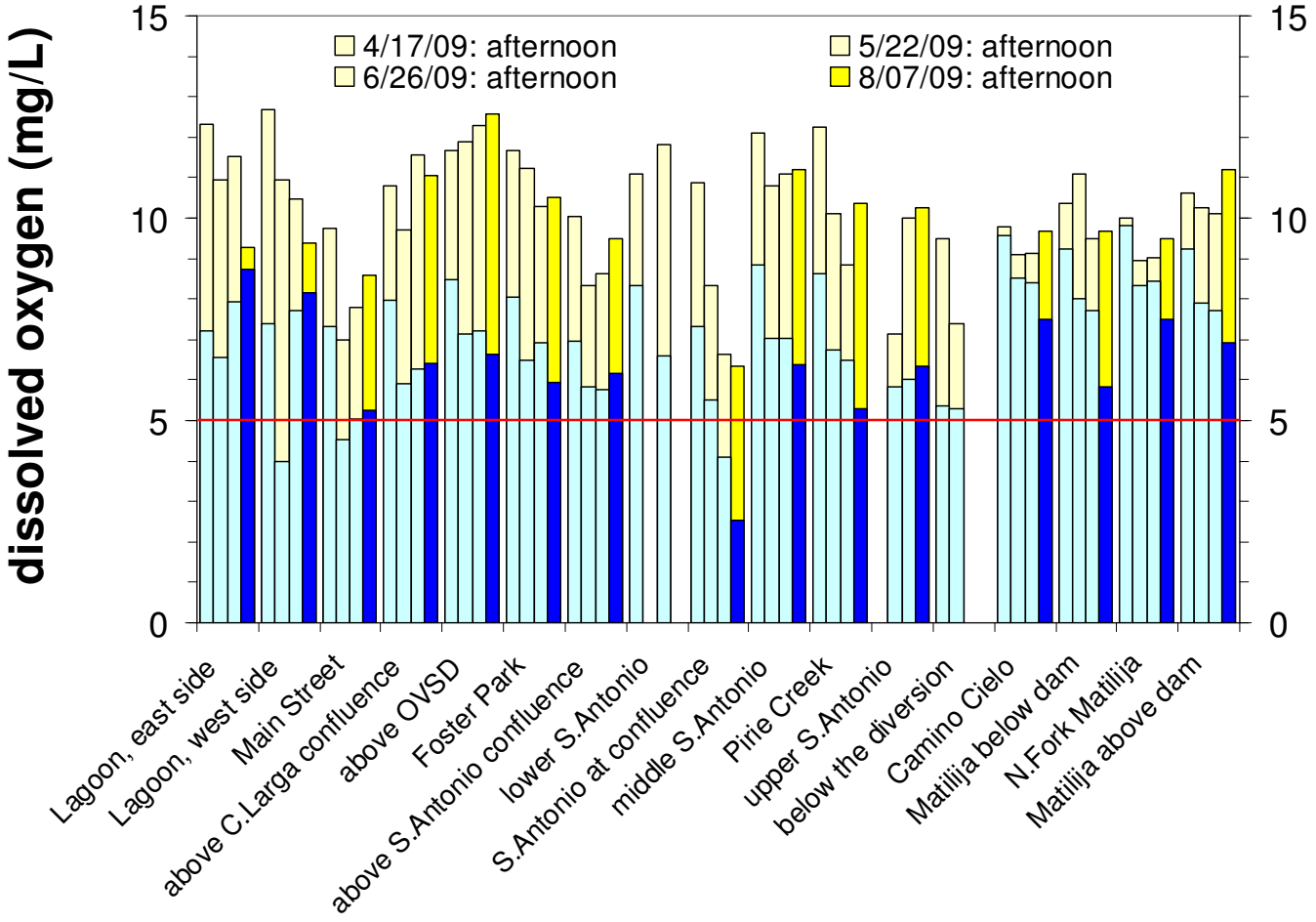
On June 26, 2009, Santa Barbara Channelkeeper completed a forth round of 2009 diel measurements of dissolved oxygen (DO), water temperature and *p*H on the Ventura River and its tributaries. As before, pre-dawn measurements were made between 4:30 to 6:30 AM, afternoon measurements between 1:30 and 3:30 PM. The dissolved oxygen values recorded on this date, and during previous 2009 sampling events, are displayed on the following graph (in mg/L, i.e., ppm). Fifteen locations, including 2 in the lagoon, were sampled in August.



The lowest DO value recorded on August 7th was 2.52 mg/L on lower San Antonio Creek, just before its confluence with the Ventura (San Antonio Creek was dry on the Westside of Hwy 33, about a half mile above this confluence). This is below the 5 mg/L Ventura basin plan limit (shown as a red line on the graph). No other sampling locations were below the limit, although Main Street, at 5.25 mg/L (up from last month's 5.04) and Pirie Creek at 5.31 mg/L (considerably down from last month's 6.49) were close.

Delta-DO values, defined as the difference between the maximum and minimum daily dissolved oxygen concentrations (or in Channelkeeper's case, the difference between mid-afternoon and pre-dawn concentrations, the approximate times when these extremes normally occur) are shown in the upper panel of Figure 1. Delta-DO for April, May, June and August 2009 are contrasted with values for the same months in 2008.

Delta-DO values below the Waste Water Treatment Plant (WWTP) and on lower San Antonio Creek continue to remain much lower than last year; elsewhere they present a mixed picture – some months higher, some lower – although the general trend was higher delta-DO values this August than we experienced in 2008.

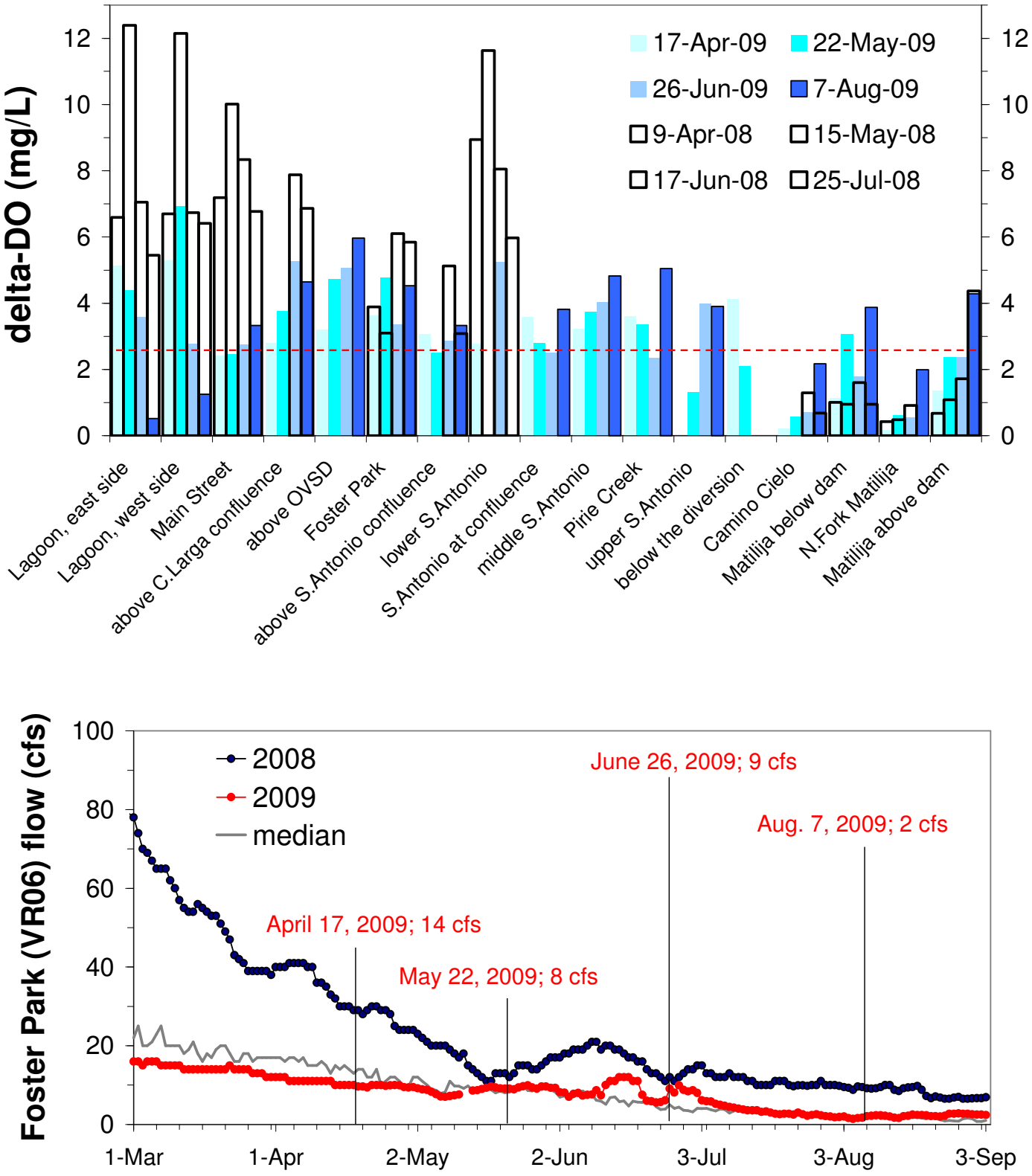


Figure 1. (upper) Delta-DO values for April, May, June and August 2009 are contrasted with data from similar months in 2008. Last year's data are shown as "white" background bars where the values were higher, as black outlines (i.e., transparent bars) when lower. The red line at 2.5 mg/L represents the delta-DO equivalent of a maximum oxygen deficit limit of 1.25 mg/L used by the Central Coast Regional Water Board. (lower) Average daily flows at Foster Park, since March 1, for 2009 (red) and 2008 (black); this year's diel sampling dates (in red) and the long-term average daily median flow are also shown. This year's flow is rather nicely tracking the long-term median. This is the "typical" year.

Unlike last year when most locations experienced a mid-May peak in delta-DO at the peak of the season's major algal bloom, a large number of this year's locations are exhibiting a steady increase in delta-DO as the season progresses. The reason seems to be that the primary producers now effecting the diel DO cycle – it's important to remember that submerged photosynthesizing parts of aquatic plants may also be playing a role at a number of these sites – are no longer predominately *Cladophora* (now only a minor player at most locations) but *Spirogyra*, diatoms and, in the upper basin, *Mougeotia*. These are species that appear to do better in quiescent waters and low nutrient environments, and they also come on late as flows (thus turbulence) appreciably decrease with the continuing dry-season. And, of course, the much lower flows of 2009, compared with those of 2008, also play a direct role, delta-DO being the product of both the amount of algae and the amount of water the algae influence (delta-DO is directly proportional algae biomass and inversely proportional to flow); decreasing flows magnify the impact of algae on dissolved oxygen.

In June I reported that the lagoon had returned to the green soup-like state of April, dominated once again by phytoplankton. This situation has continued into August; tidal inflows dominating the estuary account for the very low delta-DO values measured: the minimum pre-dawn DO values were 8.14 and 8.75 mg/L (the higher value at the sampling point closer to the lagoon mouth).

As discussed in previous diel reports, Chl-a density data collected in last year's UCSB-TMDL algal study and Channelkeeper's near contemporaneous delta-DO measurements, along with Ventura County, USGS and Channelkeeper flow records, allowed the development of a model derived by regressing delta-DO on Chl-a and Q. The model, displayed as a graph in Figure 2, features lines of equal Chl-a densities (red numbers representing density in mg/m^2), and furnishes an estimate of Chl-a after entering values of flow (in cfs on the x-axis) and delta-DO (in mg/L on the y-axis). In Figure 2 I've updated my last version by adding August flow and delta-DO values for 2008 (actually July 27th) and 2009. This year's data is shown in shades of blue, last year's in blander colors; Channelkeeper site numbers are shown only for the August 7, 2009 data.

The UCSB Report recommended the following Chl-a standards: (1) less than 50 mg/m^2 defining "unimpaired" reaches, (2) greater than 200 mg/m^2 considered " impaired"; with (3) anything falling in-between requiring further study or monitoring. Presumably, these standards or something similar will be adopted in the eventual TMDL. No location sampled in 2009 could be classified as unequivocally "impaired," and only a few have fallen into the "above 50" category where they might be regarded as contenders. It now appears unlikely that any sites during the remaining dry-season will. However, as stream flows in the watershed continue to decrease, as algae (and other photosynthetic organisms), at least in some locations, continue to flourish and grow, and as other factors that lower dissolved oxygen concentrations in increasingly quiescent waters, such as decay, exert increasing influence the possibility of excessively low levels of dissolved oxygen remain real – as we saw this month on San Antonio at its confluence.

Since the graph in Figure 2 doesn't adequately show the progression of site by site algal growth over the course of the season, I've displayed estimated Chl-a densities using a different format in the next graph. 2009 values are shown as blue or green bars (based on the month) while estimated Chl-a densities for the corresponding months in 2008 are shown as "transparent" foreground bars (i.e., they appear as a "white" bar in the back when 2009 values were higher, as a horizontal line through a colored bar when lower). Chl-a densities in 2009 on the lower Ventura River and lower San Antonio Creek are roughly an order to an order-and-a-half magnitude lower than in 2008 (order-of-magnitude = 10-times, an order-and-a-half = 50-times). Elsewhere the picture is mixed: some locations like Foster

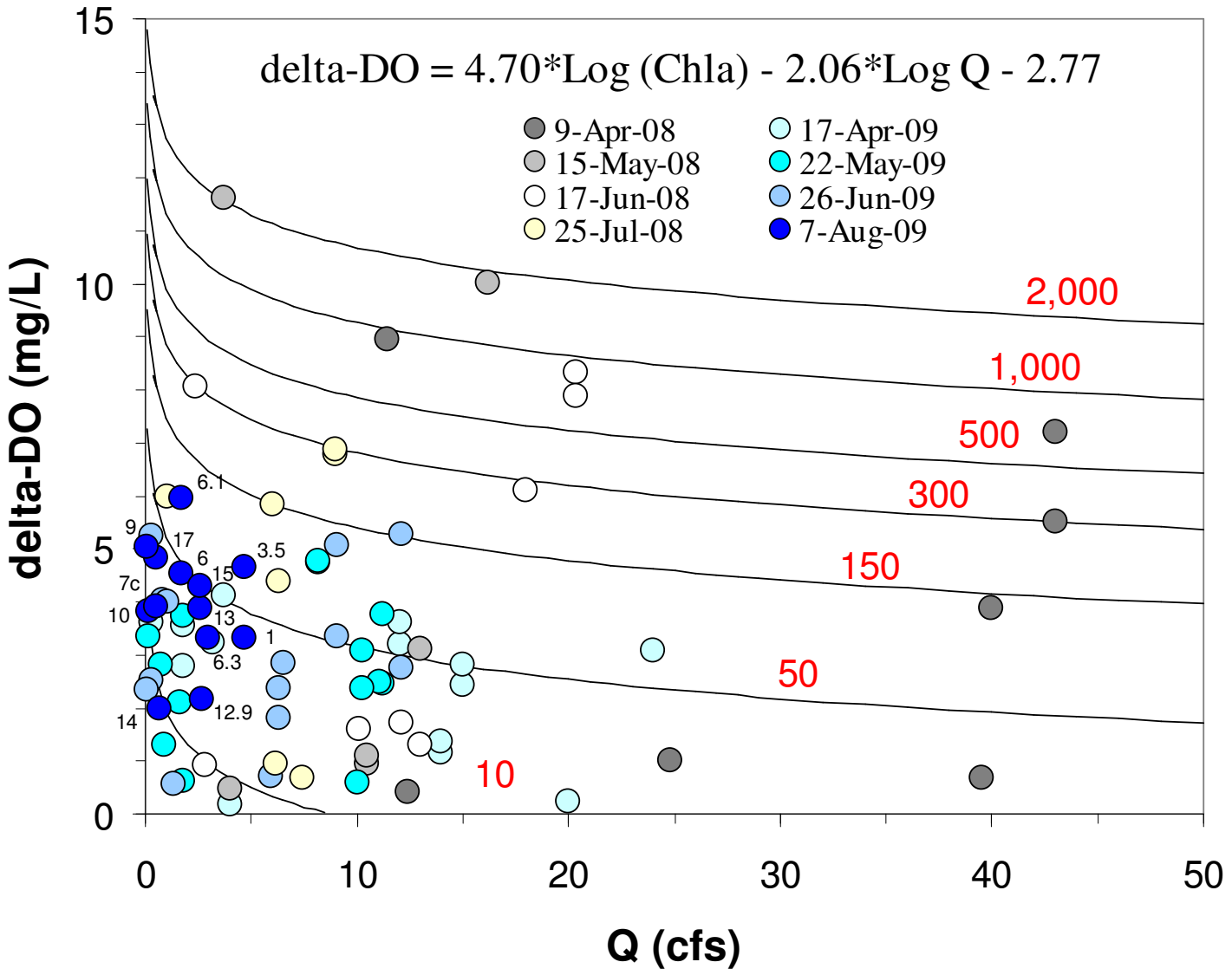
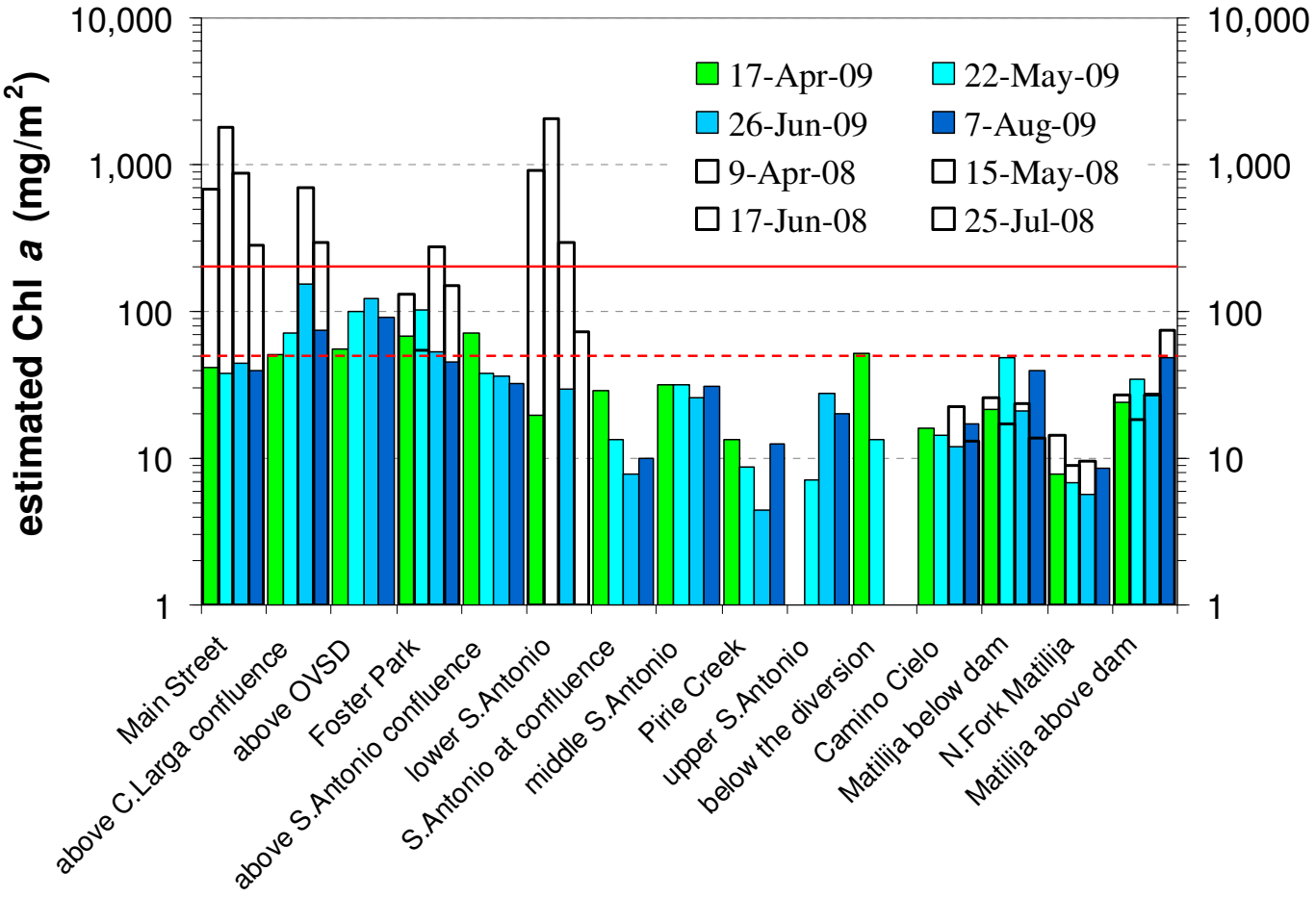


Figure 2. The chart shows the revised graphical model developed using data from the UCSB-TMDL study, Ventura data collected by Julie Simpson and myself in 2003, and 2008 Calleguas Creek data collected by Diana Engle. The regression relationship used in the model is shown on the graph ($p < 0.001$, r-squared = 0.87). Although the regression equation shows delta-DO as the dependent variable (required to plot the graph in this fashion, with Q and delta-DO on the axis', and modeled Chl-a as lines labeled in red with density in mg/m^2) the model was derived using Chl-a as the dependent variable. The chart shows 2009 diel sampling data, collected by Channelkeeper, in shades of blue, with data collected during the corresponding months in 2008 in shades of yellow and grey. Channelkeeper site codes are shown only for the August 7, 2009 data. Unlike 2008, which exhibited a wide range of algal conditions and Chl-a values, 2009 data are clustered in the lower left-hand corner. No sampled locations in 2009 have yet approached the 200 mg/m^2 recommended lower-limit of undeniable impairment; and it seems likely that no locations will. However, if Chl-a densities, and delta-DO values, continue to creep upwards (the ongoing trend – at least for delta-DO – at most locations this August) the possibility of excessive DO fluctuations remains. Note that the model indicates that even low Chl-a densities may produce extremely high delta-DO values (i.e., low levels of pre-dawn DO) if flow levels are low enough.

Park are generally lower than in 2008, while those in the upper basin are quite similar and even, at times, higher (e.g., all sites in August and Matilija Creek above the dam generally).



I've added red horizontal lines to mark the UCSB algal density criteria (200 and 50 mg/m^2). I've also come up with a new graph in an effort to clarify the relationship between Chl-a and delta-DO (Figure 3). As previously stated, the connection between them is flow: delta-DO being directly proportional to Chl-a but inversely proportional to flow. Differences between the two values, e.g., delta-DO increasing as the months wear on while Chl-a decreases, signify the influence of flow; in this example greatly decreasing flows increasing delta-DO in spite of a decrease in algal density. It's probably not all that much of a help, but what the hell, I kinda like graphs.

The remainder of this report consists of photos. Since this is probably the last (or next to last) diel sampling of the season I wanted to contrast what things look like now with conditions back in April (or whatever date the earliest comparative photo was taken). The photos and their captions are self-explanatory. The general theme is the overall reduction in flow over the course of the season at all sites (expected) and the appreciable increase in both aquatic and riparian vegetation at most (always, I'll admit, something of a surprise to me in terms of its extent and rapidity of growth).

Figure 10 shows the site just above the sewage treatment plant, the location which has been the biggest surprise to me this season. Not only has the growth of algae here been steady (see Figure 3; this is arguably the location with the highest algal densities of 2009), but the photos, and my personal experience sampling at this site, give the impression that flows have not noticeably decreased (contrast Figure 10 with Foster Park, the closest upstream site, in Figure 6). Although highly subjective at this

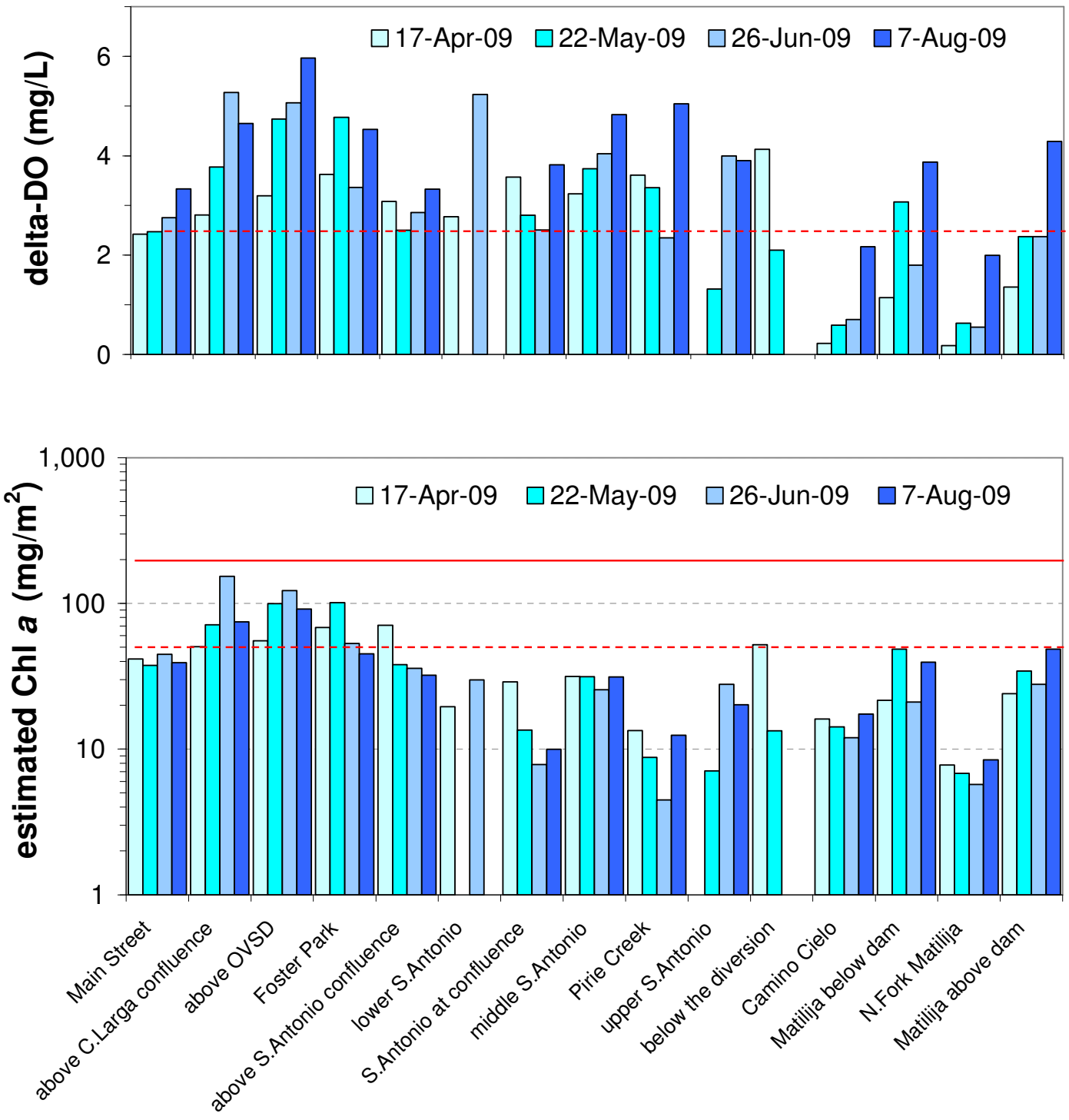


Figure 3. Delta-DO values for April, May, June and August 2009 are show in the upper panel while estimated algal densities in mg of Chl-a per m^2 are shown in the lower. The red line at delta-DO = 2.5 mg/L represents the delta-DO equivalent of a maximum oxygen deficit limit of 1.25 mg/L used by the Central Coast Regional Water Board, and the UCSB recommended Chl-a criteria of < 50 (unimpaired) and >200 mg/m^2 (definitely impaired) are shown as red lines in the lower graph. Since delta-DO is directly proportional to Chl-a and inversely proportional to flow, differences between the two graphs relate directly to changes in flow, e.g., increasing delta-DO values as the summer progressed on Middle San Antonio were caused by diminishing flows since Chl-a densities remained relatively constant.

point, the implication is of substantial groundwater inflows – in a reach where none have previously been suspected. We may well have to pay more attention to this location in the future.

I've included in Figure 11 two photos from a hike Ben and I took on August 8 up to the falls within the Wilderness Area near the head of Matilija Creek. Almost all sunlit pools (those with appreciable sunlight throughout the day) were heavily colonized by *Mougeotia* and *Chara*. To me this illustrates that with enough sunlight even low nutrient, pristine environments can foster extravagant algal blooms – at least for those species that thrive in quiescent conditions. More surprising were the patches of *Cladophora* lining the cascades that often fed the upper ends of these pools. Low nutrient concentrations do not necessarily mean a low nutrient flux, and nutrient dependent species like *Chadophora* can hang on in special environments – even if they are pristine.

I'll again forgo any discussion of water temperatures. And of *p*H. The emplaced Channelkeeper temperature loggers in the upper basin (sites VR12.9 to 15 and above) are still collecting data, and when these are gathered in and downloaded this fall we'll devote a special report to the results. Water temperatures throughout the watershed continued to climb in August (not unexpected) and continue to be slightly lower to those recorded last year – probably due to the increased presence of aquatic plants and additional growth in riparian cover. The highest temperature found on August 7th was 29 °C (84 °F) on Matilija Creek above the dam.

Finally, I'll restate my now usual appeal for a financial contribution or two to purchase a few more tid-bit temperature loggers to extend the range of this program. Come on fish-lovers, millions of dollars of *other-peoples-money* to restore steelhead on the Ventura, but nothing of your own to monitor the conditions under which they would have to survive? I know times are tough, but they're not that tough. Not yet.

Photos taken in April, May, June and July 2008 and on April 17, May 22, June 26, and August 7, 2009 (and on other Channelkeeper sampling days in 2008 and 2009) can be downloaded at:
http://sbc.lternet.edu/~leydecke/Al's_stuff/Recent%20Stream-Team%20Photos/

Photos of the initial UCSB-TMDL algal survey locations taken at the time the survey was conducted in 2008 can be downloaded at:
http://sbc.lternet.edu/~leydecke/Al's_stuff/Ventura%20Nutrient%20TMDL/TMDL%20algal%20survey%20photos/

Posted PDF copies of all my previous Ventura Nutrient TMDL reports can be found at:
http://sbc.lternet.edu/~leydecke/Al's_stuff/Ventura%20Nutrient%20TMDL/My%20PDF%20files%20on%20algae%20&%20nutrients/

For additional information or questions, or comments and opinions, please feel free to email me at:
al.leydecker@cox.net

Figure 4. Looking upstream from the Main Street Bridge in 2009: April 4th above, August 7th below. Aquatic plants, more precisely Ludwigia (all those red roots in the upper photo), and riparian vegetation which began the year with a good start have come to dominate the lower river.

Figure 5. Looking upstream from a viewpoint just below the Canada Larga confluence in 2009: April 4th above, August 1st below. Other than the big watercress die-back (the 3 trees in the middle of the river give some indication of how tall the watercress was in April), little has changed here.

Figure 6. Looking upstream from the bridge at Foster Park in 2009: April 4th above, August 1st below. Riparian growth, lower flows and the demise of watercress (the green island in the upper photo) are the major changes here. Delta-DO has been fluctuating around 4 mg/L all season long.

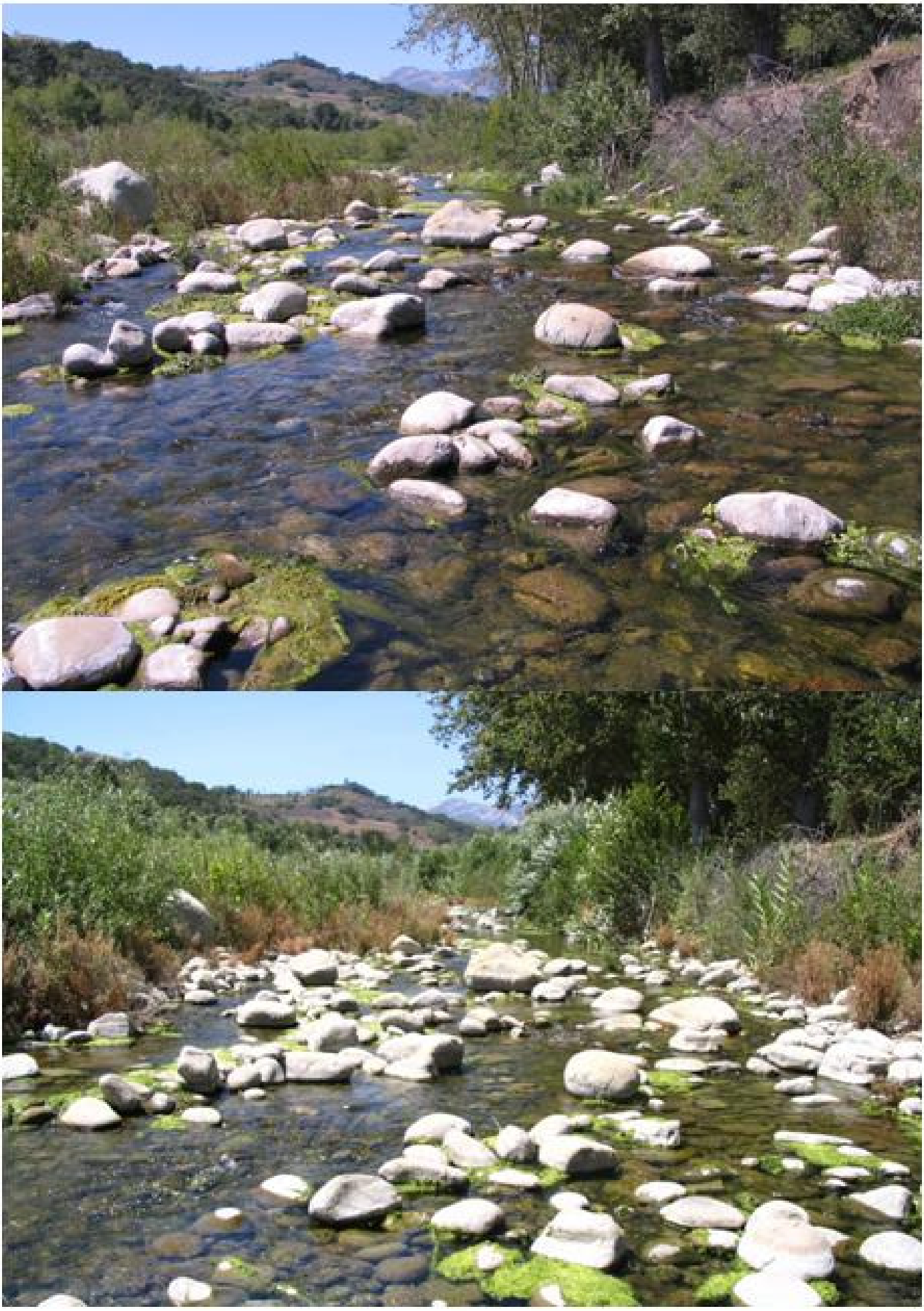


Figure 7. Looking upstream from the San Antonio confluence in 2009: April 17th above, August 7th below. Other than some further growth in riparian vegetation, a decrease in flow and the replacement of *Cladophora* with *Enteromorpha*, not much has changed.

Figure 8. Looking downstream at San Antonio Creek nr. Lion Canyon in 2009: April 17th above, August 7th below. Delta-DO has steadily increased at this location throughout the dry-season, mainly because of declining flow.

Figure 9. Looking upstream at Matilija Creek (above-dam sampling point) in 2009: April 17th above, August 7th below. The bloom (*Mougeotia & Spirogyra*), developing in the upper photo, peaked during the first half of June. Delta-DO has also steadily increased at this location throughout the Summer.

Figure 10. Looking upstream from just above the sewage treatment plant in 2009: April 17th above, June 26th below. Algal density has continued to increase throughout the Summer at this site (initially *Cladophora*, now *Spirogyra*). This is yet another location where delta-DO continues to increase.

Figure 11. Now for something different. These two photos were taken on August 8, 2009, on Matilija Creek within the Wilderness Area, more than 10 miles above the dam. Most of the pools open to substantial sunlight were filled with *Mougeotia*. More surprising, the narrow cascades leading into these pools were often lined with *Cladophora*. It would appear that the anthropogenic land-use/high nitrogen/algal nexus might not be the only game in town. I could sure use a grant to study these pools.