Supporting Information

High Resolution Synoptic Sampling to Identify Nonpoint Source Pollution from Groundwater-Surface Water Discharges in Lowland Rivers

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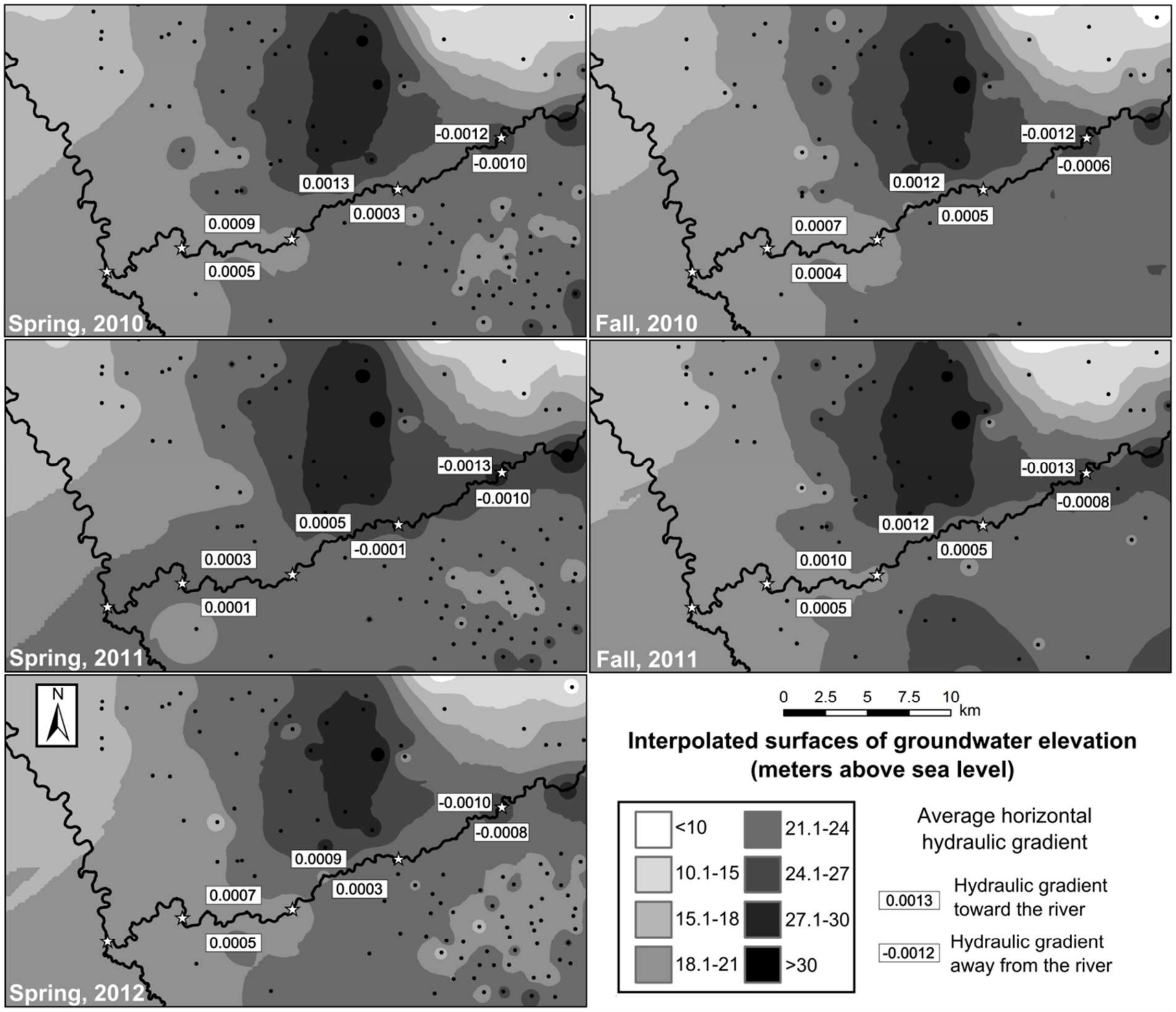

Figure S1. Interpolated groundwater surface elevation using the inverse distance weighting (IDW) method for the well data collected by the Stanislaus and Merced Counties during the 2010-2012 period. By assuming connection between the groundwater and surface water, we calculated an average horizontal hydraulic gradient for upper, middle, and lower areas of the study site using the groundwater surface elevation of wells (within an approximate 5 km buffer) and the estimated river stage at the point of interest..

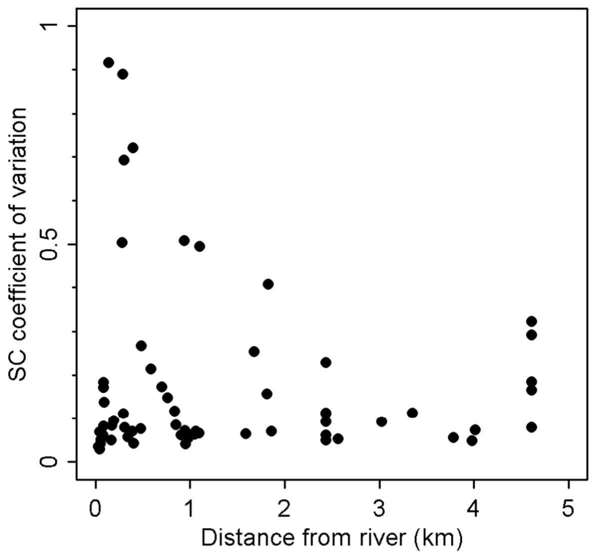

Figure S2. Salinity coefficient of variation (CV) for all wells within a 5 km buffer along the river. Only wells having 5 or more observations are shown (64 unique wells total). 54 of the 64 (84%) of the wells had a CV of less than 0.3.

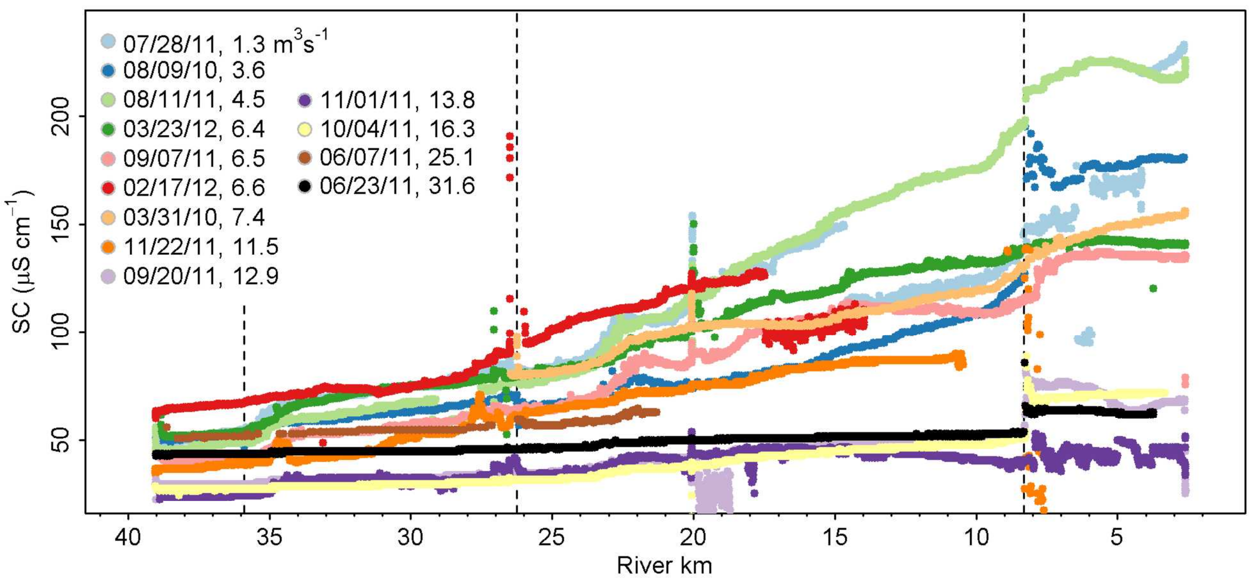

Figure S3. Unfiltered specific conductivity values with the sampling dates and daily upstream flow values denoted in the legend. The dashed vertical lines indicate the major SW inlets. The last inlet (Lower Stevinson Lateral around river km 8) showed significant disturbance to SC values on multiple runs and data downstream from the inlet was filtered (i.e., analysis was stopped at river km 8). Two additional spikes around river km 20 and 26 were from transition locations where the kayak required battery replacement causing sediment disturbance and corresponding SC spikes. To filter the spikes, a 600 m buffer both upstream and downstream of the transition locations was applied. Finally, we manually filtered SC data when the sensor values exhibited high variance (e.g., 9/20/11, river km 20 to 18) due to known investigator error (sensor out of water) and sensor cleaning, and for two unexplained shifts (2/17/11 for river km 18 to 14 and 7/28/11 at river km 14 and beyond).

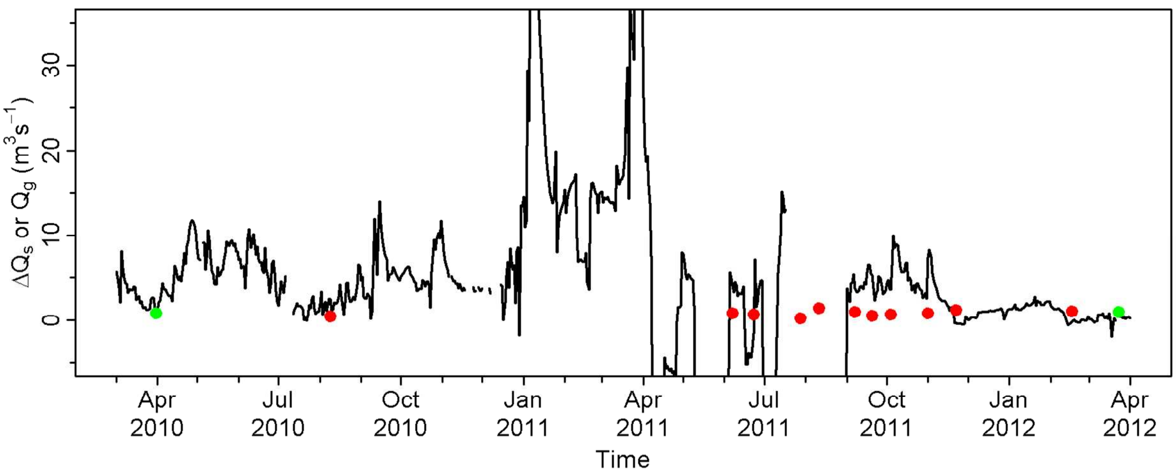

Figure S4. Comparison of differential gauging station estimates, ΔQ_s, (black line, based on average daily flows at CRS and MST stations) with model-estimated Q_g (green and red symbols). Red and green symbols are for surveys affected and unaffected by ungauged flow from the Lower Stevinson Lateral (approximate location river km 8). The travel time used to calculate the differential gauging estimates was 15 hours, based on hydrograph peak analysis between the two gauging stations. Large variations in differential gauging-based ΔQ_s estimates reflect sensitivity to flow changes with respect to travel time between the gauging stations.

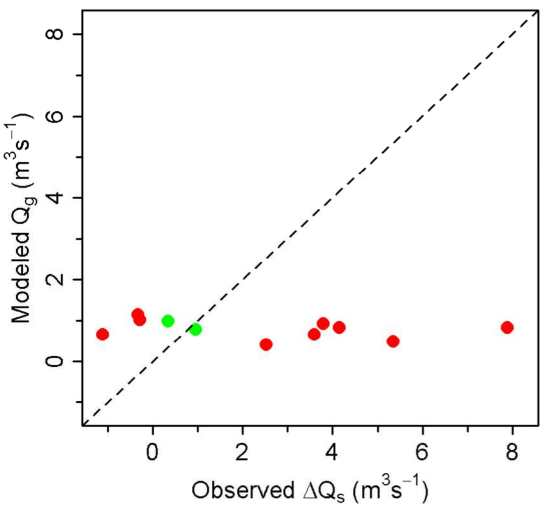

Figure S5. Comparison of modeled Q_g and daily differential flow gauging estimates, ΔQ_s,values (from Figure S4). The red symbols indicate surveys for which the Lower Stevinson Lateral had observable ungauged inflow to the Lower Merced River. Green symbols indicate surveys for which there were no observable SC influences from the same lateral.

Table S1. Comparison between modeled Q_g and observed differential gauging station values (ΔQ_s). Bold values are for surveys for which there were no observable SC influences from lateral canals (i.e., for bold cases, observed ΔQ_s is more representative of the observed Q_g).

Date	Daily CRS flow (m^3 s^{-1})	Modeled Q_g (m^3 s^{-1})	Daily observed ΔQ_s (m^3 s^{-1})	Modeled Q_g to daily MST flow (%)	Observed ΔQ_s to daily MST flow (%)
7/28/2011*	1.33	0.21	ND	--	--
8/9/2010	3.60	0.40	2.52	6.59	41.28
8/11/2011	4.50	1.44	ND	--	--
3/23/2012	**6.40**	**0.99**	**0.34**	**14.63**	**4.98**
9/7/2011	6.54	0.93	3.79	8.99	36.69
2/17/2012*	6.57	1.01	-0.29	16.10	4.65
3/31/2010*	**7.39**	**0.79**	**0.95**	**9.44**	**11.38**
11/22/2011	11.47	1.15	-0.33	10.29	3.00
9/20/2011	12.88	0.48	5.35	2.62	29.38
11/1/2011	13.79	0.82	7.89	3.81	36.67
10/4/2011	16.25	0.65	3.59	3.27	18.09
6/7/2011*	25.12	0.84	4.16	2.86	14.21
6/23/2011	31.57	0.65	-1.12	2.16	3.71

ND = No data available for downstream gauging station (MST).

* = Incomplete survey runs.

Table S2. Root mean squared error (RMSE) between modeled and observed SW-GW discharge, Q_g, for two sampling dates (3/31/10 and 3/23/12) that were not affected by the Lower Stevinson Lateral (green symbols in Figures S4 and S5). Four spatial methods (nearest, average of 3 closest wells, inverse distance weighting of 3 closest wells, and applying interpolated GW SC surface) were used to assign SC to the distributed mixing model. The observed Q_g are daily estimates accounting for a constant 15 hour travel time.

Chosen GW SC, C_g, description	Q_g RMSE values for two sampling dates ($m^3 s^{-1}$)
Nearest well	1.0823
Average of nearest 3 wells	0.8378
Inverse distance weighted of nearest 3 wells	0.8460
Interpolated SC surface	0.4738