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Nutrient Response of the Ventura River to Drought Conditions in Southern California

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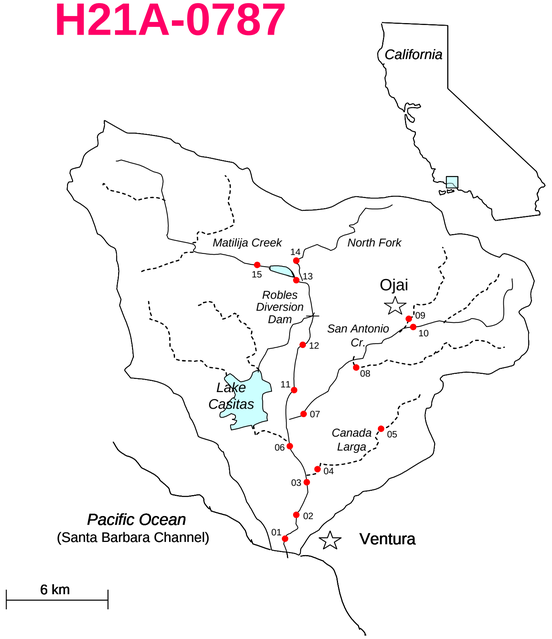
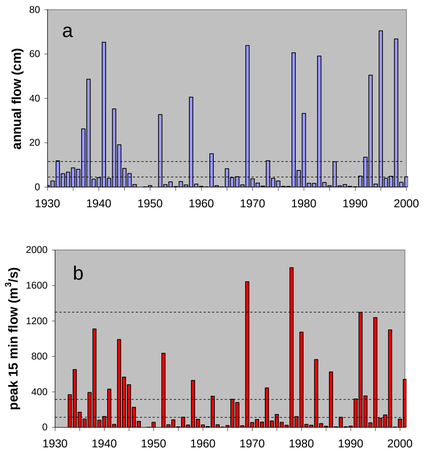
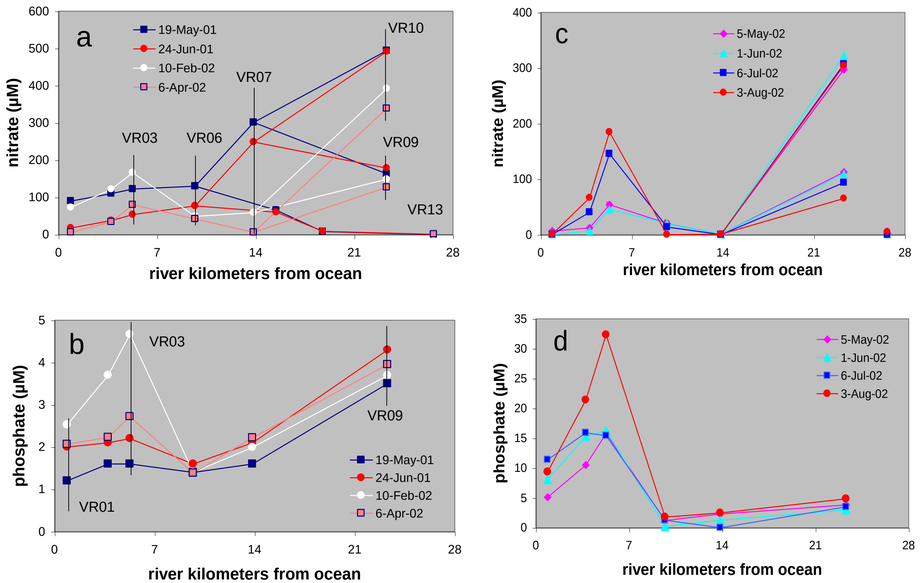




1

We have been measuring nutrient concentrations once a month at 15 locations (numbered red dots) on the Ventura River, a 580 sq. km mountainous coastal watershed 100 km northwest of Los Angles, Ca. The climate is Mediterranean with an average annual rainfall of 500 mm. More than 90 % of the rain falls between Nov. and Apr., and most of the annual flow occurs within a few days. The seasonal and inter-annual variations are extreme: dashed lines in "a" represent the annual mean (12 cm) and median (1.5 cm) outflows, and in "b" the 2, 5 and 20 yr peak flows.

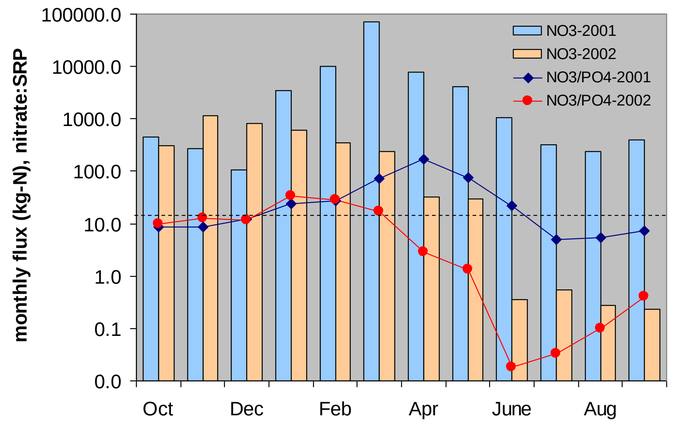


2

Rainfall in the winter of 2001-2002 was only 40 % of the annual mean and average winter flow was 0.15 m^3/s vs. 7.4 m^3/s the year before (mean 70 yr. winter flow = 4.6 m^3/s). With lower flows, nitrate concentrations were substantially reduced (below detection limits in many reaches) while soluble reactive phosphate (SRP) remained approximately the same. Panel (a) and (b) show the variation in concentrations along the river for two, roughly similar, flow regimes following the respective rainy seasons; (c) and (d) show further temporal changes through the past summer. The only exception to the reduced-nitrate/stable-SRP trend is in the lower river (VR03 to VR01) where treated sewage effluent (entering at river km 8.5) has become almost the sole dry-season water source.

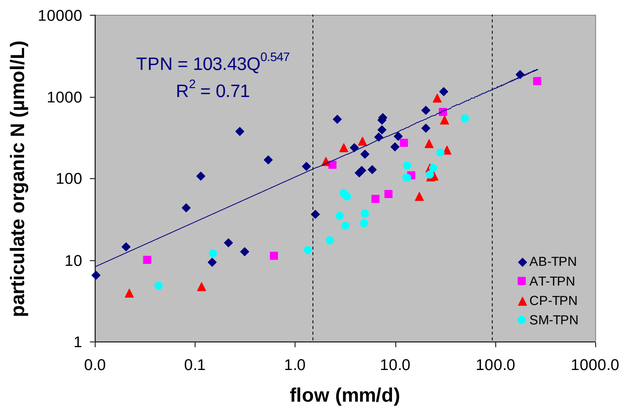
3

Photos at the left show the dramatic growth in channel vegetation over a one year period. In the absence of a major channel-scouring, winter storm since early March 2001, exuberant plant growth overwhelmed the lower river and replaced algae as the dominant primary producer. While some nitrate reductions are probably due to lower ground and soil water inflows, and the relative increase in floodplain buffer area and vegetation, dense velocity-inhibiting beds of macrophytes and lower flows have led to enhanced uptake and denitrification. Below the sewage treatment plant outfall, nitrate and SRP reductions in a ratio of 10:1 point to uptake as the principal mechanism.



4

Lower nitrate concentrations combined with lower flows have led to a substantial decrease in the annual dissolved nutrient flux. The 2002 (Oct. through Sept. water year) nitrate and phosphate fluxes at VR01 (above) represent 4 and 16 % of the corresponding 2001 values. The figure also shows changes in the nitrate:SRP ratio at this location, indicating a probable shift to N-limitation since spring 2002 (the dashed line represents the 16:1 "Redfield" ratio); similar changes have taken place throughout the river.



5

Drought year changes in the particulate flux are even more pronounced. In the absence of data for the Ventura, the figure shows the variation in particulate organic nitrogen concentrations with scaled outflow for 4 coastal streams in the Santa Barbara-Carpenteria area (25-40 km to the west). The dashed lines represent peak 2001 and 2002 Ventura River flows at VR06 (substantial particulate export is usually restricted to the rising limb of the storm hydrograph). The inference is that particulate concentrations varied by 1 to 2 orders-of-magnitude between the two years, i.e., a 3 to 4 order-of-magnitude decrease in 2002 particulate fluxes given the decrease in stormflow.