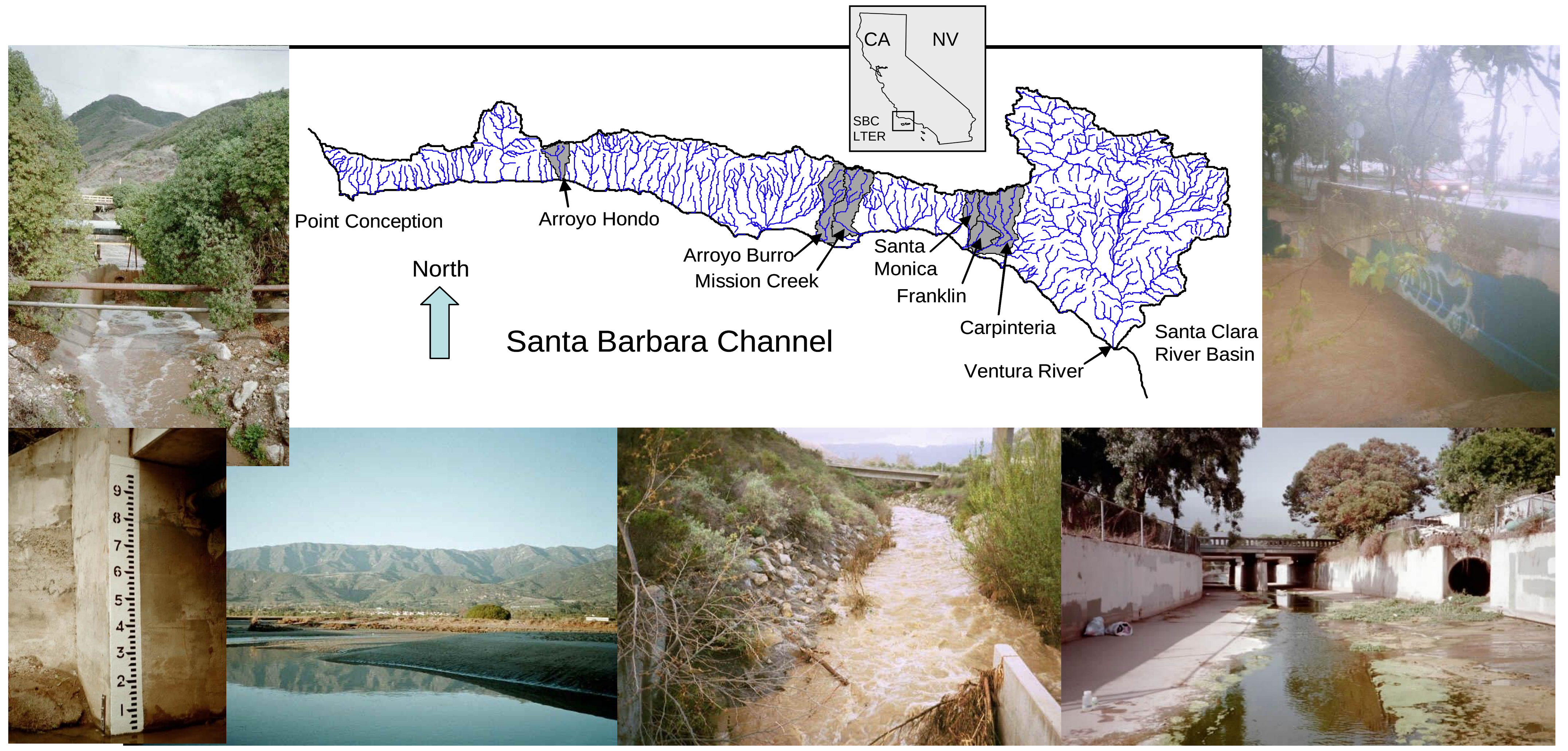
Stormflow Nutrient Concentrations in Coastal Streams Tributary to the Santa Barbara Channel, California: A Common Urban Response

H51C-0347

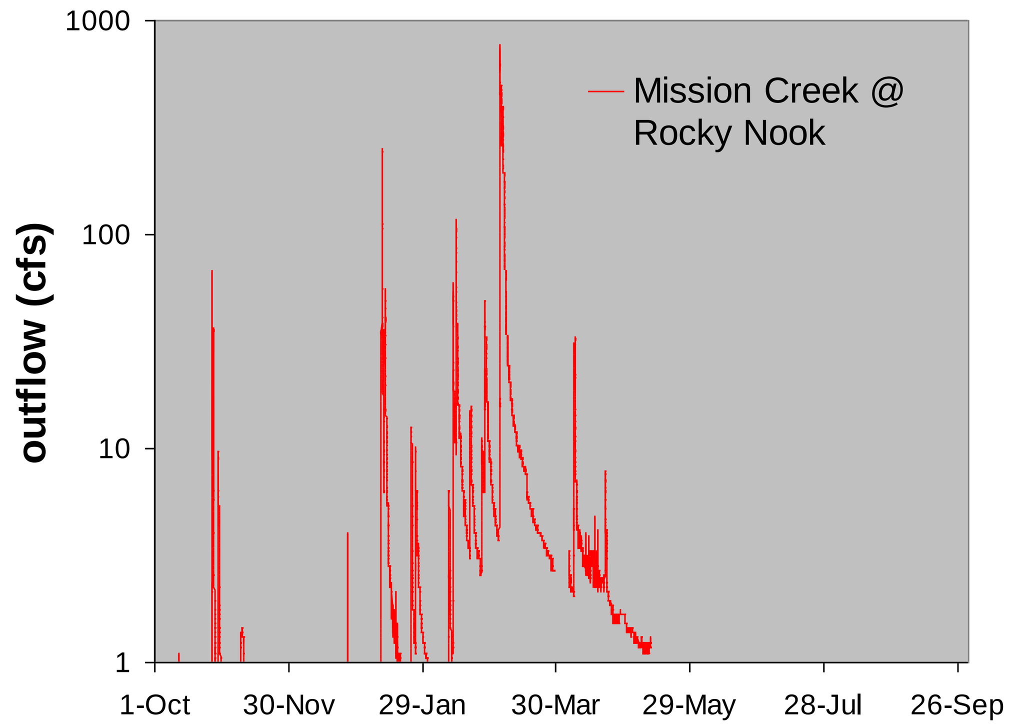
Al Leydecker, Tim Robinson and John Melack

Bren School of Environmental Science, University of California, Santa Barbara; e-mail: al@icess.ucsb.edu



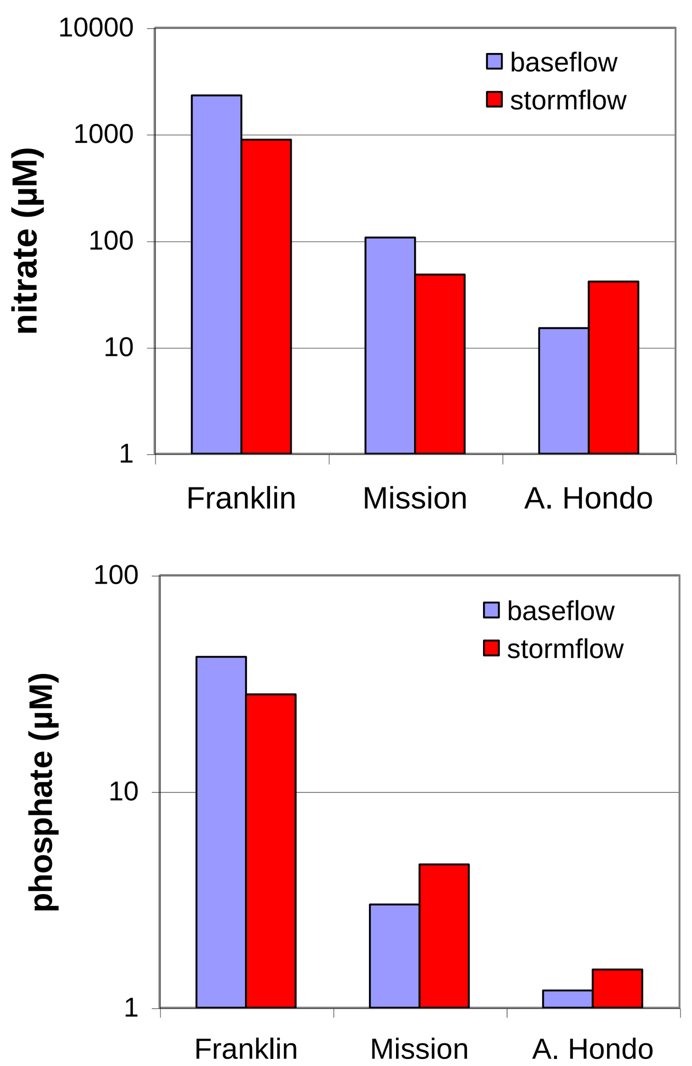
1

We have been sampling nutrient concentrations in coastal streams as part of the Santa Barbara Coastal LTER. The ultimate goal is to determine nutrient export to the Santa Barbara Channel and to model how export varies with land use. We are using two approaches: (1) sampling, at their outflow, streams that represent different dominant land uses; and (2) sampling at land use transitions in a subset of selected streams. (photos counterclockwise from the upper left: a chapperal catchment with extensive oil development; the Arroyo Burro gauging station {20 have been installed to date}; the Carpinteria area from the esturary; a forested undeveloped catchment in flood; channelized Franklin Cr.; Mission Cr. in flood)



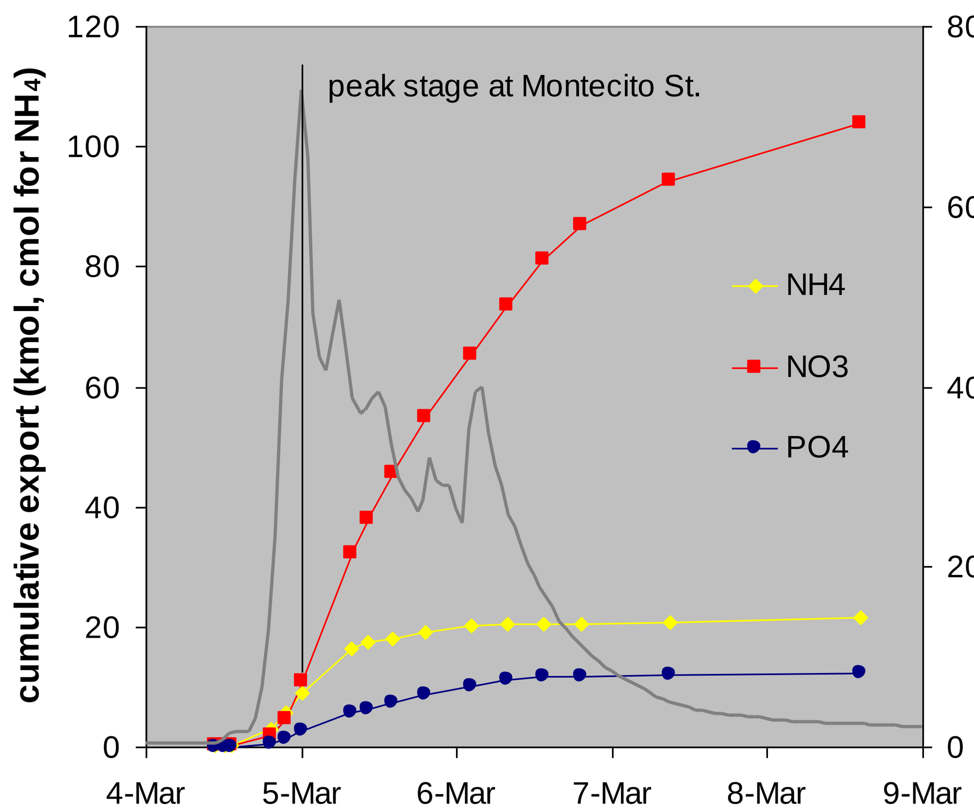
2

The watersheds are steep and short, and have a rapid, “flashy” response to rainfall. The climate is Mediterranean with dry summers and approximately 20 inches of winter rainfall. Ninety % of the annual runoff occurs in less than 30 days, the majority of nutrient export takes place within 7 days. (data: MC06, 2000-2001)



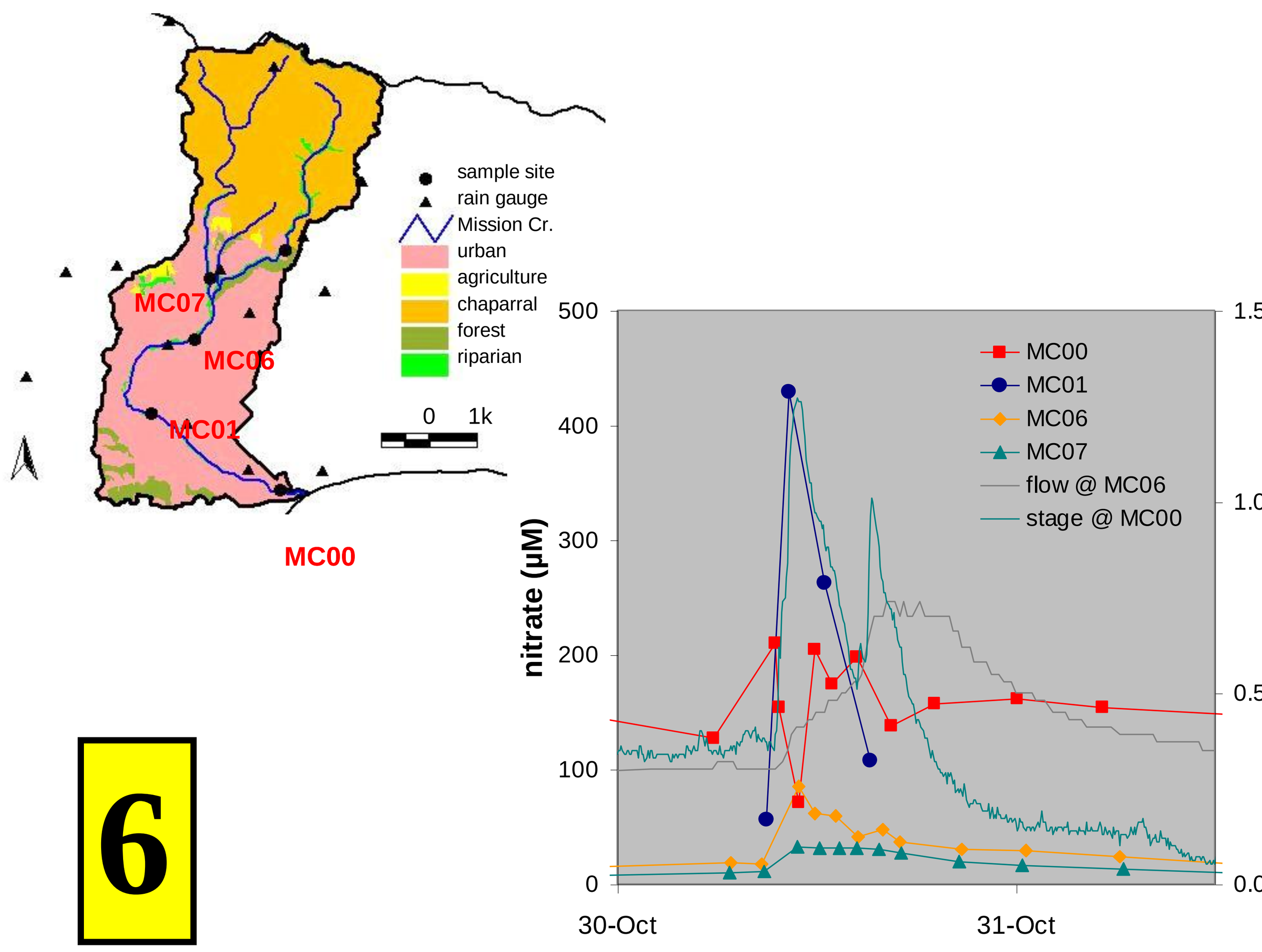
3

The catchments vary in area, topography, vegetation, soils, geology and land use, and display a wide range of base- and storm-flow nutrient concentrations. Arroyo Hondo is relatively pristine, Mission densely urban along the coastal plain, and Franklin highly impacted by “green house” agriculture. (data: winter 2001)



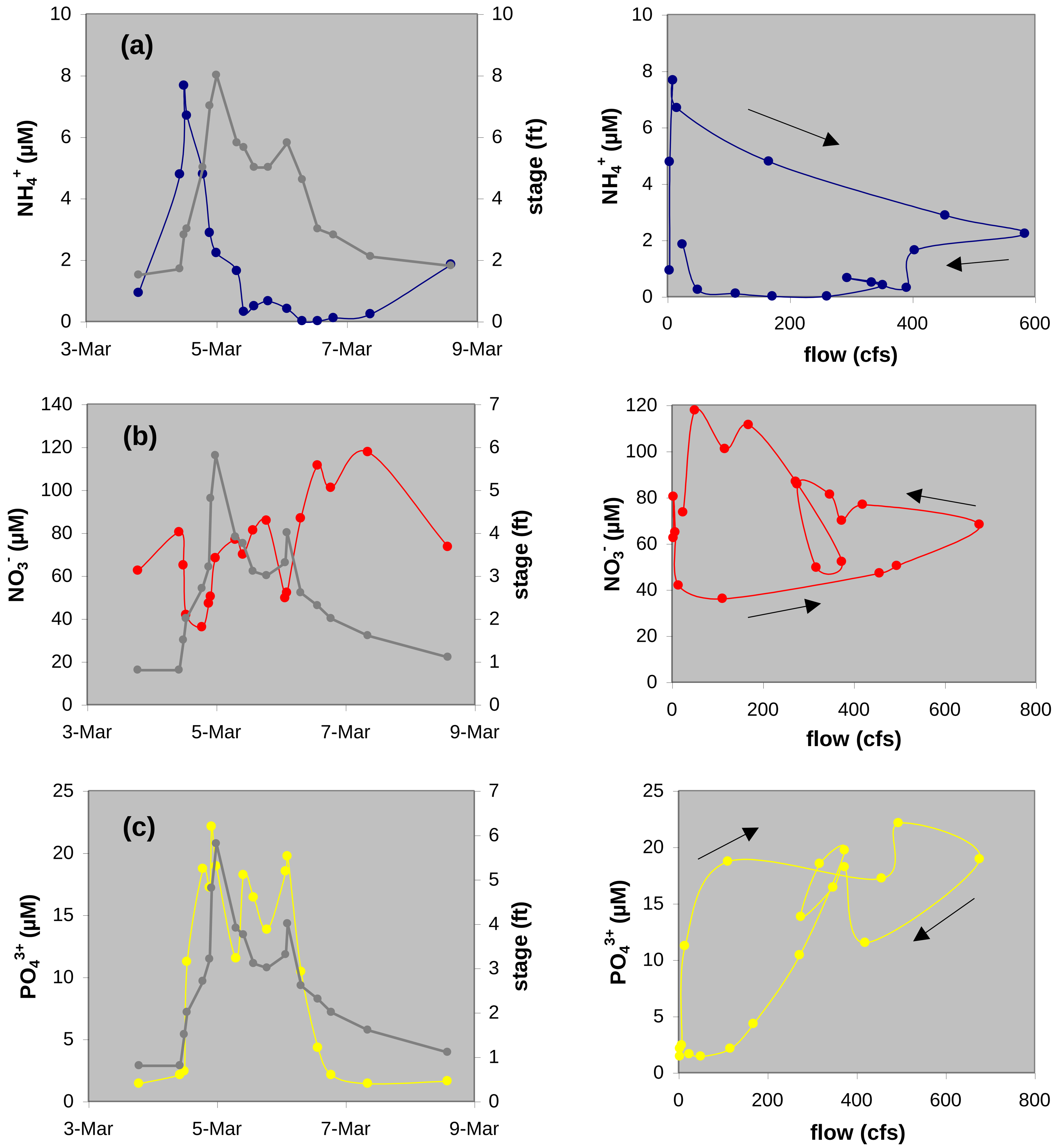
4

The relative export associated with urban streams was consistent: phosphate export at least 5-times that of ammonium, , nitrate at least 5-times that of phosphate. Export on the rising hydrograph limb was most important for ammonium (where 30 to 50 % of the ammonium is lost), somewhat important for phosphate (~25 % of total export) and relatively unimportant for nitrate (10 to 15 %). (Mission Cr. {MC00}data, 2001)



6

This winter we are sampling storms “along the line of flow” to determine how concentrations change with land use in selected streams. During the first storm of the year, nitrate concentrations from early surface runoff increased downstream in Mission Creek, coincident with increasing residential densities (MC07 to MC06 to MC01). The greatest increase in nitrate occurred below a series of urban parks between MC06 and MC01. Interestingly, the lowest section of the stream, which flows through downtown Santa Barbara, produced a decrease in nitrate concentrations (MC00); “lawns and dogs” may contribute more nitrate than the flushing of impervious surfaces. For this small storm, where urban runoff predominated, only MC00 produced the characteristic urban nitrate signature shown previously.



5

The stormflow response of “non-urban” streams varies, but streams with appreciable urban sub-catchments in their lower basins exhibit a common pattern: (a) ammonium declines exponentially after a peak at the beginning of storms, (b) the rise and fall of nitrate concentrations are 180 degrees out of phase with the hydrograph, and (c) variations in phosphate concentrations are in parallel with the hydrograph.

Concentration-discharge relationships for the urban streams show hysteresis and fit a 3-compartment baseflow/surface-flow/soilwater model. The pattern for each species is different in shape and temporal variation, indicating the lack of a common source or hydrologic response. The inference is that high ammonium concentrations are produced by early surface-flow flushing of urban surfaces, high soilwater concentrations produce the highest nitrate concentrations late on the receding storm hydrograph, and phosphate is characterized by a “flashy” urban effect (note how phosphate leads the rising hydrograph limb and lags the falling limb) superimposed on an overall catchment response. (data from 2001: (a) Mission Creek {MC00}, (b) and (c) Arroyo Burro)