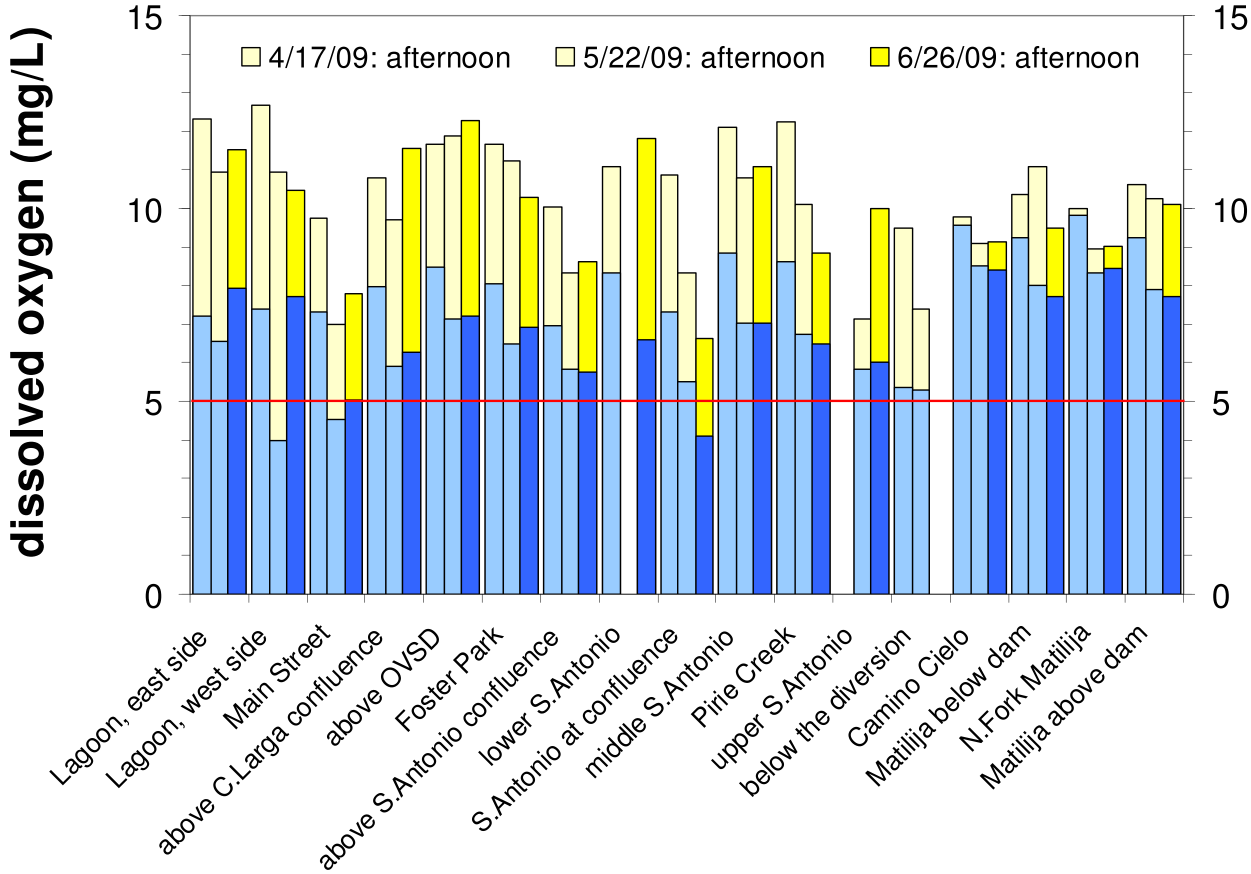
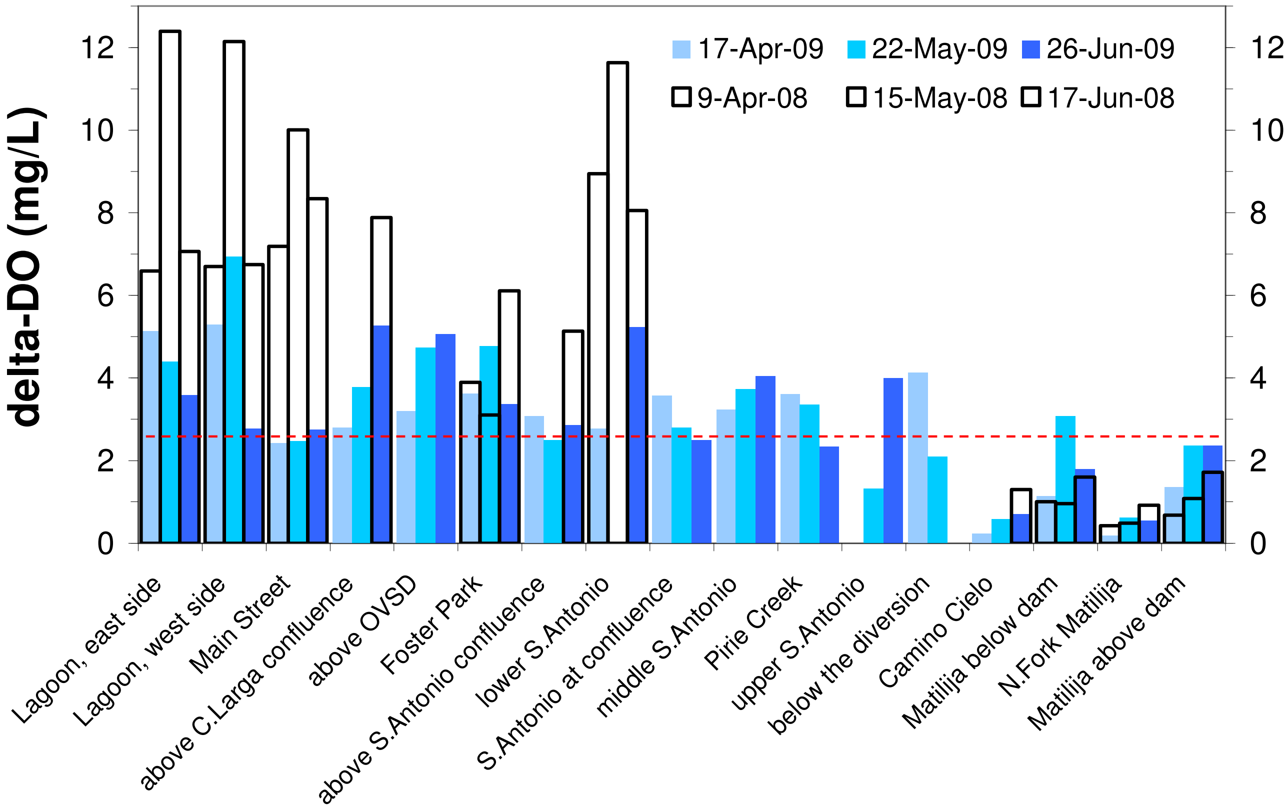



On June 26, 2009, Santa Barbara Channelkeeper completed a third round of 2009 diel measurements of dissolved oxygen (DO), water temperature and *p*H on the Ventura River. Pre-dawn measurements were made between 4:30 to 6:30 AM, afternoon measurements between 1:30 and 3:30 PM. The dissolved oxygen values recorded, displayed to emphasize differences between pre-dawn and mid-afternoon concentrations, are shown on the graph (in mg/L, i.e., ppm). Sixteen locations were sampled, including 2 in the lagoon. Unfortunately, due to equipment failure, there are no June results from just below the Lake Casitas (Robles) diversion.

The lowest DO value recorded on June 26 was 4.11 mg/L on lower San Antonio Creek, just before its confluence with the Ventura. 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 5.04 mg/L, came 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 and June 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 are much lower than last year; elsewhere they remain roughly similar except on Matilija Creek where there has been a noticeable increase. Unfortunately, differences between this year's and last year's selection of sampling locations don't allow us to directly compare a large number of sites.



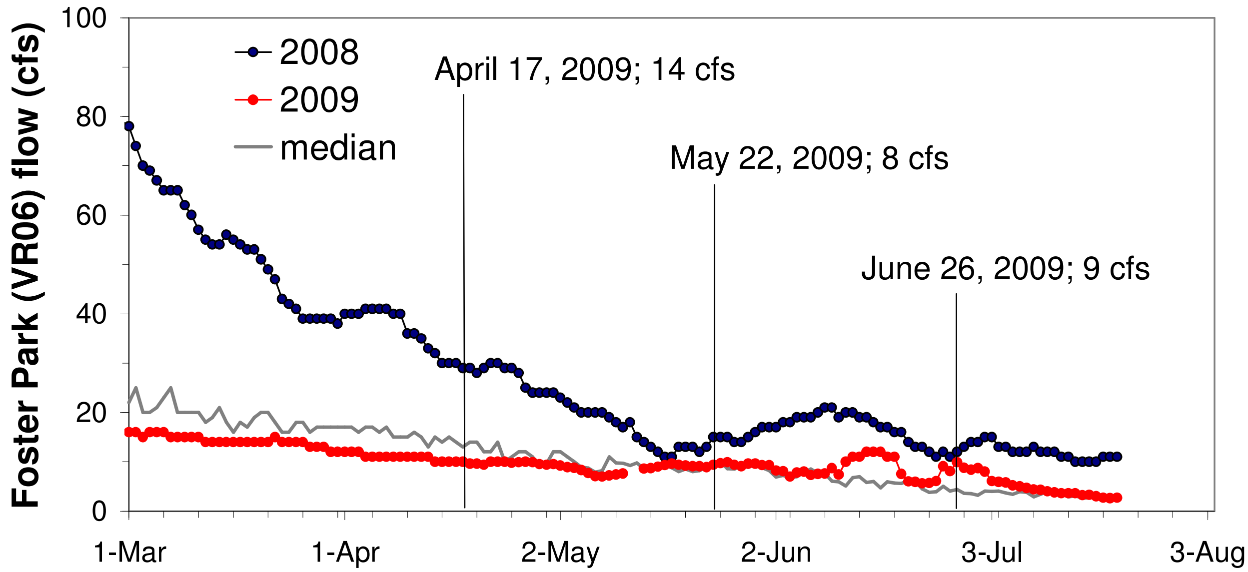




**Figure 1**. (upper) Delta-DO values for April, May and June 2009 are contrasted with data from the same months in 2008. Last year's data are shown as "white" background bars where the values were higher, as black outlines (i.e., transparent bars) when lower. The red line at 2.5 mg/L represents the 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 and the long-term average daily median flow are also shown.

A large number of this year's locations are exhibiting a steady increase in delta-DO as the season progresses (from May to June, e.g., just below and above the WWTP, San Antonio Creek, Camino Cielo and the upper Matilija); an increase indicates a more severe problem with oxygen depression. This is in contrast with 2008 when delta-DO reached a maximum in May, caused by an pronounced initial algal bloom (almost invariably Cladophora) which peaked in mid-April/early-May, and then steadily declined. This year, absent a similar, well-defined bloom, the steady increase into June seems to have been produced by some combination (varying from site to site) of a steadily, albeit slowly, developing algal crop and continually decreasing flows. Flows in the watershed are now only 1/5 to 1/3 of their values in April.

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 (currently only a minor player at some locations) but Spirogyra, diatoms and, in the upper basin, Mougeotia. That we are seeing the early appearance of algal species that appear to do better in quiescent waters and low nutrient environments – Spirogyra, Mougeotia and Chara – says something about lower nutrient availability in the Ventura system following a dry winter.

The most dramatic change from May to June took place in the Ventura lagoon, more specifically on the eastern side, the side furthest away from the outlet and nearest the river. The largely fresh-water environment of early June, which fostered an expanding crop of submerged macro-algae growing upwards from the bottom, has been replaced by highly brackish waters. The change, probably caused by erosion of the blocking sand berm at the lagoon mouth from high tides around the time of the new moon (circa June 22$^{nd}$), eliminated the macro-algae. The lagoon has now returned to the green soup-like state of April, dominated once again by phytoplankton. Lowering of the blocking berm (evident as lower water levels in the lagoon) also appears to have increased the strength of tidal flows in the estuary which flushed out the detached Enteromorpha that had been accumulating along the lagoon shore. The end result has been a substantial decrease in delta-DO over what we reported in May; minimum DO on the Westside of the lagoon was 7.11 mg/L on June 26$^{th}$ compared with 3.99 in May. Photos in Figures 2, 3 and 4 attempt to show the described changes in the lagoon.

Changes elsewhere are shown and described in Figures 6-10.

As I discussed in the April and May 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. Since my last report I've updated the model, revising the regression after the addition of more data. The additional data – contemporaneous delta-DO, flow and Chl-a measurements – came from work done by Julie Simpson and myself on the lower Ventura River in 2003 (4 locations from Foster Park to Main Street) and by Diana Engle on Calleguas Creek in 2008 (3 locations). The revised model (described in my "Predicting Chl-a from Delta-DO and Q" report – available as a PDF download) is shown in Figure 5 as a graph. The graph 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).

Although the model's equation has been modified, in practical terms – and in visual appearance – there is very little change from what I've shown previously; the new data fit in very well with UCSB results. In the figure I've updated last month's version by adding June flow and delta-DO values for 2008 and 2009. This year's data is shown in shades of blue, last year's in blander colors; Channelkeeper site numbers are now shown only for the June 26, 2009 data (it's becoming too crowded to identify each

**Figure 2**. A view across the Lagoon, from the RR bridge towards the sand berm blocking the mouth; the upper photo taken on June 6$^{th}$, the lower on July 11$^{th}$. A yellow arrow in the lower photo marks the steel girder shown in the next figure. In early June most of the lagoon consisted of fresh or mildly brackish waters dominated by a flourishing crop of macro-algae; by the 22$^{nd}$ saltier conditions had eliminated these algae almost completely, decreasing the magnitude of the daily DO cycle.

**Figure 3**. The steel girder from Figure 2 is also in both of these photos; the upper, taken on June 6th, showing extensive macro-algae in the foreground, the lower, from June 22nd, indicates that sometime in the interim these algae had disappeared. The lower photo also shows the marked lowering of the lagoon water level that also took place. The cause of the change, whether as a single event or the gradual erosion of the blocking sand berm, remains unknown.

**Figure 4**. A side channel north of the RR bridge also shows the change in lagoon waters from mostly fresh to appreciably brackish that occurred sometime in mid-June; upper photo from June 6$^{th}$, lower from June 22$^{nd}$. Not only attached macro-algae, but extensive clusters of Enteromorpha disappeared with the change (increased tidal flushing associated with the drop in water levels may have been a contributing factor in the Enteromorpha disappearance).

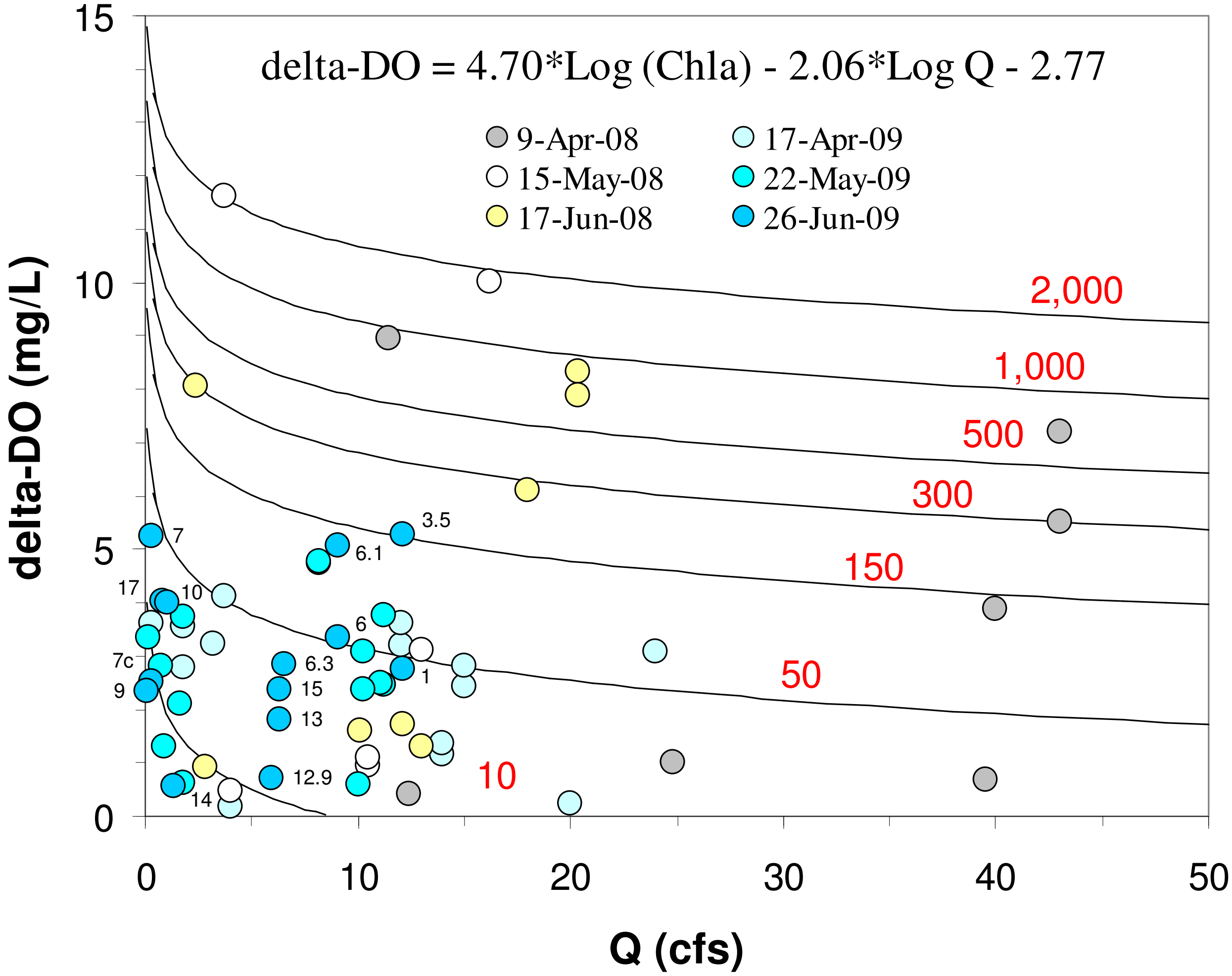
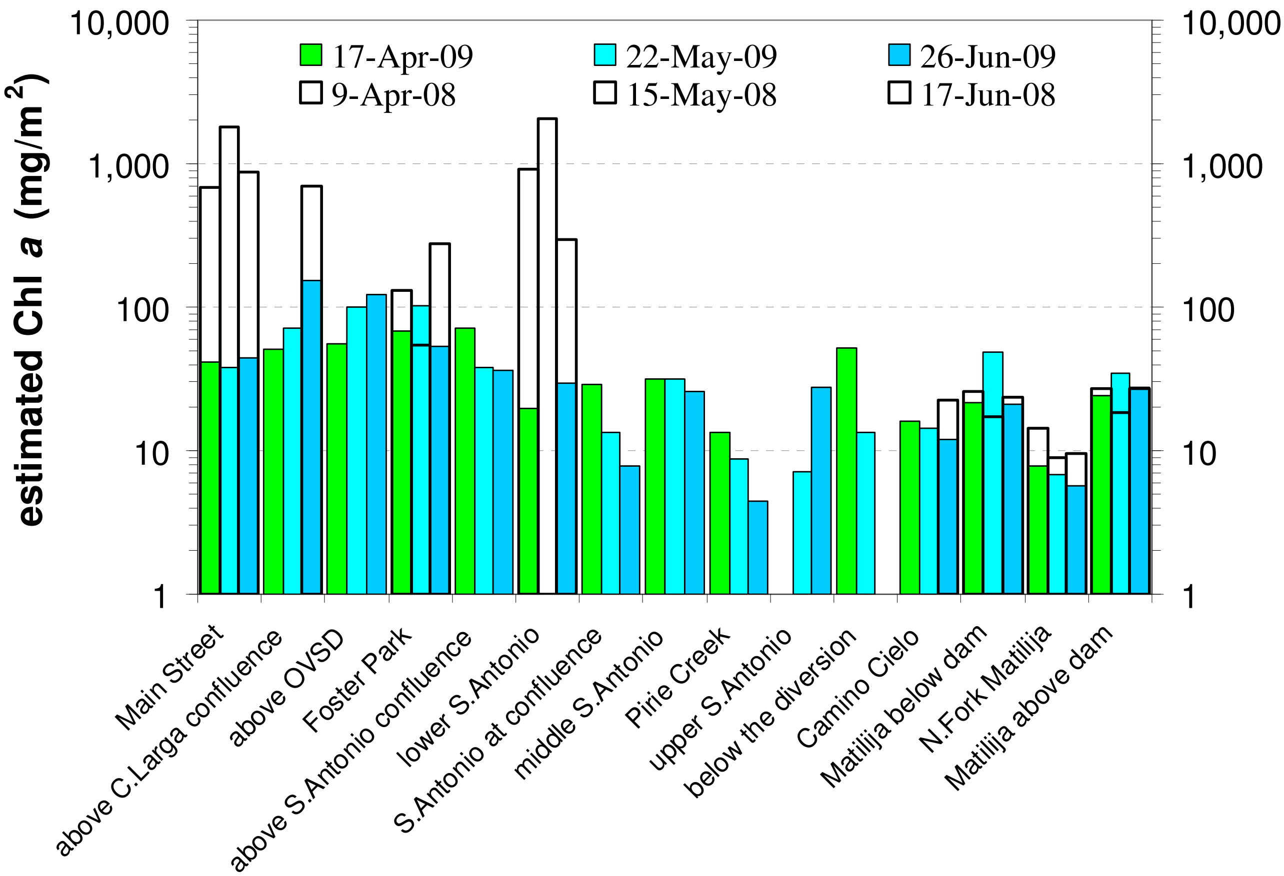



**Figure 5**. The chart shows the revised graphical model developed using data from the UCSB-TMDL study, Ventura data collected by Julie Simpson and myself in 2003, and 2008 Calleguas Creek data collected by Diana Engle. The regression relationship used in the model is shown on the graph ($p < 0.001$, 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$^2$ ) it was initially 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 June 26, 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. However, if Chl-a densities, and delta-DO values, continue to creep upwards (the ongoing trend at some, but by no means all locations) the possibility 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.

point). This year's data continue to be clustered in the lower left-hand corner, characterized by both low flows and low delta-DO values.

The UCSB Report recommended the following Chl-a standards: (1) less than 50 mg/m$^2$ defining "unimpaired" reaches, (2) greater than 150 or 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 2009 sampled location could be classified as unequivocally "impaired," and only two, both above the WWTP, might be regarded as contenders. 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 situation bears continued watching.




Since the graph shown in Figure 5, enamored of it as I might be, doesn't adequately show the progression of algal growth from month-to-month since the season started, I've displayed estimated Chl-a densities using a different format in this 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). 2009 Chl-a densities 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 Park are generally lower than in 2008, while those in the upper basin are quite similar and even, at times, higher (e.g., Matilija Creek above the dam).

I'll forgo at this time any discussion of water temperatures. Channelkeeper has emplaced five tid-bit temperature loggers in the upper basin (sites VR12.9 to 15 and above), and when these are collected and downloaded in the fall we'll devote a special report to those results. Elsewhere in the watershed water temperatures are similar, perhaps slightly lower, to those recorded last year – probably due to the increased presence of aquatic plants and additional growth in riparian cover.

Finally, I'll mention again that we could use a financial contribution or two to purchase a few more tid-bit temperature loggers to extend the range of this program. It seems rather odd to me, with all the fish lovers out there, that we're willing to spend millions of dollars to restore steelhead on the Ventura (admittedly, most of it *other-peoples-money*), but no one seems willing to kick in a few bucks to monitor the conditions under which they would have to survive.

Photos taken in April, May and June 2008 and on April 17, May 22 and June 26, 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/

The table below lists the sampling location name along with the Channelkeeper site code shown in some of the graphs included in this report.

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

| location name | no. | location name | no. |
|---|---|---|---|
| Lagoon, east side | 0e | Lion Canyon | 8 |
| Lagoon, west side | 0w | Pirie Creek | 9 |
| Main Street | 1 | upper S.Antonio | 10 |
| Stanley Drain | 2 | Santa Ana Blvd. | 11 |
| Shell Road. | 3 | Hwy. 150 | 12 |
| above C.Larga confluence | 3.5 | below the diversion | 12.4 |
| Canada Larga | 4 | above the diversion | 12.4 |
| Upper C. Larga | 5 | Camino Cielo | 12.9 |
| Foster Park | 6 | Matilija below dam | 13 |
| above OVSD | 6.1 | N.Fork Matilija | 14 |
| above S.Antonio confluence | 6.3 | Matilija above dam | 15 |
| S.Antonio at confluence | 7c | middle S.Antonio | 17 |
| lower S.Antonio | 7 | | |

**Figure 6**. Just above the Canada Larga confluence (and just below the treatment plant): upper photo taken on June 6th, lower on June 22nd. The continued deterioration and elimination of watercress at this location has created more open conditions (conditions possibly responsible for slightly increased values in delta-DO). By July 11th, watercress appeared to be recovering, and whatever may have caused its earlier demise seems to have lost its grip; I've circled the patch of dying Ludwigia that made me initially suspect (and continue to suspect) some waterborne cause – in my view very few things kill Ludwigia.

**Figure 7**. It's interesting that this reach, just above the treatment plant, is almost the only one showing a continual increase in algal coverage (along with increasing delta-DO) as the season progresses; looking upstream on May 22nd above, on June 26th below. Algae at this location, almost solely Cladophora at the beginning of the season are now more than half Spirogyra. The new, healthy-looking Enteromorpha in the lower photo are probably floating into this reach from higher velocity upstream locations.

**Figure 8**. (upper) The Ventura above the San Antonio confluence: algae are sparse but present. (middle) San Antonio Creek just above the confluence (taken from the bicycle path culvert): min. DO = 4.1 mg/L, mostly from decay and not algal photosynthesis. (bottom) Matilija Creek below the dam: the bottom of the pool at the old gauging station is algal covered, as usual. All photos taken on June 26th.

**Figure 9**. (upper) Mougeotia making its appearance on the upper Ventura, downstream from the Camino Cielo low water crossing. Other sections of this reach are relatively algal free. (bottom) A close-up of Mougeotia and Chara about a mile above our usual upper Matilija Creek sampling site. Both of these species appear to have a competitive advantage in low nutrient situations, particularly in quiescent waters. This year may be particularly favorable for them. These photos were taken on June 12th.

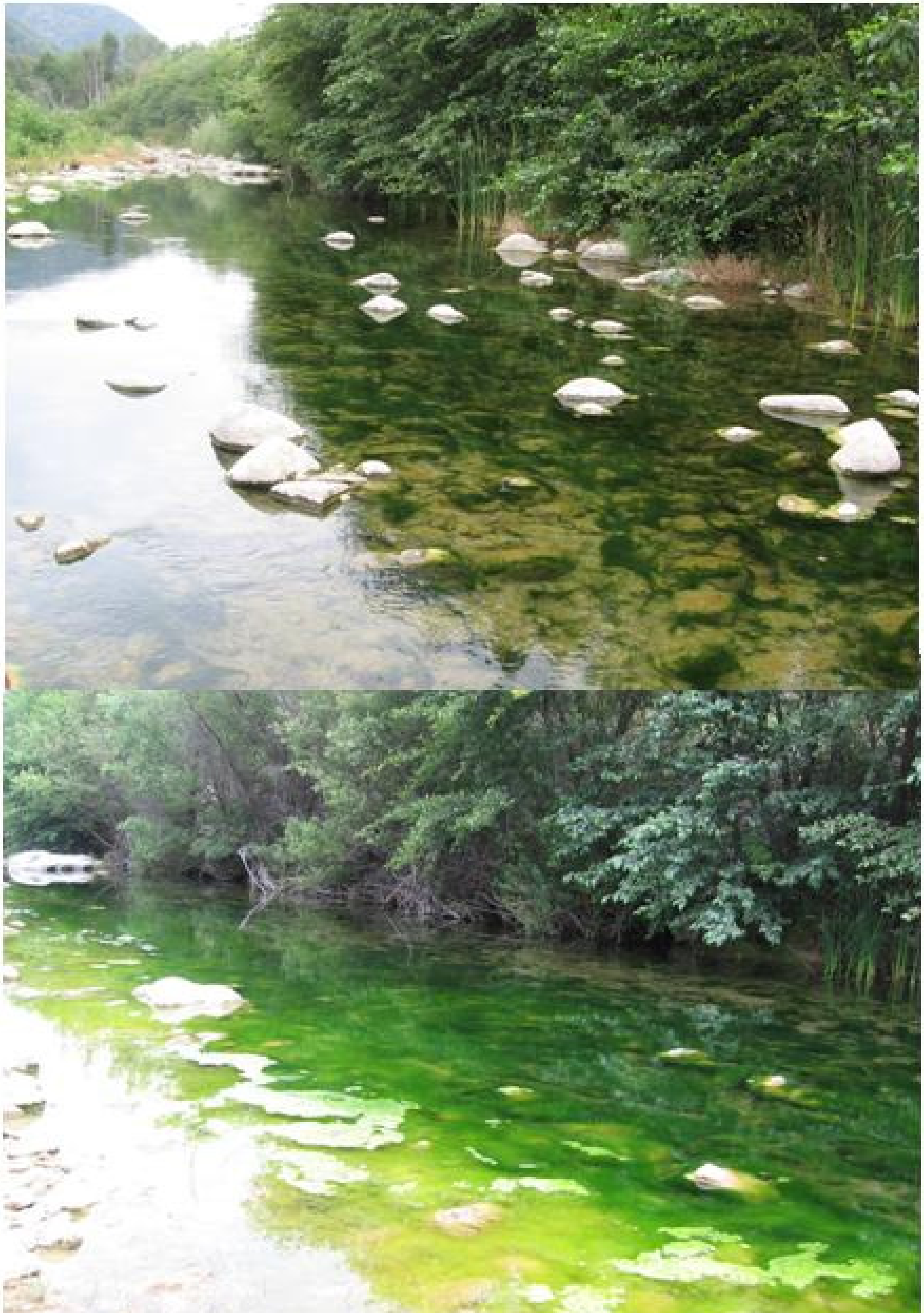


**Figure 10**. Algae are relatively abundant on Matilija Creek above the Dam. The upper photo looks upstream at a Spirogyra covered bottom. The lower photo at a pool-like stretch further downstream. Given the light green color, I suspect this to be Mougeotia. My simplistic identification procedure is: slimy and light green = Mougeotia; slimy and dark green = Spirogyra. Both photos taken on June 12th.