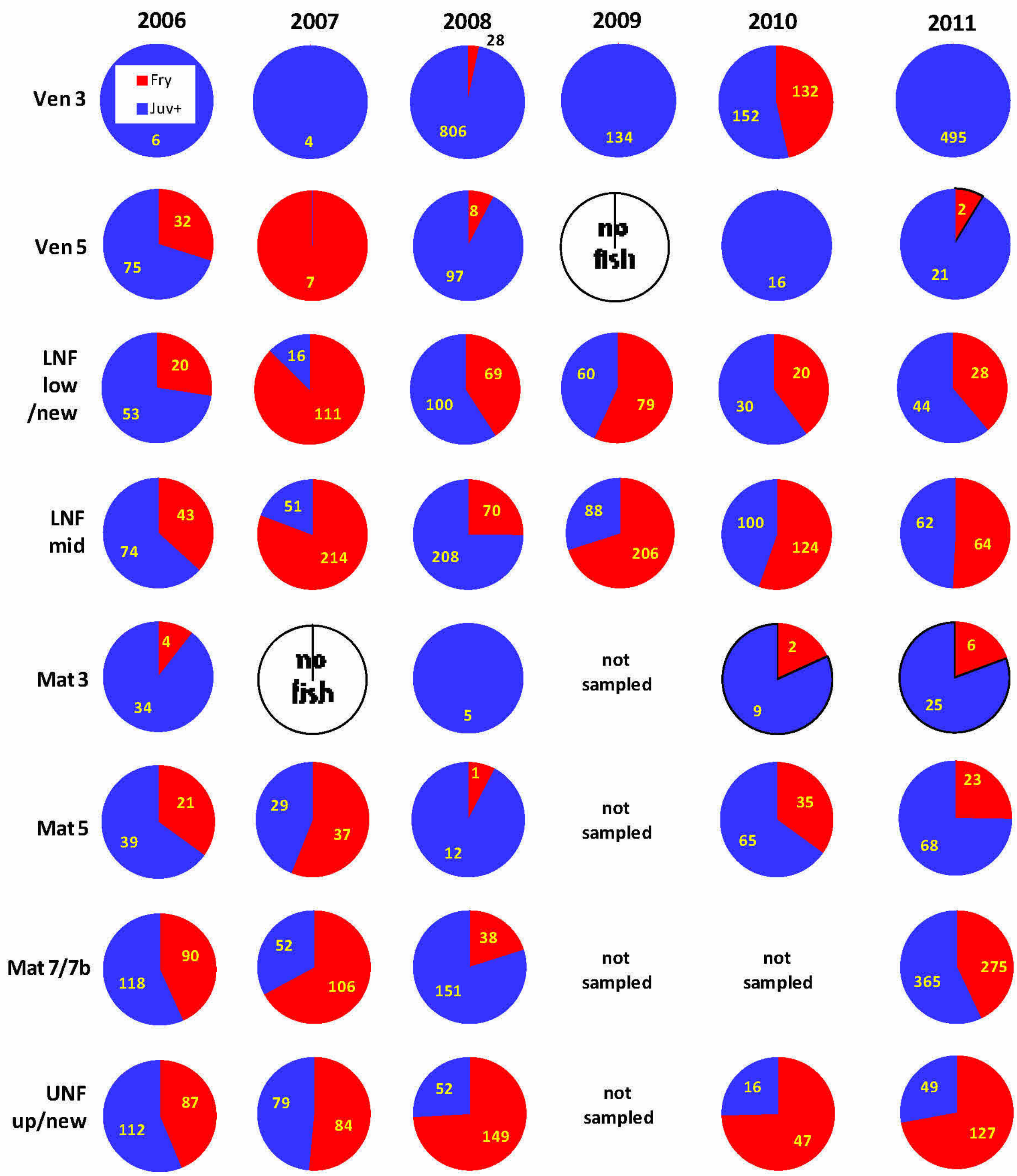


Figure 8. Relative abundance of *O. mykiss* fry (< 10 cm) and juvenile + ($\geq$ 10 cm) in pools by year and study site (some sites not shown), 2006-2011.

2011 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 and Figures 9-12. Abundance estimates are determined by a combination of *O. mykiss* density (number per unit area) and the availability of habitat (e.g., larger channels may have lower densities but higher abundance due to greater habitat area). Abundance estimates are useful in demonstrating which areas of the Ventura River Basin support the most *O. mykiss*, whereas the density estimates may provide a better measure of the relative quality of habitat.

The estimated abundance of *O. mykiss* fry was highest in the Mat 7b and UNF study sites, except in riffles where abundance was slightly higher in the Ven 5 study site (Figure 9). Fry abundance was near zero in the lower basin study reaches, likely due in part to growth of fry beyond the 10 cm fry criterion in the larger, warmer channels. Estimated densities of fry showed a similar relationship, with high and nearly identical densities in the Mat 7b and UNF study sites, intermediate densities in the LNF *new*, LNF *mid*, Ven 5, and the Mat 5 study sites, and low or zero densities in all other study sites (Figure 10). The abundance and density of fry in 2011 was not substantially higher in riffle habitats than in pool habitats, unlike in most prior years when fry densities were highest in riffles and lowest in pools.

Note that the Mat 7b estimates for both fry and juvenile+ did not include dive counts from the terminal pool just below an 18 ft high waterfall-cascade. The 84 ft long, 5 ft deep pool was estimated to contain over 90 *O. mykiss* (mostly juvenile+); however because fish appeared to be "stacked-up" immediately below the barrier falls (see cover photo), that pool was considered an outlier and was not used in the abundance calculations.

The juvenile+ size class was more evenly distributed within the Ventura River Basin than the fry size class, with non-zero estimates of abundance in all thirteen study sites (Figure 11). Estimated abundance was greatest in the Ven 3 and Mat 7b study sites at over 500 *O. mykiss* each. Estimates exceeding 100 fish also occurred in the Ven 5, both LNF, and the UNF study sites. Estimated densities of juvenile+ *O. mykiss* again emphasized the abundant population in the Mat 7b study site, with intermediate densities in all middle segment study sites (Ven 5 and both LNF sites), as well as in the UNF (Figure 12). The density of juvenile+ *O. mykiss* in upper San Antonio Creek pool habitats was similar to densities in other high quality habitats, such as Ven 3, LNF mid, and the UNF.

Annual Trends in Abundance by Study Site. A comparison of annual *O. mykiss* fry and juvenile+ abundance estimates over six years (2006 to 2011) 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 displayed for either of the two San Antonio Creek study sites since they were only surveyed in a quantitative manner in 2010 (pools only)

Table 2. 2011 *O. mykiss* abundance and density estimates for the Ventura River Basin 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 7b	UNF new
Fry <10cm	Pools	# Units Sampled	7	7	8	8	8	7	8	8	8	8	8	7	8
		Abundance	0	0	0	0	0	0	2	28	64	6	23	275	127
		Variance	0	0	0	0	0	0	1	89	190	4	35	2273	106
		95% C.I.	0	0	0	0	0	0	2	22	33	4	14	117	24
		Density (#/mi)	0.0	0.0	0.0	0.0	0	0	12.0	146.8	337.9	36.2	143	1,209	725
		Variance (#/mi)	0.00	0.00	0.00	0.00	0	0	50.75	2,521.44	5,311.35	140.53	1,397	43,853	3,456
		95% C.I. (#/mi)	0.0	0.0	0.0	0.0	0	0	16.8	118.7	172.3	28.0	88	512	139
		Density (#/100ft^2)	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.14	0.42	0.02	0.10	1.03	1.13
		Variance (#/100ft^2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0022	0.0082	0.00006	0.0007	0.0319	0.0083
		95% C.I. (#/100ft^2)	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.11	0.21	0.02	0.06	0.44	0.22
	Flatwaters	# Units Sampled	8	8	8	8	8	8	8	8	8	8	8	8	7
		Abundance	0	0	2	0	0	2	24	52	42	25	51	180	148
		Variance	0	0	0	0	0	1	459	214	55	8	299	1373	1023
		95% C.I.	0	0	0	0	0	3	51	35	18	7	41	88	78
		Density (#/mi)	0.0	0.0	7.3	0.0	0	11	103	345	352	129.1	183	1,117	1,015
		Variance (#/mi)	0.00	0.00	0.00	0.00	0	57	8,528	9,553	3,853	233.24	3,826	52,962	48,207
		95% C.I. (#/mi)	0.0	0.0	0.0	0.0	0	18	218	231	147	36.1	146	544	537
		Density (#/100ft^2)	0.00	0.00	0.004	0.00	0.00	0.01	0.07	0.36	0.50	0.08	0.17	1.63	1.75
		Variance (#/100ft^2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0035	0.0105	0.0078	0.0001	0.0034	0.1124	0.1429
		95% C.I. (#/100ft^2)	0.00	0.00	0.00	0.00	0.00	0.02	0.14	0.24	0.21	0.02	0.14	0.79	0.93
	Riffles	# Units Sampled	8	8	8	8	8	8	8	8	8	8	8	8	8
		Abundance	0	0	0	2	0	4	94	18	28	10	18	60	80
		Variance	0	0	0	2	0	8	84	36	43	9	31	458	454
		95% C.I.	0	0	0	3	0	7	22	14	16	7	13	51	50
		Density (#/mi)	0.0	0.0	0.0	12.8	0	18	812	287	296	69.6	115	516	484
		Variance (#/mi)	0.00	0.00	0.00	81.79	0	208	6,304	9,183	4,991	443.19	1,280	33,832	16,656
		95% C.I. (#/mi)	0.0	0.0	0.0	21.4	0	34	188	227	167	49.8	85	435	305
		Density (#/100ft^2)	0.00	0.00	0.00	0.01	0.00	0.02	0.63	0.28	0.41	0.05	0.09	0.71	0.75
		Variance (#/100ft^2)	0.0000	0.0000	0.0000	0.00002	0.0000	0.0004	0.0038	0.0089	0.0098	0.0002	0.0009	0.0637	0.0401
		95% C.I. (#/100ft^2)	0.00	0.00	0.00	0.01	0.00	0.05	0.15	0.22	0.23	0.04	0.07	0.60	0.47
	All Habitats	# Units Sampled	23	23	24	24	24	23	24	24	24	24	24	23	23
		Abundance	0	0	2	2	0	5	119	97	133	40	92	515	355
		Variance	0	0	0	2	0	10	544	340	288	21	364	4103	1582
		95% C.I.	0	0	0	3	0	7	49	40	37	9	40	134	83
		Density (#/mi)	0.0	0.0	2.2	3.7	0	20	245	243	473	82	154	1,020	730
		Variance (#/mi)	0.00	0.00	0.00	6.72	0	142	2,283	2,116	3,618	86	1,038	16,092	6,711
		95% C.I. (#/mi)	0.0	0.0	0.0	5.4	0	26	99	99	130	19	67	265	171
		Density (#/100ft^2)	0.00	0.00	0.00	0.00	0.00	0.03	0.16	0.24	0.61	0.05	0.13	1.11	1.17
		Variance (#/100ft^2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0009	0.0021	0.0061	0.0000	0.0007	0.0192	0.0172
		95% C.I. (#/100ft^2)	0.00	0.00	0.00	0.002	0.00	0.03	0.06	0.10	0.17	0.01	0.06	0.29	0.27

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 7b	UNF new
Juv+ ≥10cm	Pools	# Units Sampled	7	7	8	8	8	7	8	8	8	8	8	7	8
		Abundance	2	43	495	6	8	20	21	44	62	25	68	365	49
		Variance	0	5	737	0	15	1	72	87	412	42	53	8754	128
		95% C.I.	0	5	64	0	9	2	20	22	48	15	17	229	27
		Density (#/mi)	7	214.0	1,334.0	47.0	80	325	149.2	235.4	327.7	156.8	430	1,605	279
		Variance (#/mi)	0	121.27	5,356.56	0.00	1,399	189	3,630.55	2,459.95	11,505.96	1,659.25	2,119	168,908	4,186
		95% C.I. (#/mi)	0	26.9	173.1	0.0	88	34	142.5	117.3	253.6	96.3	109	1,006	153
		Density (#/100ft^2)	0.00	0.09	0.44	0.02	0.07	0.40	0.08	0.22	0.41	0.10	0.31	1.37	0.43
		Variance (#/100ft^2)	0.0000	0.0000	0.0006	0.0000	0.0011	0.0003	0.0011	0.0022	0.0179	0.00069	0.0011	0.1229	0.0101
		95% C.I. (#/100ft^2)	0.00	0.01	0.06	0.00	0.08	0.04	0.08	0.11	0.32	0.06	0.08	0.86	0.24
Juv+ ≥10cm	Flatwaters	# Units Sampled	8	8	8	8	8	8	8	8	8	8	8	8	7
		Abundance	7	10	15	13	17	12	15	81	36	39	73	135	25
		Variance	4	24	34	62	59	14	61	595	96	71	2399	1088	55
		95% C.I.	5	11	14	19	18	9	18	58	23	20	116	78	18
		Density (#/mi)	18.2	20.0	58.3	50.0	68	80	65	537	302	207.5	261	841	169
		Variance (#/mi)	30.84	103.96	516	905.12	910	605	1,133	26,517	6,743	1,963.45	30,742	41,962	2,602
		95% C.I. (#/mi)	13.1	24.1	53.7	71.1	71	58	80	385	194	104.8	415	484	125
		Density (#/100ft^2)	0.01	0.01	0.03	0.02	0.06	0.10	0.04	0.56	0.43	0.13	0.24	1.22	0.29
		Variance (#/100ft^2)	0.00001	0.0000	0.0002	0.0002	0.0007	0.0009	0.0005	0.0290	0.0137	0.0008	0.0270	0.0891	0.0077
		95% C.I. (#/100ft^2)	0.009	0.01	0.03	0.03	0.06	0.07	0.05	0.40	0.28	0.07	0.39	0.71	0.21
Juv+ ≥10cm	Riffles	# Units Sampled	8	8	8	8	8	8	8	8	8	8	8	8	8
		Abundance	0	7	5	0	8	21	89	36	33	10	74	63	28
		Variance	0	7	4	0	8	37	52	27	94	4	135	375	34
		95% C.I.	0	6	5	0	6	14	17	12	23	5	28	46	14
		Density (#/mi)	0.0	21.9	21.9	0.0	43	106	771	574	349	69.6	475	544	167
		Variance (#/mi)	0.00	69.25	75.96	0.00	249	919	3,912	6,729	10,854	224.55	5,617	27,731	1,241
		95% C.I. (#/mi)	0.0	19.7	20.6	0.0	37	72	148	194	246	35.4	177	394	83
		Density (#/100ft^2)	0.000	0.01	0.01	0.00	0.04	0.14	0.60	0.57	0.49	0.05	0.39	0.75	0.26
		Variance (#/100ft^2)	0.00000	0.0000	0.0000	0.00000	0.0003	0.0017	0.0023	0.0065	0.0214	0.0001	0.0037	0.0522	0.0030
		95% C.I. (#/100ft^2)	0.000	0.01	0.01	0.00	0.04	0.10	0.11	0.19	0.35	0.03	0.14	0.54	0.13
Juv+ ≥10cm	All Habitats	# Units Sampled	23	23	24	24	24	23	24	24	24	24	24	23	23
		Abundance	9	60	514	19	33	54	125	161	131	76	214	561	101
		Variance	4	36	774	62	81	52	166	709	602	121	2587	9524	217
		95% C.I.	4	12	58	16	19	16	27	58	53	23	106	204	31
		Density (#/mi)	9.5	59.4	604.8	35.0	119	204	256	401	462	155	362	1,111	208
		Variance (#/mi)	5	35.59	1,070.24	208.62	1,058	754	695	4,413	7,556	505	7,372	37,355	920
		95% C.I. (#/mi)	5	12.4	68.0	30.0	70	60	55	144	188	47	179	403	63
		Density (#/100ft^2)	0.005	0.026	0.259	0.02	0.11	0.27	0.164	0.40	0.60	0.10	0.30	1.21	0.33
		Variance (#/100ft^2)	0.00000	0.00001	0.0002	0.0000	0.0010	0.0013	0.0003	0.0043	0.0126	0.0002	0.0052	0.0446	0.0024
		95% C.I. (#/100ft^2)	0.002	0.005	0.03	0.013	0.07	0.08	0.035	0.14	0.24	0.03	0.15	0.44	0.10

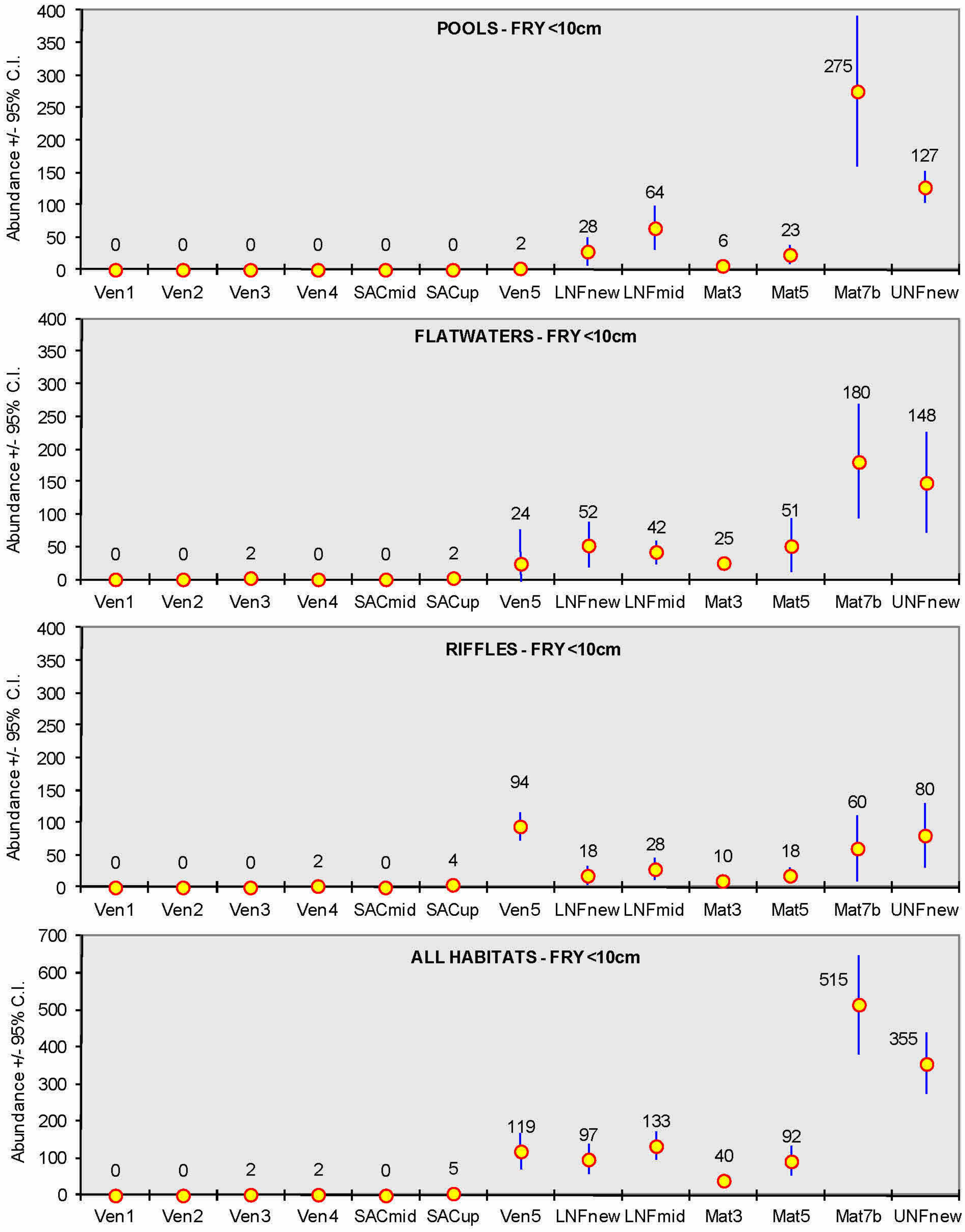


Figure 9. 2011 abundance estimates for *O. mykiss* fry by habitat type and study site.

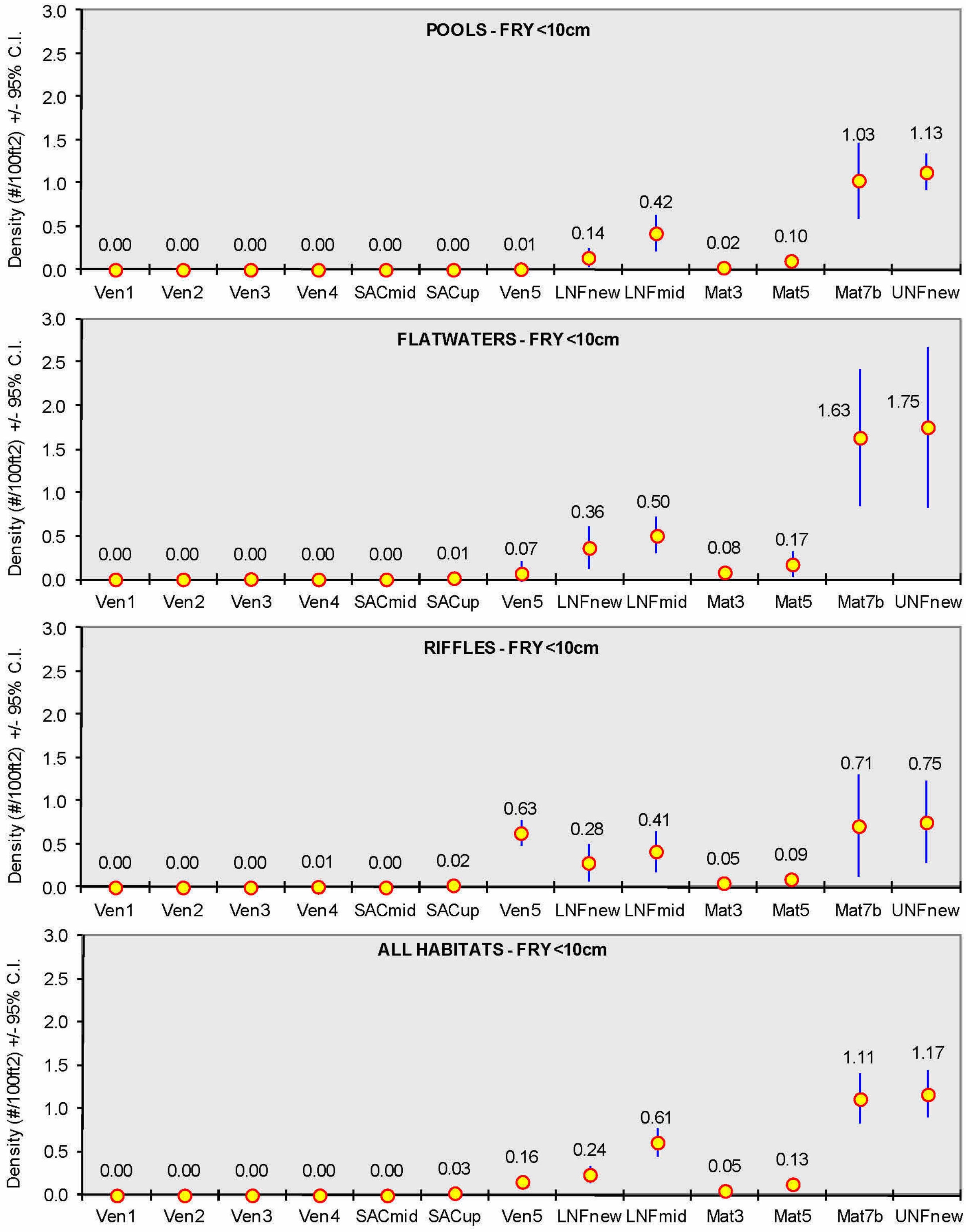


Figure 10. 2011 density (#/100ft^2) estimates for *O. mykiss* fry by habitat type and study site.

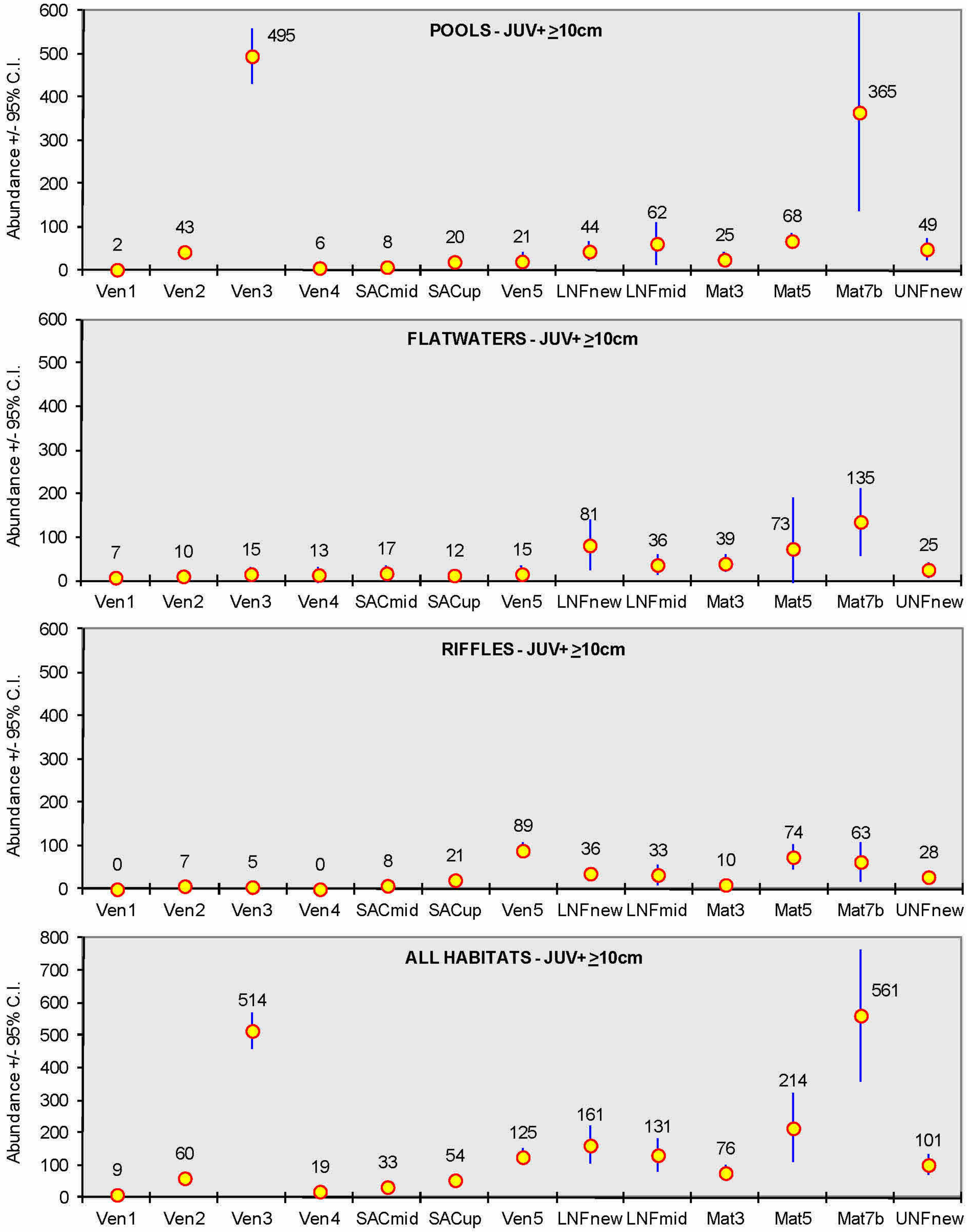


Figure 11. 2011 abundance estimates for juvenile+ *O. mykiss* by habitat type and study site.

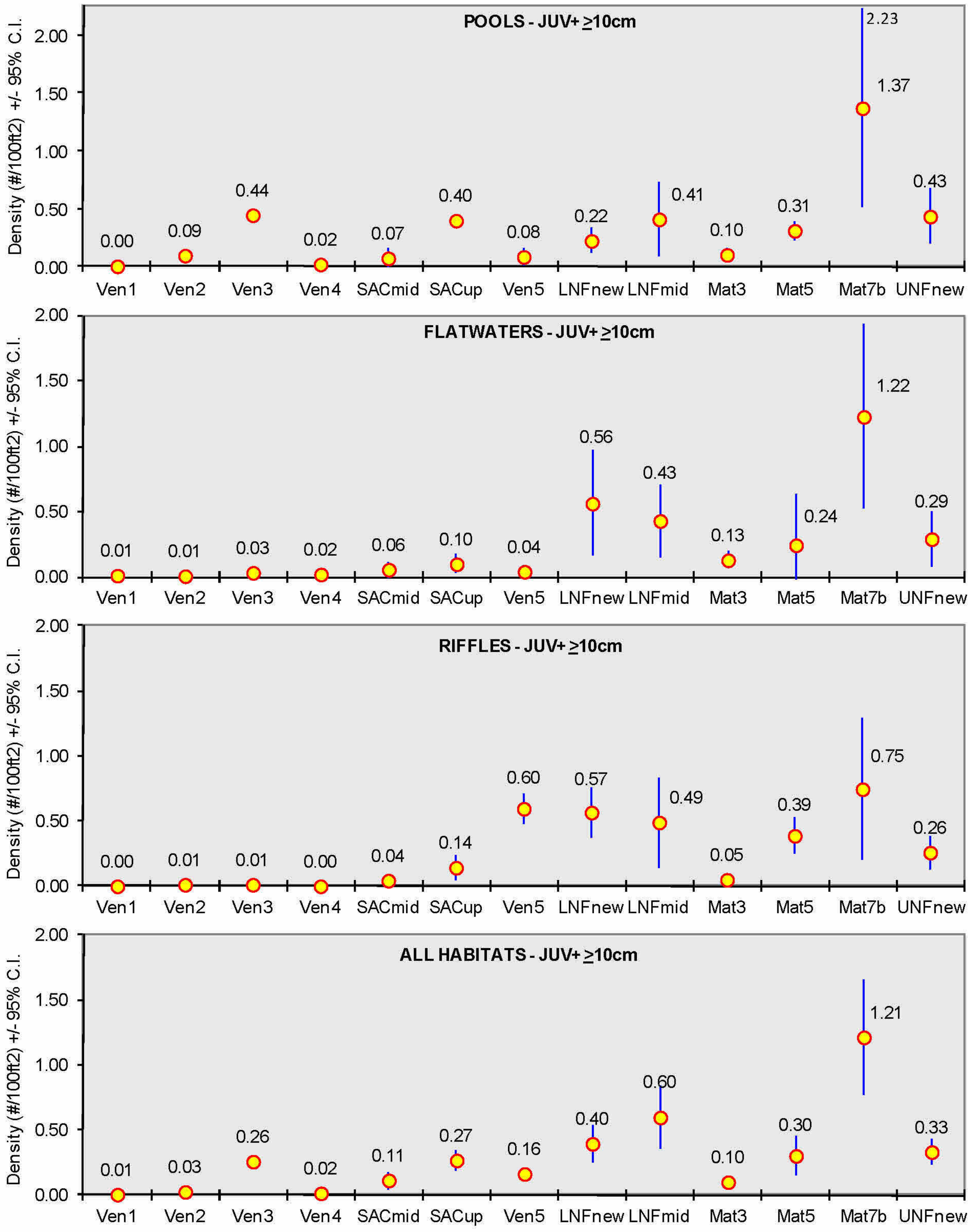


Figure 12. 2011 density (#/100ft^2) estimates for juvenile+ *O. mykiss* by habitat type and study site.

and in 2011. Note that the specific boundaries of the Ven 1 and Mat 7 study sites were shifted in 2011, however annual comparisons are assumed to remain valid due to the close proximity of the adjusted sites.

In the lower Ventura River basin sites, *O. mykiss* fry and juveniles have only been commonly observed in the Ven 3 reach, and then only in 2008 and 2010, with near zero estimates in 2011 (Figure 13). The decrease in 2011 was statistically significant in flatwaters, riffles, and all habitat types combined. As previously noted, *O. mykiss* young-of-year may grow from the fry size class (<10 cm) into the larger size class in the larger mainstem reaches, which may be represented in the juvenile+ abundance trends.

The Ven 3 study site also supported the highest abundance of juvenile+ *O. mykiss*, although few O. mykiss of any size were observed in the first two years of study (Figure 14). The 2011 abundance estimates of juvenile+ in Ven 3 were significantly higher than in 2010 in pools, but were significantly lower in flatwaters and riffles. The combined habitat estimates in 2010 and 2011 were similar. Only the 2008 abundance estimates exceeded the 2010 and 2011 estimates. Juvenile+ trout abundance estimates in the remaining lower basin sites were consistently low (zero or near zero) in 2006 to 2008, but *O. mykiss* were more commonly observed in the Ven 2 and Ven 4 study sites in both 2010 and 2011.

In the three middle Ventura River basin sites, fry and juvenile+ *O. mykiss* were typically abundant in all years, although fry have remained rare in Ven 5 pools (Figure 15). Abundance of *O. mykiss* fry declined from 2010 to 2011 to the lowest (or near lowest) value over the six year study period, with the most significant declines observed in the LNF mid study site. In contrast, trends in juvenile+ abundance estimates were variable but often increasing from 2010 to 2011 (Figure 16). When combined across habitat types, Ven 5 showed a statistically significant decline, whereas the LNF new study site showed a strong increase and the LNF mid site showed little change.

In contrast to trends in the lower and middle basin segments, abundance estimates of *O. mykiss* fry in the upper basin study sites generally increased from 2010 to 2011 (Figure 17). Increases were relatively minor in the Mat 3 study site, but were substantial and significant (for pools and combined habitats) in the UNF study site. The Mat 5 study site, however, showed large and statistically significant decreases in 2011. Many of the 2011 abundance estimates were the highest or nearly the highest estimates over the study period, except for Mat 5 which showed the lowest abundance in 2011. Portions of the Mat 5 study site had changed over the winter and spring of 2010-2011, with a significant portion of the flow entering a 900 ft side channel that was largely devoid of riparian vegetation and was several degrees warmer than the primary, shaded channel. The habitat changes that occurred in the Mat 5 reach could be in part responsible for the decline in abundance of fry in 2011.

In contrast to fry, changes in abundance of juvenile+ *O. mykiss* from 2010 to 2011 were

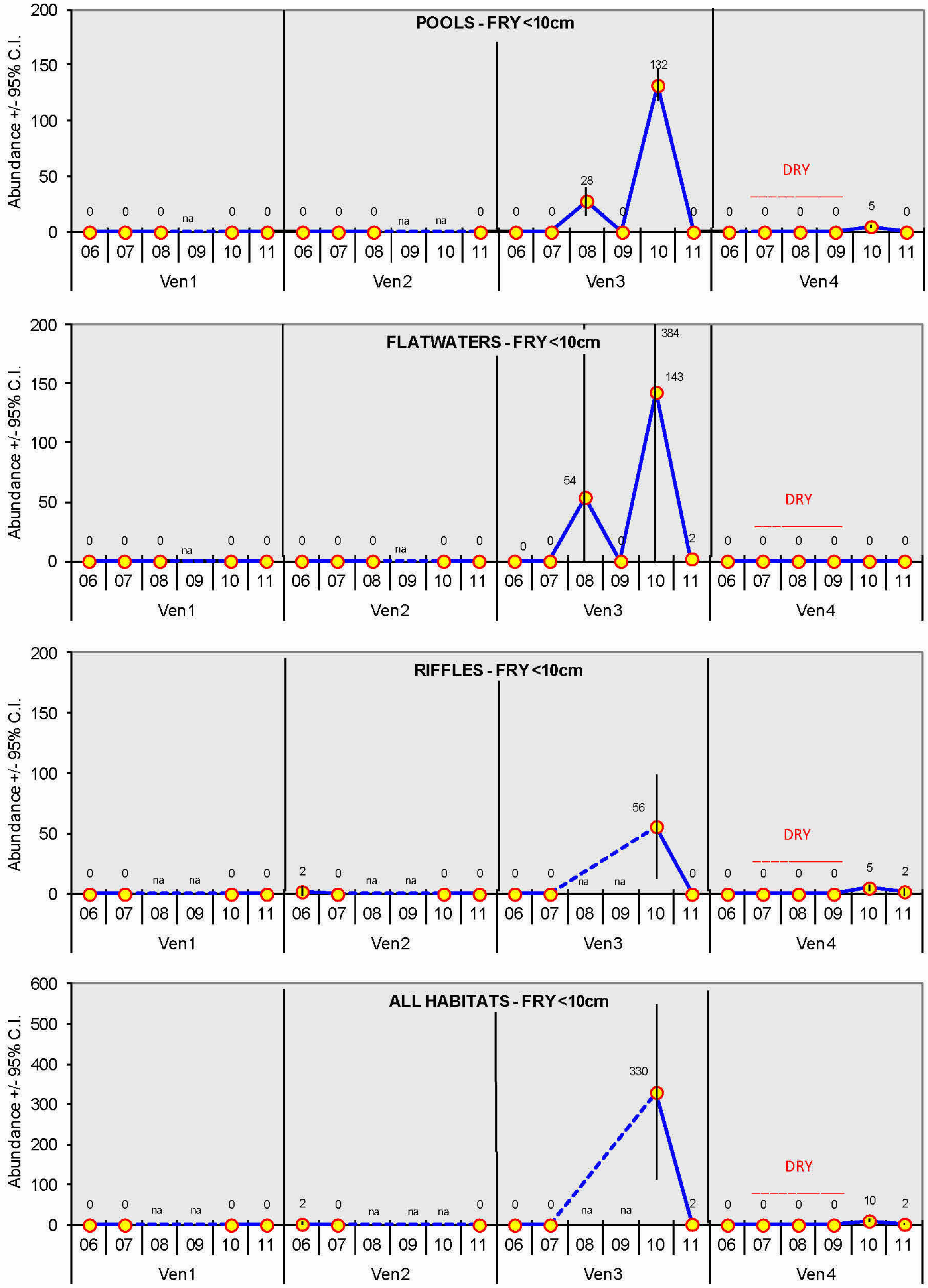


Figure 13. Abundance estimates for *O. mykiss* fry in lower Ventura River basin by year, habitat type, and study site (San Antonio Creek not shown).

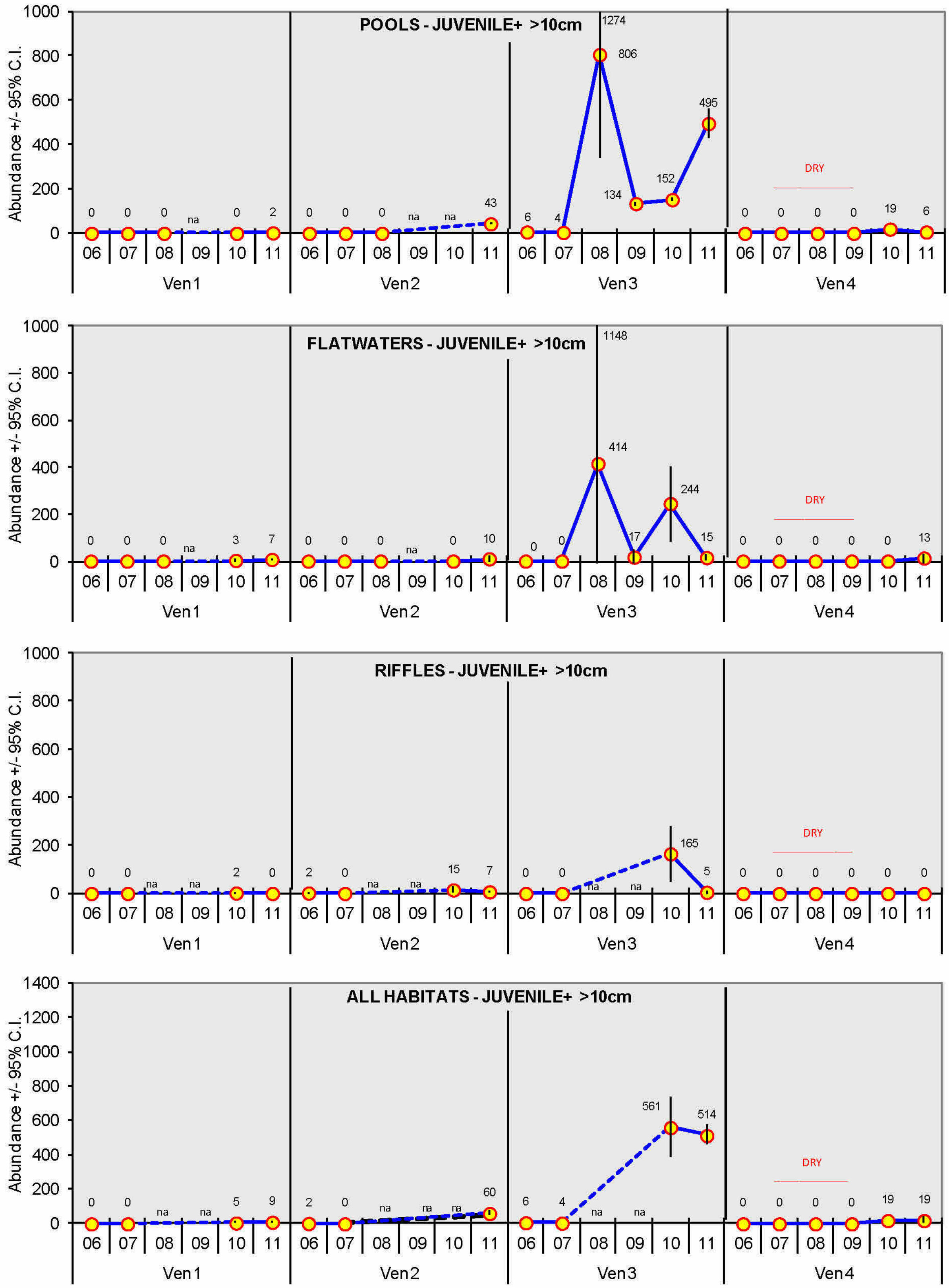


Figure 14. Abundance estimates for *O. mykiss* juvenile+ in lower Ventura River basin by year, habitat type, and study site (San Antonio Creek not shown).

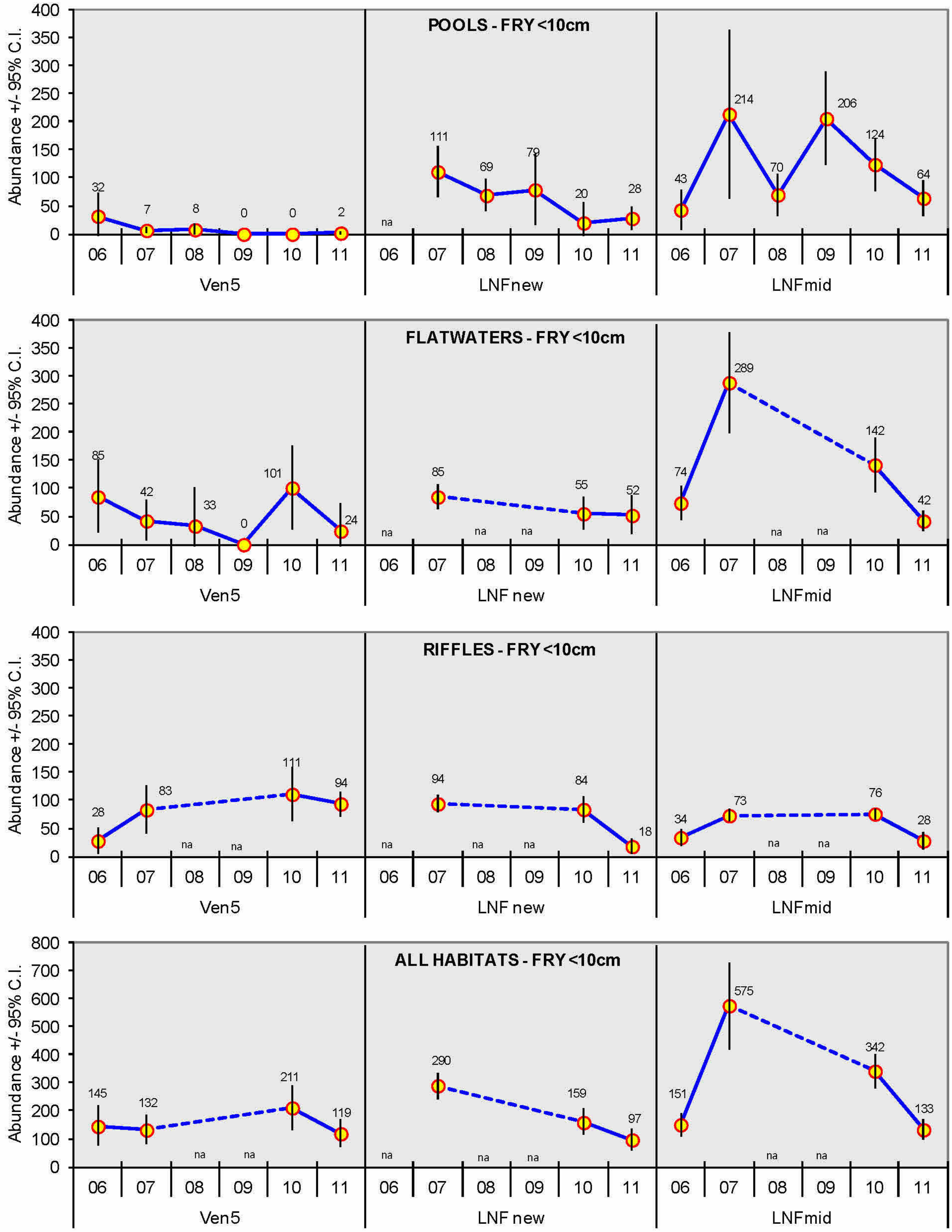


Figure 15. Abundance estimates for *O. mykiss* fry in middle Ventura River basin by year, habitat type, and study site.

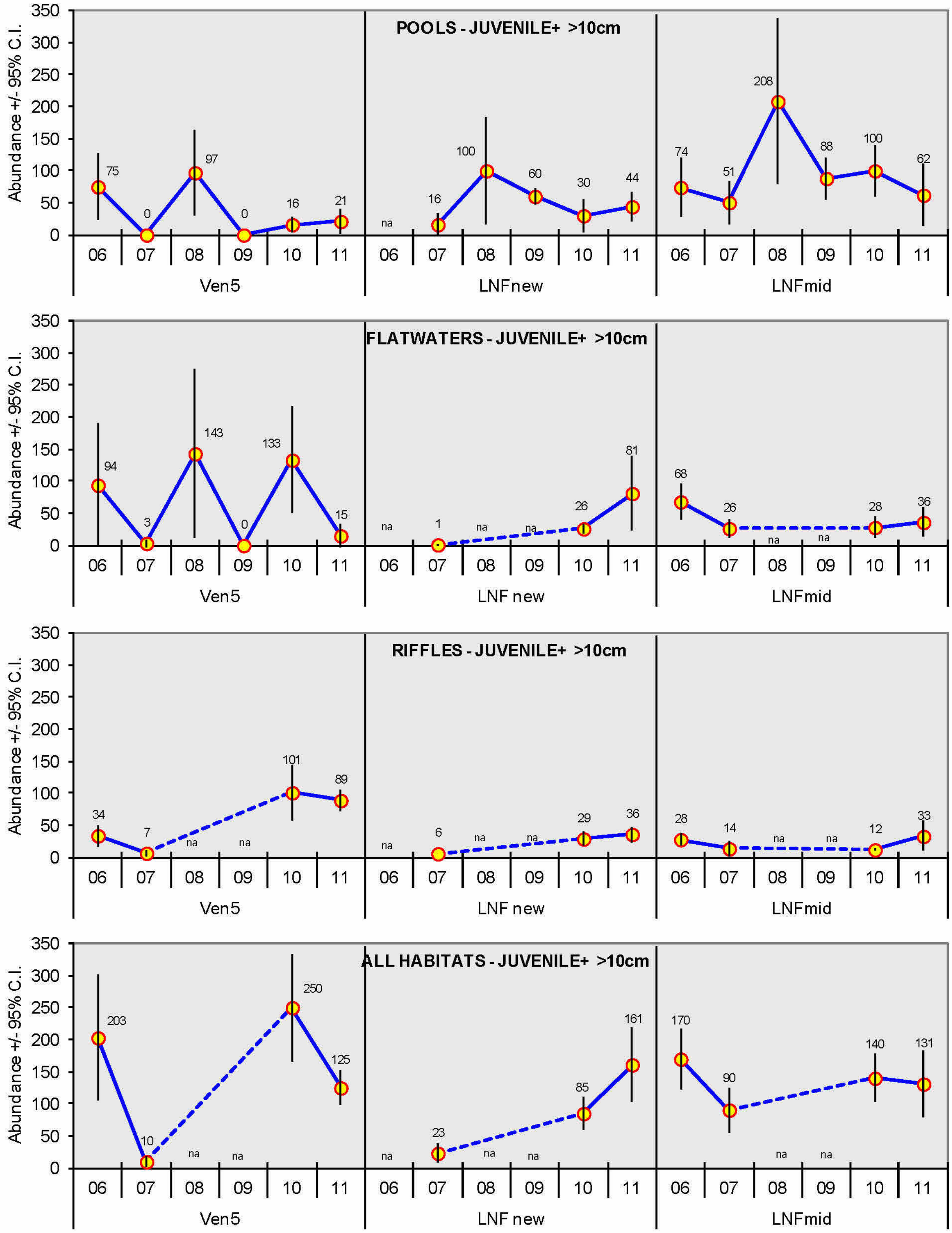


Figure 16. Abundance estimates for *O. mykiss* juvenile+ in middle Ventura River basin by year, habitat type, and study site.

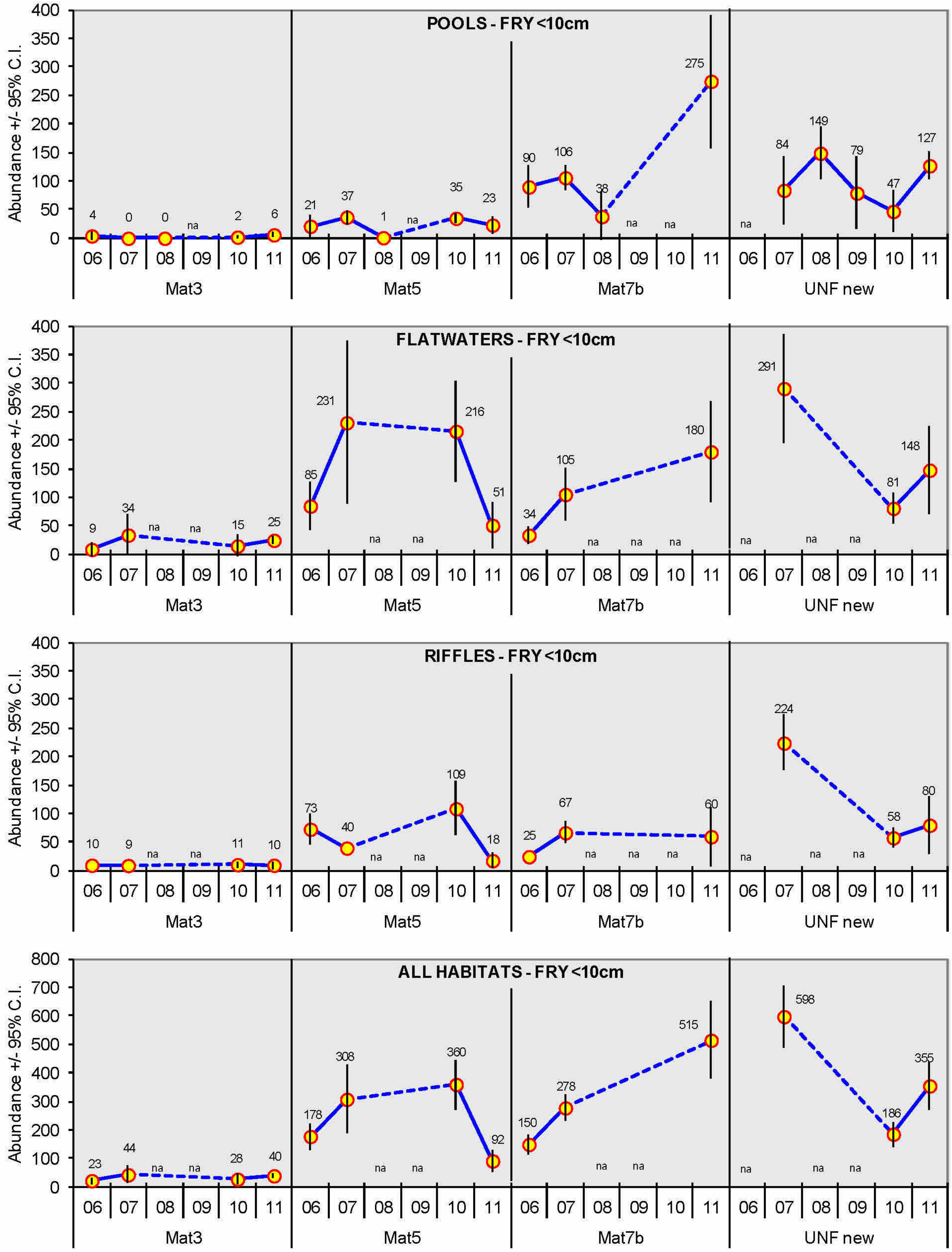


Figure 17. Abundance estimates for *O. mykiss* fry in upper Ventura River basin by year, habitat type, and study site.

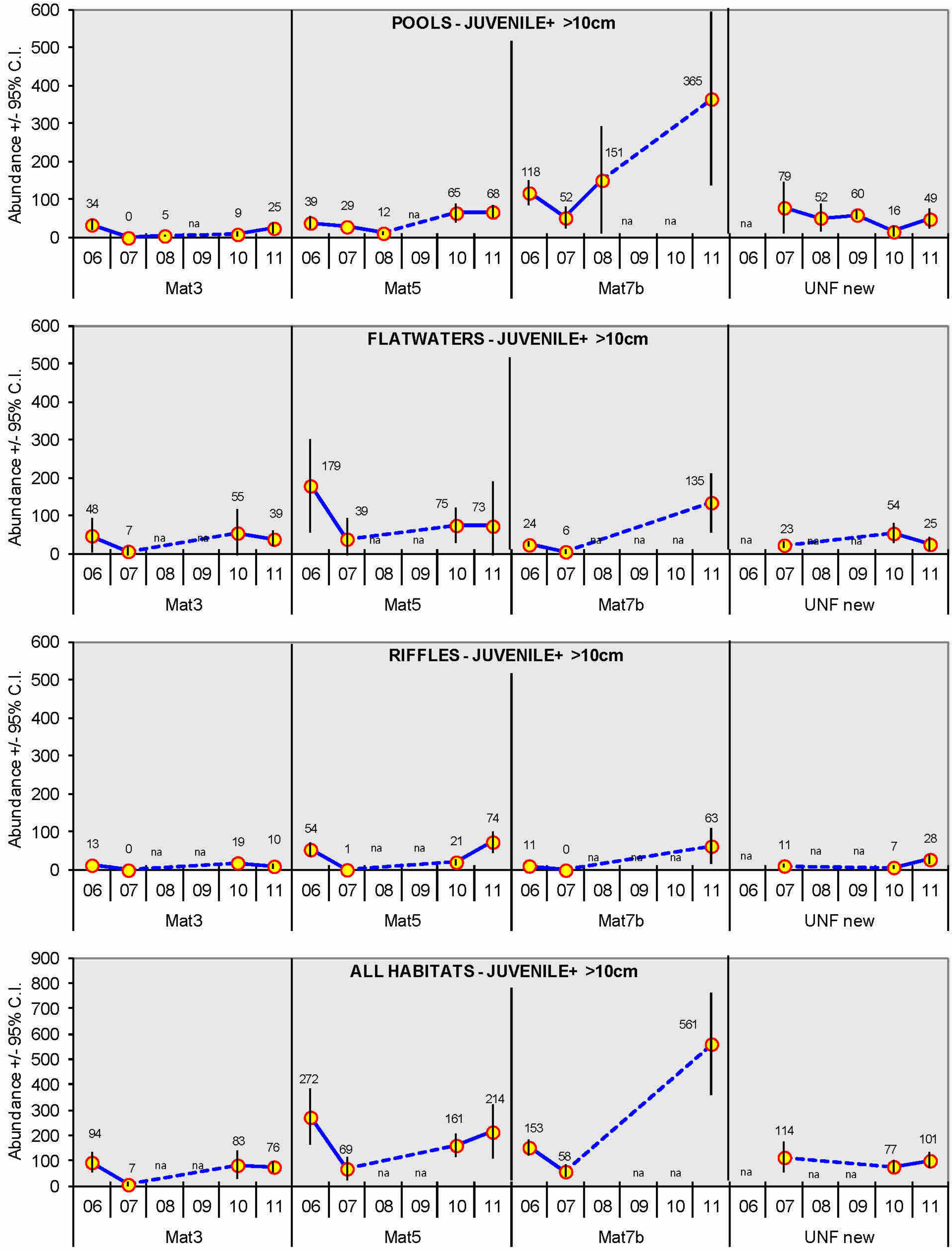


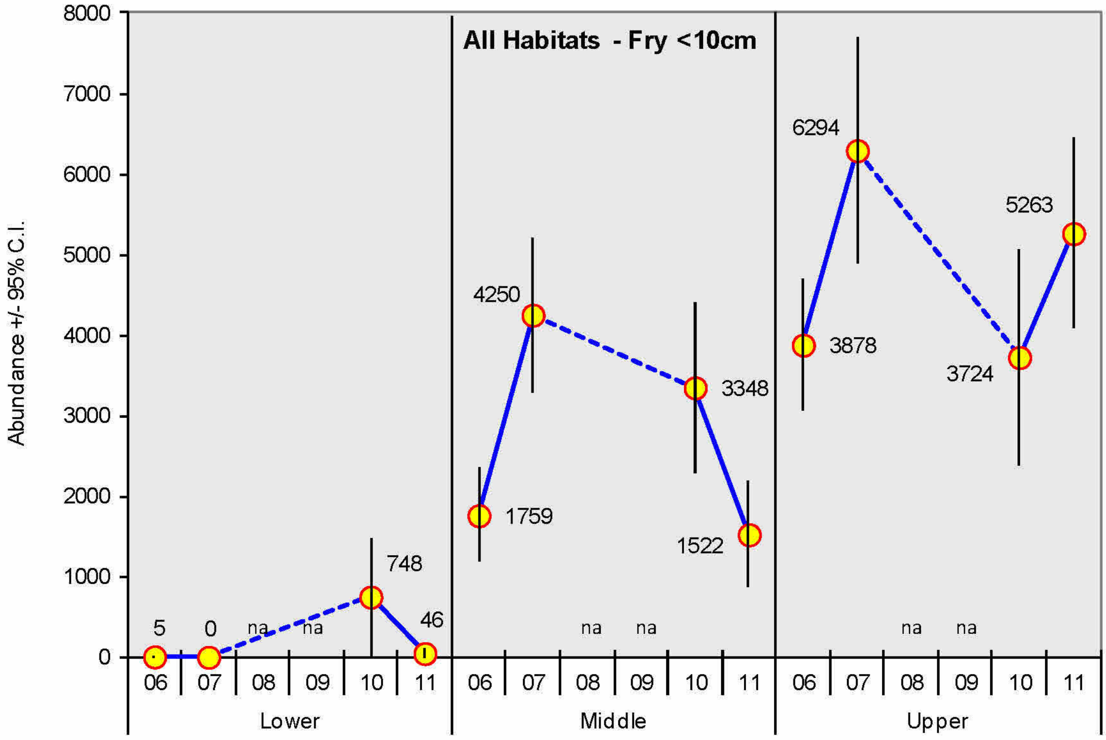
Figure 18. Abundance estimates for *O. mykiss* juvenile+ in upper Ventura River basin by year, habitat type, and study site.

relatively minor in the upper basin study sites, although the combined habitat estimates were increasing in most study sites and habitat types (Figure 18). The comparatively high estimates from the Mat 7b study site may be due to a shift in site boundaries. Access to the original Mat 7 study site was denied by the landowner in 2010, therefore the Mat 7 study site was moved to an adjacent reach ½ mile upstream on public land. Although stream character appeared relatively similar between the two locations, differences in habitat quality and/or human impact (e.g., fishing) could be in part responsible for the high abundance estimates in 2011.

Annual Trends in Abundance by Basin Segment. 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 (Figures 19 and 20). 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 four of the six study years. In contrast, pools were sampled each of the six 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.). Also, basin segment estimates were re-calculated for the 2010 data to better account for areas of wet and dry channels, so slight differences in the 2010 abundance estimates are apparent between this report and the 2010 summary report (Normandeau 2011).

For the estimates combined across all three habitat types (pools, flatwaters, and riffles), the 2011 data continued the general trend of higher abundance in the upper segment and lowest abundance in the lower segment (Figure 19). For *O. mykiss* fry, substantial and statistically significant (middle segment only) declines occurred in the lower and middle basin segments, whereas a strong but non-significant increase was observed in the upper basin. The 2011 lower basin estimate was only 6% of the 2010 estimate, but was higher than previous estimates from 2006 and 2007. Changes in the lower basin for both fry and juvenile+ fish are almost wholly driven by changes in the Ven 3 study site (Figures 13 and 14). The 2011 middle segment estimate was the lowest over the four years of data, and was due to general declines in all three study sites. The substantial increase in the upper segment estimate from 2010 to 2011 was influenced by increases in both the Mat 7b study site and the UNF study site, and was second in magnitude to the maximum estimate from 2007.

Juvenile+ *O. mykiss* showed strong increases in abundance from 2010 to 2011 in the lower basin and in the upper basin, but with little change in the middle basin (Figure 19). The increase in the



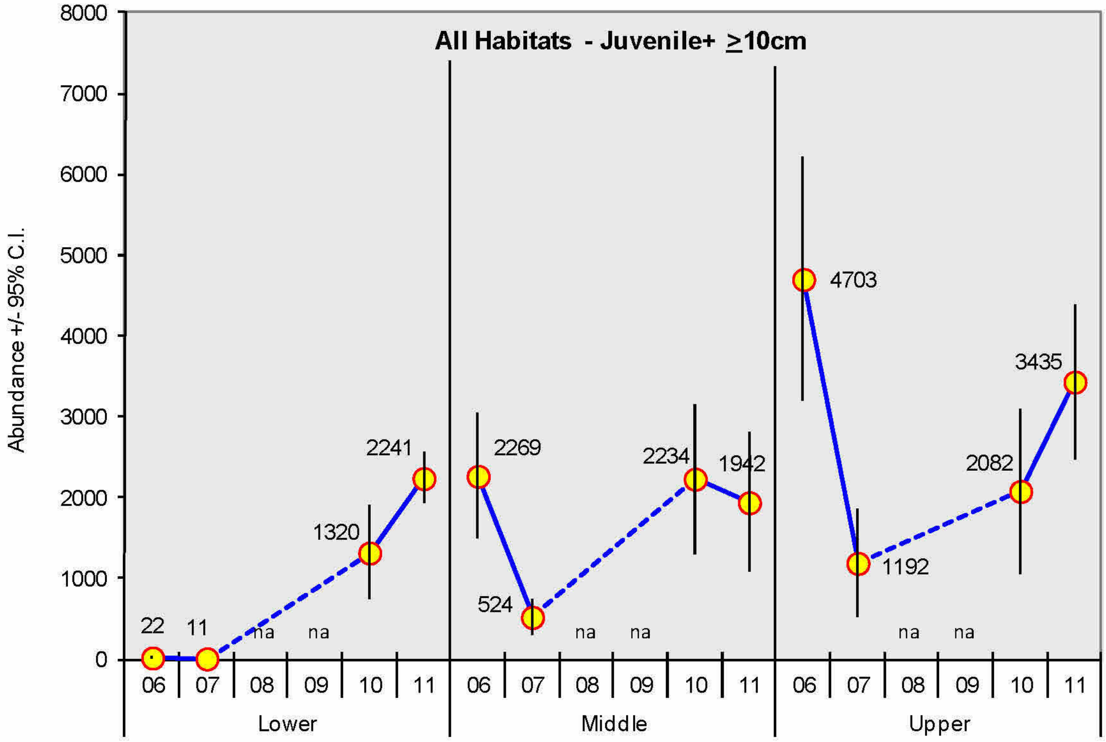


Figure 19. Abundance estimates for *O. mykiss* fry (top) and juvenile+ (bottom) across all habitat types in the lower, middle, and upper Ventura River basin by year. Lower=below Robles Diversion Dam, Middle=between Robles and Matilija Dams, Upper=above Matilija Dam.

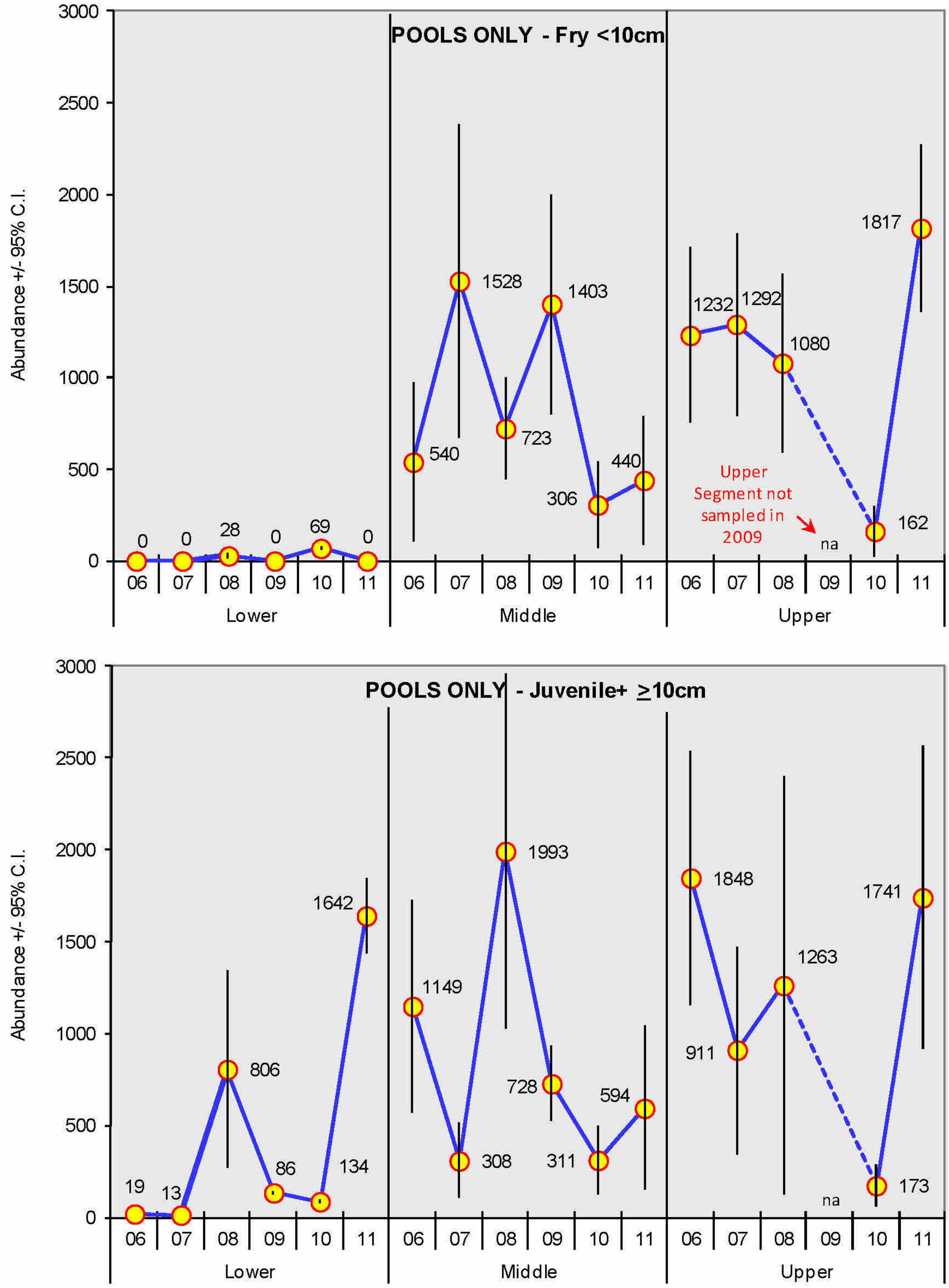


Figure 20. Abundance estimates for O. mykiss fry (top) and juvenile+ (bottom) within pool habitats in the lower, middle, and upper Ventura River basin by year. Lower=below Robles Diversion Dam, Middle=between Robles and Matilija Dams, Upper=above Matilija Dam.

lower basin from 1,320 fish to 2,241 fish was statistically significant, and was wholly due to the large increase in abundance in Ven 3 pool habitats (Figure 14). The increase in the upper basin was consistent with trends in the Mat 5, Mat 7b, and UNF study sites, but was likely most influenced by the high abundance of juvenile+ fish in Mat 7b pools in 2011 (Figure 18).

The pool-only abundance estimates help to "fill-in the gaps", due to the lack of flatwater and/or riffle sampling in 2008 and 2009. Juvenile+ *O. mykiss* were particularly abundant in pool habitats in 2008, and fry were very abundant in 2009 (Figure 20). However it should be noted that in most years pool habitats contained only a minor proportion of fry in comparison to flatwaters and (especially) riffles, where fry were most abundant. For example, when data was combined across all study sites from 2006, 2007, and 2010, 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). 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). 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* should be viewed with caution.

The 2011 data was unusual in that overall fry densities in pools (0.36 fry/100ft^2) was equal to densities in riffles (0.37 fry/100ft^2), although still less than densities in flatwaters (0.57 fry/100ft^2). Despite this limitation, the pool-only trend data generally supported the 2010 to 2011 trends from all habitats combined, but increased the magnitude of changes for juvenile+ *O. mykiss* which tend to occur at higher densities in pools than in riffles. Overall the pool-only data suggested a decline in abundance of fry in the lower basin, little change in the middle basin (versus a significant decrease according to all habitats, Figure 19), and a strong and highly significant increase in the upper basin. For juvenile+ *O. mykiss*, strong and statistically significant increases were observed from 2010 to 2011 in lower basin pools and in upper basin pools. The pools-only data also suggested a substantial (but non-significant) increase in middle segment pools, in contrast to the minor decline indicated by the all-habitats trend.

Conclusions and Additional Observations

In most previous years and in 2011, 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 lowest in the lower basin segment. The upper basin was estimated to contain 77% of *O. mykiss* fry, with only 1% in the lower basin. However, several important tributaries were not included in the basin-wide estimates, namely Murietta Creek in the upper basin and San Antonio Creek in the lower basin. These tributaries will be assessed in relation to other basin streams in 2012.

Relative abundance of juvenile+ *O. mykiss* was more evenly distributed among basin segments in 2011, with 45% in the upper basin, 25% in the middle basin, and 29% in the lower basin (again, not including San Antonio Creek). Overall, over one-half of the estimated abundance of juvenile+ *O. mykiss* in 2011 occurred in the Ventura River Basin's anadromous zone; however a substantial proportion of those fish (~15%) exceeded 20 cm in length during the summer survey. Many of these juvenile+ *O. mykiss* were already much larger than steelhead smolts (e.g., 30-40 cm in length), and the others would be expected to exceed smolt size by the spring of 2012. It is known that some *O. mykiss* in the mainstem Ventura River and in the lower North Fork Matilija Creek spawn as resident adult trout (TRPA 2003), however the proportion of resident to anadromous *O. mykiss* in the juvenile or adult spawning population is unknown, and likely varies from year to year. Data collected to assess the maternal origin of juvenile *O. mykiss* (e.g., whether of anadromous or resident parents) were collected in 2000-2002 (Zimmerman and Reisenbichler 2002), however the conclusions of that study have not been found.

Although the 2006-2011 studies demonstrate that most *O. mykiss* reside above Matilija Dam, the 2011 data again illustrated the importance of the mainstem Ventura River near the San Antonio Creek confluence for rearing *O. mykiss*. Also, 2011 was the first year of sampling when juvenile+ *O. mykiss* were observed in the lowest mainstem reach of the Ventura River (Ven 1), with observations in one pool and in three flatwater habitats. In the Ven 2 study site, abundance of juvenile+ *O. mykiss* was higher in 2011 than in any previous year, with juvenile+ fish observed in 6 of 7 pools. The relatively high summer flows that occurred in 2011 may be associated with the increased abundance of *O. mykiss* in the lower Ventura River study sites, however high flows also existed in 2006 when fry or juveniles were not observed in those two reaches.

Intensive sampling in 2006 and 2007 did not reveal significant densities in any of the four lower basin study sites; but subsequent sampling in 2008, 2009, 2010, and 2011 showed significant rearing of juvenile+ *O. mykiss* in the Ven 3 study site. 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 all three locations, including the mainstem Ventura River, suggest that multiple sources may contribute to these mainstem densities. These observations support historical data showing that the lower Ventura River serves as an important rearing area for juvenile *O. mykiss* (Moore 1980, Capelli 1997), as well as a critical migratory pathway for upstream rearing smolts.

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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