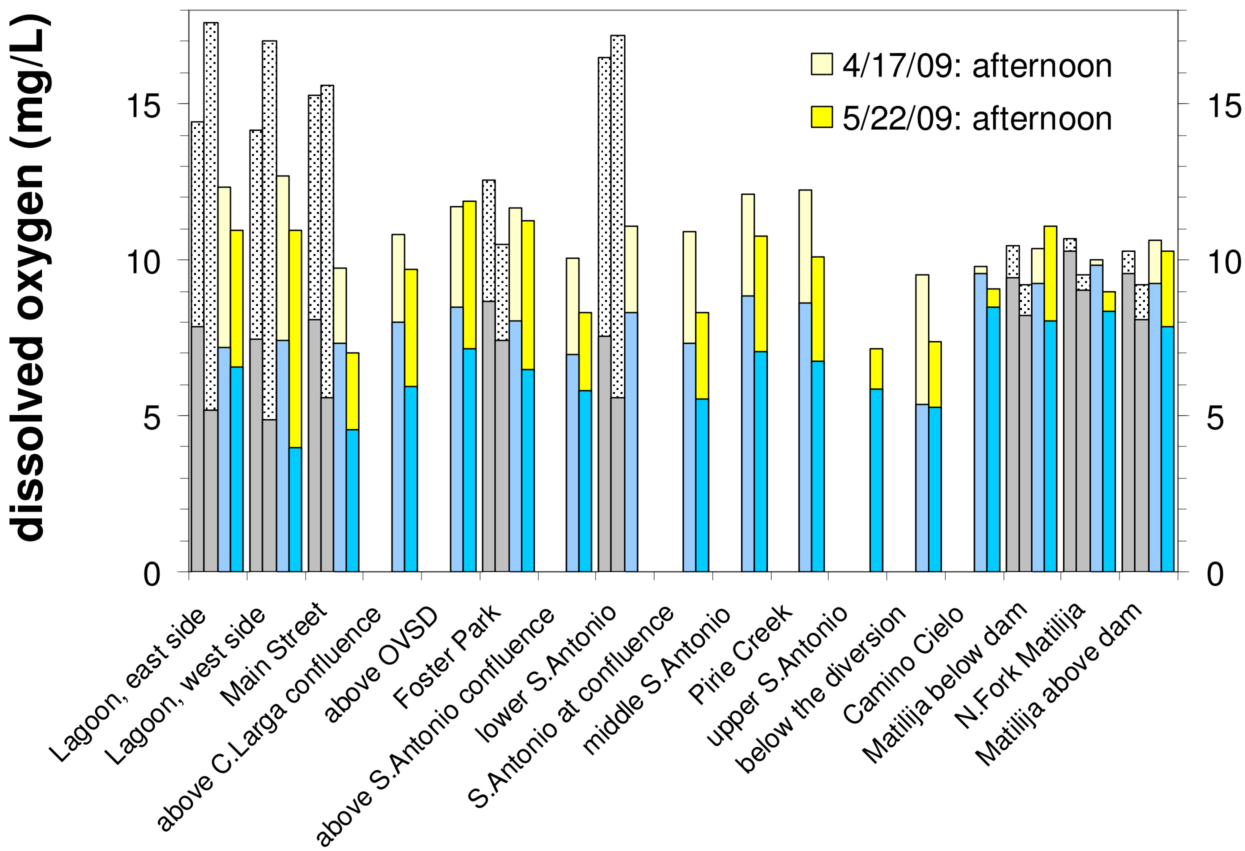
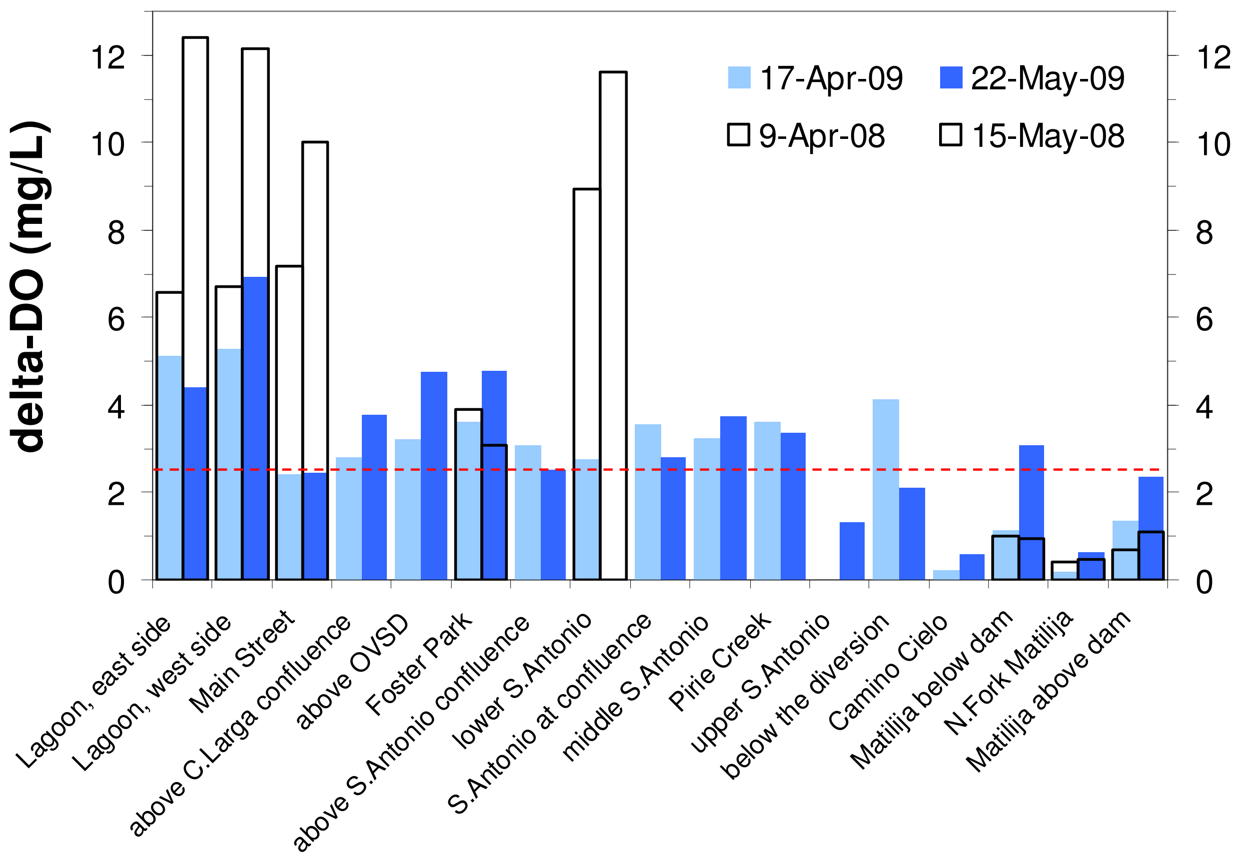


On May 22, 2009, Santa Barbara Channelkeeper completed a second round of 2009 diel measurements of dissolved oxygen (DO), water temperature and *p*H on the Ventura River. Pre-dawn measurements were made between 4:30 to 6:30 AM, afternoon measurements between 1:30 and 3:30 PM. The dissolved oxygen values 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. This is the same number as were sampled in April; however, one April location, lower San Antonio Creek (on Old Creek Road) was missed and another, upper San Antonio Creek, added. Results from just below the Lake Casitas (Robles) diversion (sampled on May 21) are provided by Scott Lewis and the other fisheries guys from Casitas Municipal Water District. For comparison with May 22 data, diel results from April 17, 2009 and last year's results from April and May (April 9 & May 15, 2008) are also shown (2008 data in shades of grey).

The lowest DO values recorded on May 22 were 3.99 mg/L on the west side of the lagoon (measured from the RR causeway) and 4.54 mg/L at Main Street; both were below the 5 mg/L Ventura basin plan limit (at no other locations did DO fall below this value). However, the low May DO values at Main Street and in the estuary may not be entirely, nor even mainly, related to algal density. Note on the graph, that while minimum values this April and May are roughly similar to those of last year maximum concentrations are very much different (the lagoon reaching circa 120 % of saturation on May 22 while Main Street was just below 80 %, in contrast with values around 190 % in May 2008). The buildup of fine sediment combined with low flows through reaches choked with aquatic plants (limiting aeration) indicate the possibility of decay processes as a primary causal factor.

Figure 1. The lagoon was a real surprise – a substantial sand berm has formed blocking most saltwater inflows (it's overtopped at high tides). This has led to substantial growth of macroalgae in freshwater dominated sections of the lagoon – very much like what happened last year (upper photo June 6, lower May 22, 2009).



Delta-DO is 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). The above graph contrasts delta-DO values for April and May 2009 with the same months in 2008. Last year's data is shown as "white" background bars where the values were higher, as black outlines (i.e., transparent bars) when lower.

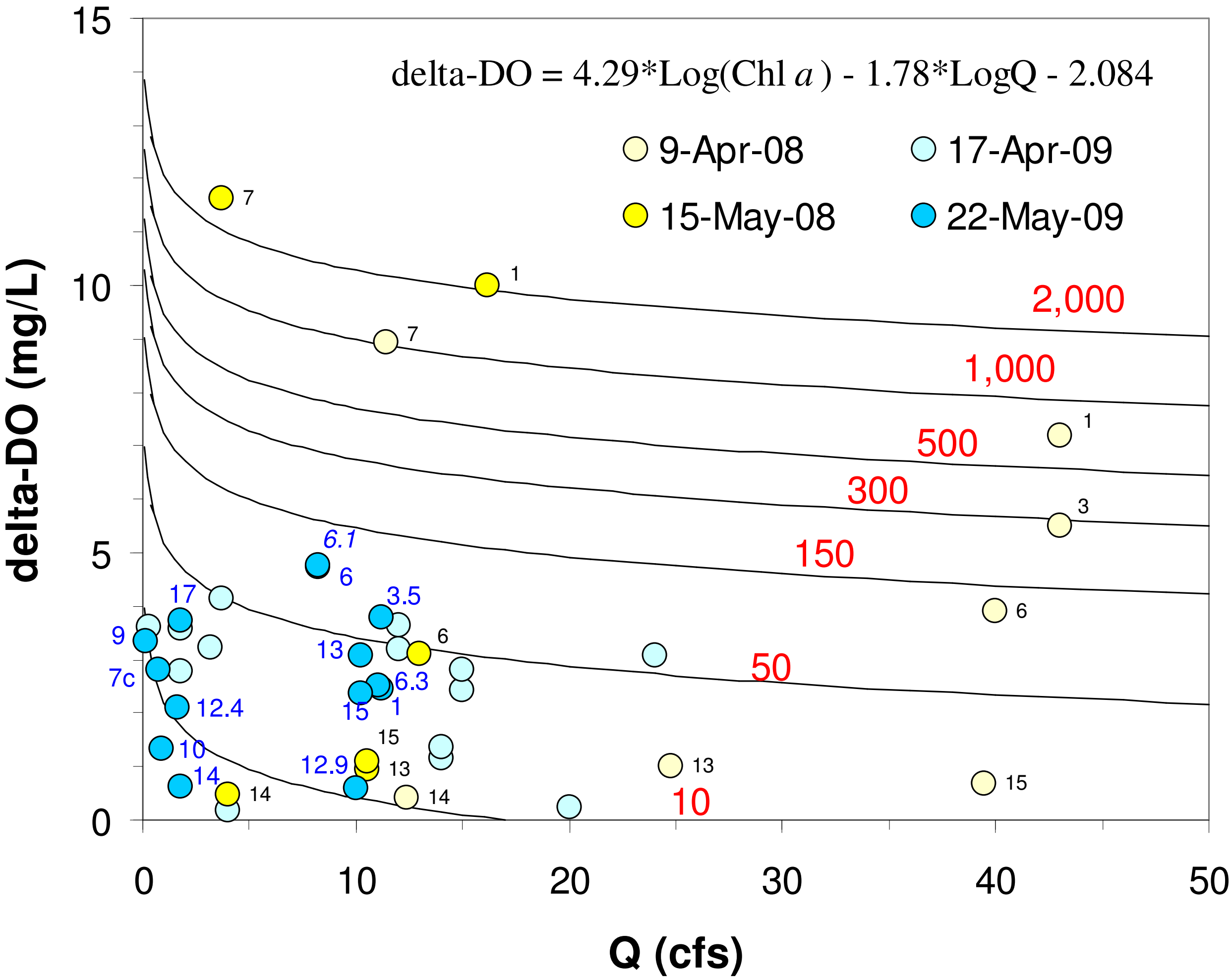
Values on the lower river (Main Street and the lagoon) have stayed roughly the same throughout April and May 2009, and are much lower than they were last year. The middle Ventura and San Antonio Creek present a mixed picture: increasing May values extended from just below the WWTP to Foster Park while elsewhere delta-DO has decreased. Interestingly, the highest DO fluctuations in May were found above, not below, the treatment plant, and Foster Park values are now higher than they were in 2008. The upper basin displayed the same characteristic: May increases over April delta-DO. with both months generally showing greater DO depression than in 2008. Delta-DO around the Robles diversion is now appreciably lower than in April signifying an end to the early bloom noted at the beginning of that month.

I've included a new line, at 2.5 mg/L, on the graph. The Central Coast RWQCB has adopted a concept of *maximum oxygen deficit* as a dividing line between reaches which do not meet objectives for excessive biostimulatory substances and those that do: the limit, fluctuations below which there is little risk of algal growth depressing dissolved oxygen to unacceptable levels, has been initially set at 1.25 mg/L. This corresponds to a delta-DO of 2.5. While not directly applicable to the Ventura (which is under the jurisdiction of the Los Angles RWQCB) it provides a convenient yardstick to judge when

Figure 2. The lower river is becoming even more plant dominated; Ludwigia is starting to bloom at Main Street (upper), while watercress remains the primary aquatic plant above the Canada Larga confluence (lower) (both photos May 22, 2009). With regards to my report on the subsequent dying of watercress at this location, note the “yellowing” patches in this photo.

delta-DO may be reaching problematic levels.

As I discussed last month, the 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, featuring lines of equal Chl-a densities (red numbers represent density in mg/m^2), allows us to estimate Chl-a by entering values of flow (in cfs on the x-axis) and delta-DO (in mg/L on the y-axis).

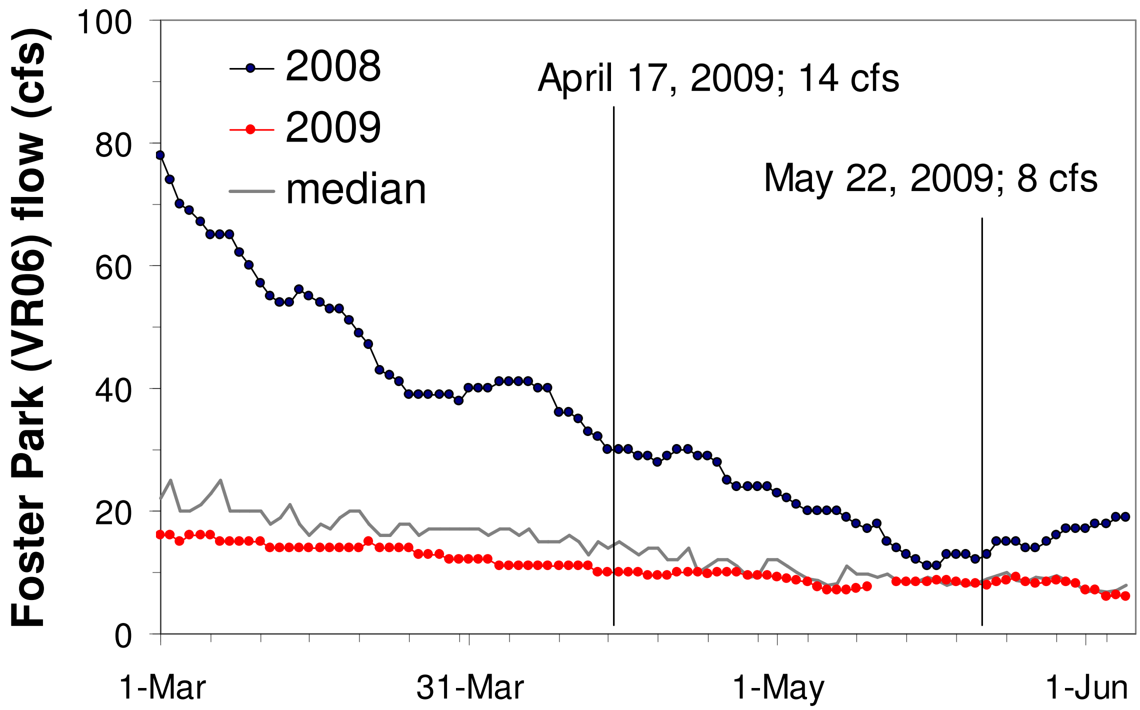


I've updated last month's version (shown above) by adding May flow and delta-DO values for 2008 and 2009. Last year's data is shown in shades of yellow, this year's in shades of blue; Channelkeeper site numbers are shown along side for each 2008 point and for May 2009 (it's becoming too complicated to identify each point). This year's data continues to be clustered in the lower left-hand corner, characterized by both low flows and low delta-DO values. This is in marked contrast with last year when declining flows from April to May considerably worsened the algal problem.

The UCSB recommended Chl-a standards are: (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

Figure 3. Algae were notably prevalent only above the WWTP. These photos (upper, just above the WWTP on May 22; lower, Foster Park on June 6) show the locations with the highest delta-DO and highest estimated Chl-a densities. The cladophora patch in the upper photo has been expanding for over a month. Why it appears confined to only one side of the river might be an interesting question.

will be included in the eventual TMDL. Notice that with this version of the model no 2009 locations would be classified as unequivocally "impaired," and only two, both above the WWTP, might be regarded as contenders. [Technical note: In this version of the model values of delta-DO, which were more or less normally distributed, were not log-transformed prior to developing the regression model. I have another version in which log-transformed values were used. Although the differences are minor, this alternate version tends to predict higher Chl-a for lower delta-DO values and lower Chl-a for higher. I have since tested both models with data from the algal study done by Julie Simpson and myself in 2003 – alas only 4 data points – and a study done by Diana Engle on Calleguas Creek in 2008. The 2003 Ventura data fit very well indeed, but only half of Diana's did. I must say, however, that the data that didn't fit was very uncharacteristic, representing two locations immediately below large WWTPs and Revlon Slough. Those interested in details should contact me.]

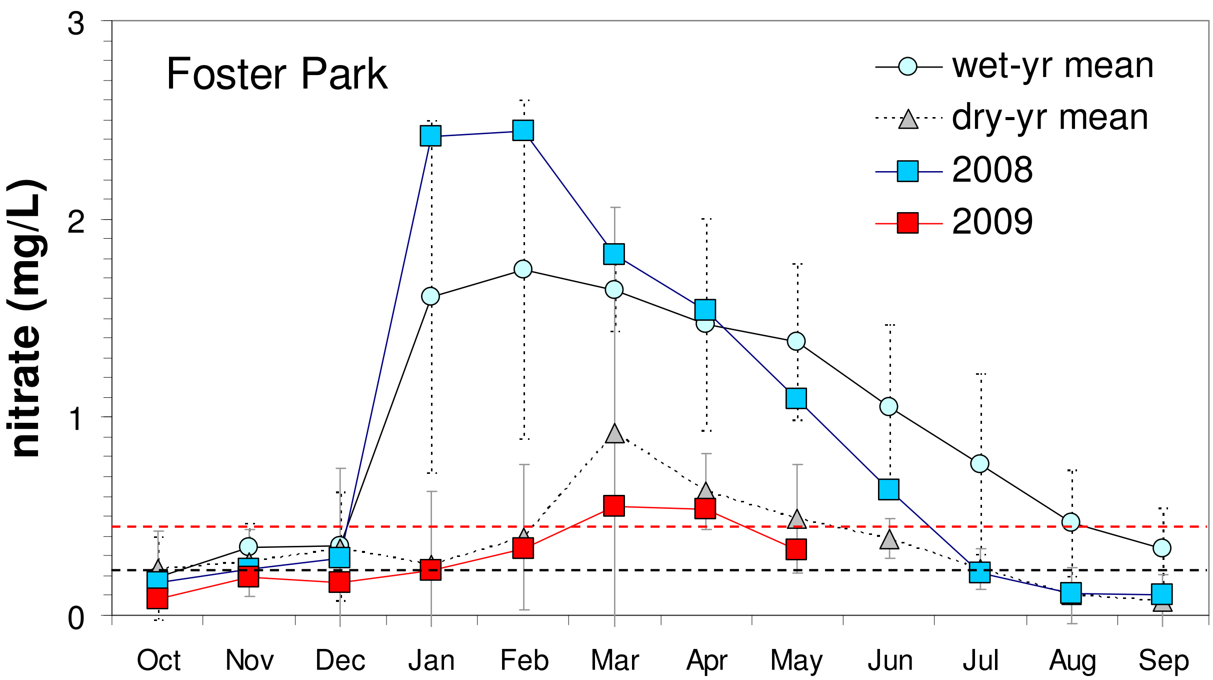


As the season evolves flows continue to decrease. Changes from last year at Foster Park are now less dramatic than they were in April (above graph), but elsewhere flows are about a third of last year's and down ~50 % from last month (this can probably be best observed in Figure 4 which contrasts May 2008 with May 2009). Low flows are the primary cause of the relatively appreciable delta-DO values recorded in April and May of this year since algae are nowhere in evidence to the extent they were in 2008. Estimates (modeled) of Chl-a show current densities more than an order of magnitude lower on the lower and middle Ventura and San Antonio Creek than in 2008, and the contrasting photos I've included in earlier reports offer compelling visual evidence. This raises the question of *why*? What has changed? What change in circumstance or condition has led to much lower than expected algal densities?

Part of the explanation lies in the advent of aquatic plant dominance, especially on the lower river and parts of San Antonio Creek. Aquatic plants reduce the available habitat, overshadow the water

Figure 4. This is the middle San Antonio, photographed from a private bridge: the upper photo on Aug. 17, 2008, the lower on May 22, 2009. Channelkeeper has sampled nutrients at this location for years but it was never formally included in the monitoring program until 2009. Unlike much of San Antonio Creek this reach gets lots of sunlight and usually has lots of algae, but, as can be seen, apparently not this year. This site is a good illustration for the big 2009 conundrum: Why? What happened to the algae? Lots of plants, sure, but still lots of open water and sunlight. And sufficient nutrients since the upper San Antonio is the highest source of nitrate in the Ventura watershed.

surface, help maintain high velocities in those open-water areas that remain and compete for available nutrients. However, expansive aquatic plant growth (a by-product of the lack of significant storm flows over the winter of 2008-09) can not be the sole explanation since nowhere, not even in reaches without aquatic vegetation, have we seen anything even remotely comparable to the early Chadophora bloom of last year. So what else is there?

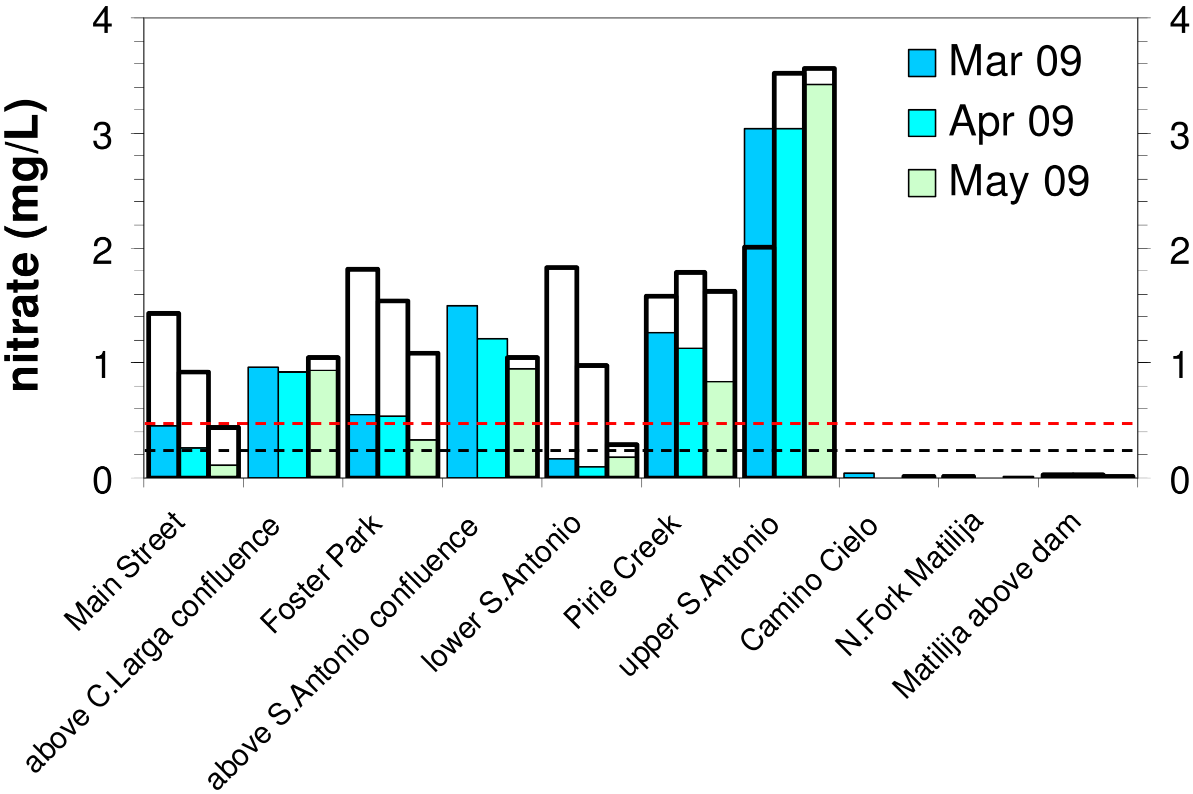


One possibility is a lack of nutrients. Often, as the above graph shows, there is a wide difference between dry-year (below median annual rainfall. i.e., 2002, 04 & 07) and wet-year (i.e., 2001, 05, 06 and 08) nitrogen concentrations (the error bars indicate twice the standard error of the mean; I'm showing nitrate since May results for total dissolved nitrogen are not yet available and nitrate is a better measure of the status of nitrogen availability). Besides monthly nitrate concentrations for 2008 and 09 (which rather nicely fit past patterns), the graph shows two dashed lines: at 0.23 and 0.45 mg/L. These represent the *total nitrogen* limits defining unimpaired and impaired reaches as proposed in the UCSB TMDL Report; notice that since total nitrogen concentrations were, in all probability, higher than the nitrate concentrations shown here (e.g., April TN was 0.69 mg/L in contrast with 0.53 mg/L of nitrate) there would seem to have been more than enough available nitrogen to fuel a substantial bloom.

Of course, when considering concentrations as a measure of nutrient availability there is always something of a chicken/egg problem; are we seeing low concentrations because there is less nitrogen available or because greater amounts have been subsumed by the biota? Since we now see little evidence of the extensive algae of last season this is probably less of a problem this year than last, and we can be pretty confident that these differences, at least at this location, are real. There is also no doubt that throughout the entire Ventura system the total *amount* (the flux in contrast to concentration) of nitrogen is dramatically lower. Amount is the product of concentration multiplied by flow and in the case of Foster Park, taking April as an example, with flow and concentration less than a third of last year's, available nitrogen in 2009 is only about a tenth of the 2008 flux.

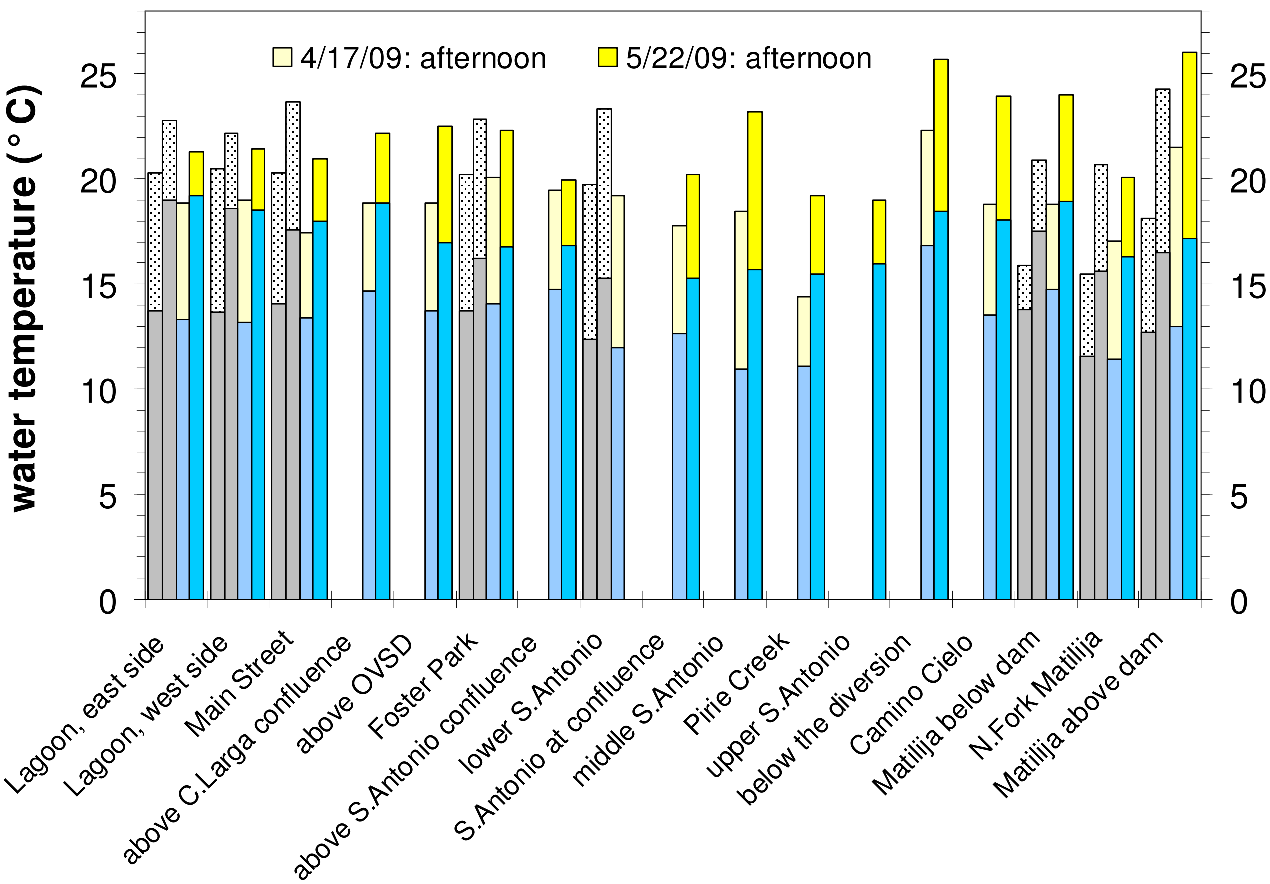
Figure 5. The upper Ventura at Camino Cielo: looking upstream from the crossing, (upper) June 4, 2008, (lower) May 22, 2009. The lower flows and the increased streambed vegetation of this year have also influenced the upper basin, albeit to a lesser extent than lower down.

But this does not answer the question. Which is not *is there less nitrogen*, but *is there so much less that the growth of algae is being significantly retarded*?



The answer is probably yes – in some locations. The above chart shows March, April and May 2009 nitrate concentrations for Channelkeeper sampling locations (as colored bars). Also shown are 2008 concentrations for the same months (as transparent bars in the back- or fore-ground), along with dashed lines indicating the proposed 0.23 and 0.45 mg/L total nitrogen benchmarks mentioned previously (March and April 2008 values are unavailable for sites above the C.Larga and S.Antonio confluences). While it appears that lack of nitrogen might well be impacting algal growth in the upper basin, there does not seem to be a shortage elsewhere. [A shortage of upper basin nitrogen would also explain why there has been no Cladophora bloom in these reaches. Instead of Cladophora, which appears to require a higher nutrient environment, we are seeing species, Spirogyra and Mougeotia, that can cope with lower nutrient availability.] Even after eliminating lower river locations where aquatic plants have become dominant we are left with a number of sites where neither plant growth nor lack of nutrients seem to offer an adequate explanation (above the WWTP and on San Antonio Creek, see Figures 3 and 4). Another possibility, at least as an explanation for lower amounts of Cladophora, has crossed my mind: the accumulation of bottom sediment (again, due to the absence of significant winter storm flows) may be limiting the bare-rock habitat that this species prefers. Limited anchor points in the higher flow areas which are increasingly becoming the only habitat left open for algal growth, aquatic plant dominance and lower nutrient levels, all these, singularly or in combination, may be enough of an explanation. Or maybe not. If anyone has other ideas I'd love to hear them.

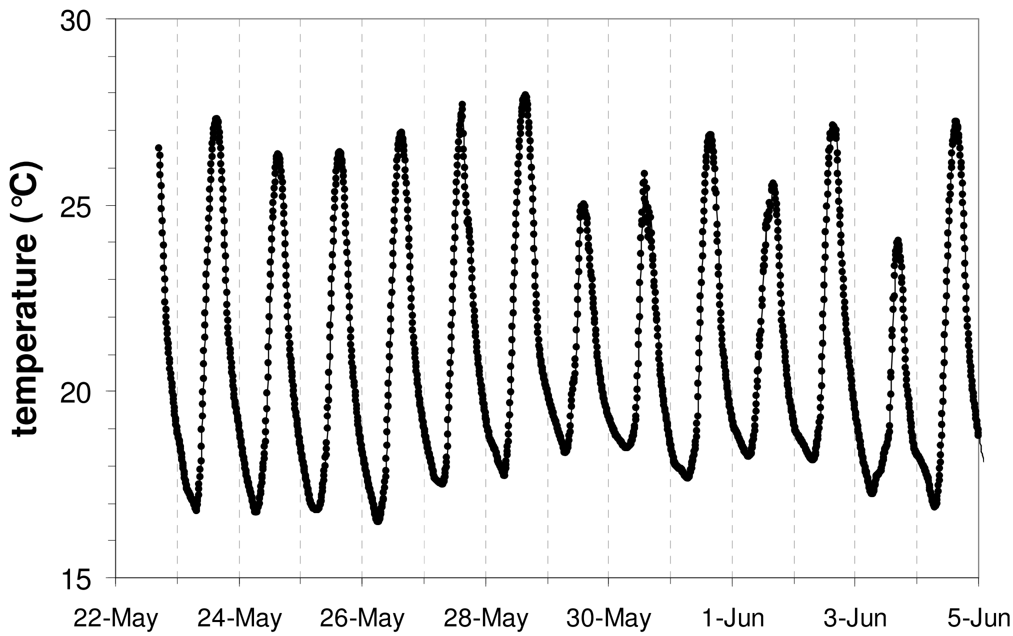
Figure 6. Above Matilija Dam (May 22, 2009) the bottom continues to look clean – cleaner than last May when decaying algae were ubiquitous – but the oxygen cycle is stronger, mostly due to flows being down by more than half and, I'd surmise, diatoms and crustal algae.



And now to water temperature. The graph shows pre-dawn and mid-afternoon water temperatures for April and May 2008 and 2009. The situation remains unchanged from last month: in the mid- and lower-basins, temperatures were generally both slightly lower and showed a diminished range over last year. Given much lower flows, this is probably due to the increased amount of shading (and increased evapotranspiration) from the aquatic plants that now dominate these reaches The opposite pattern, of higher temperatures and greater variation than last year, continues in the upper basin. Lower flows, in the absence of the dense aquatic vegetation we see below, are the obvious culprit.

I mentioned in my last report that we suspected water temperature problems in the upper basin might be worse than initially thought and we were planning to put out a bunch of tidbit loggers and begin recording daily temperature cycles. We have since set out the first logger, on Matilija Creek in a open area above the Dam, and the results are shown in Figure 7. The good news is that the peak in stream temperature is not occurring as late in the afternoon here as it is at the Robles Diversion; the bad news is that it is still occurring later than we thought (between 4-5 PM) and the mid-afternoon temperatures shown in the above graph continue to be an underestimate of the true situation.

We have 4 more loggers to set out and we'd like to have at least 5 more to do a more complete survey. They cost about $110 a piece. It's not a lot of money as things go today, but we don't have it. So if anyone out there is as concerned about this situation as I am, Channelkeeper would appreciate donations. Or just buy us a couple of damn loggers.



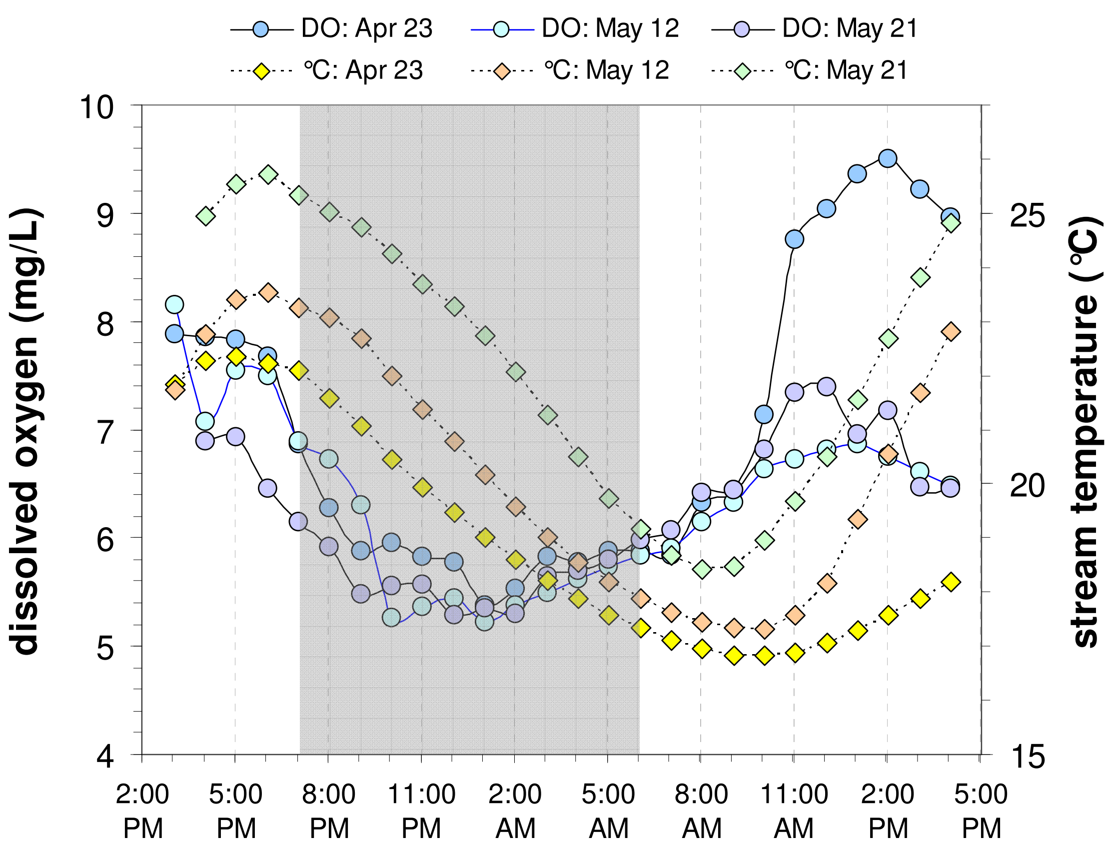


Figure 7. (above) Tidbit stream temperature data, center of flow above Matilija Dam (site VR15): May 22 through June 5, 2009. (below) Water temperature and DO measurements below the Robles Diversion on April 23, May 12 and May 21, 2009 (our thanks to Scott Lewis and crew).

I've tried to simplify, and shorten, this month's report, for both mine and your sakes. Rather unsuccessfully as you can see. I'll try again next month, but since I want to address a relatively complicated problem – the total nitrogen vs. Chl-a relationship featured in the UCSB TMDL Report – I can't promise to be successful.

Photos taken in April and May, 2008 and on April 17 and May 22, 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		