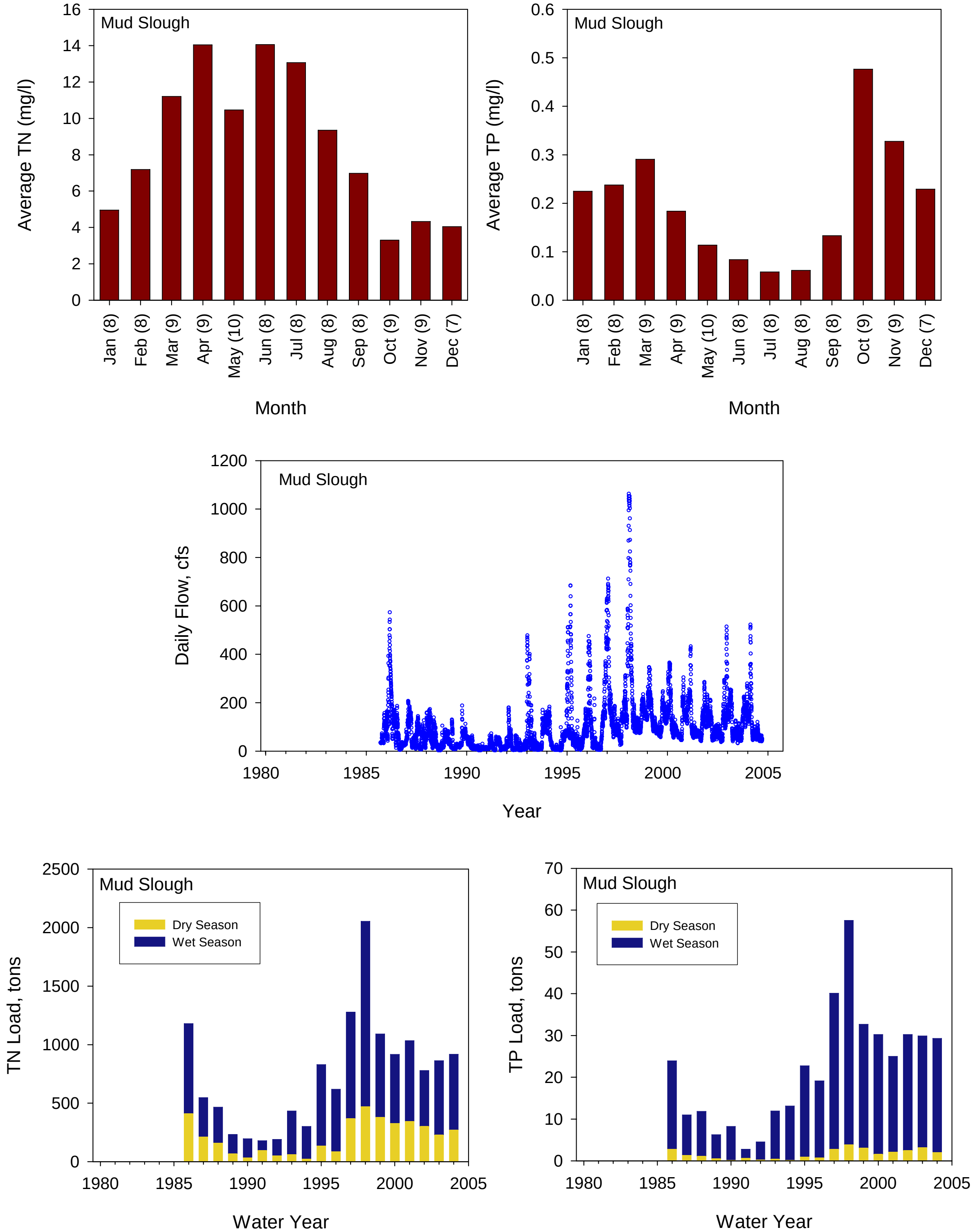

Figure 4-28. Monthly average concentration, daily discharge, and estimated wet and dry season loads by water year for the Mud Slough. These data were used to estimate the nutrient export rate from agriculture in the San Joaquin River basin.

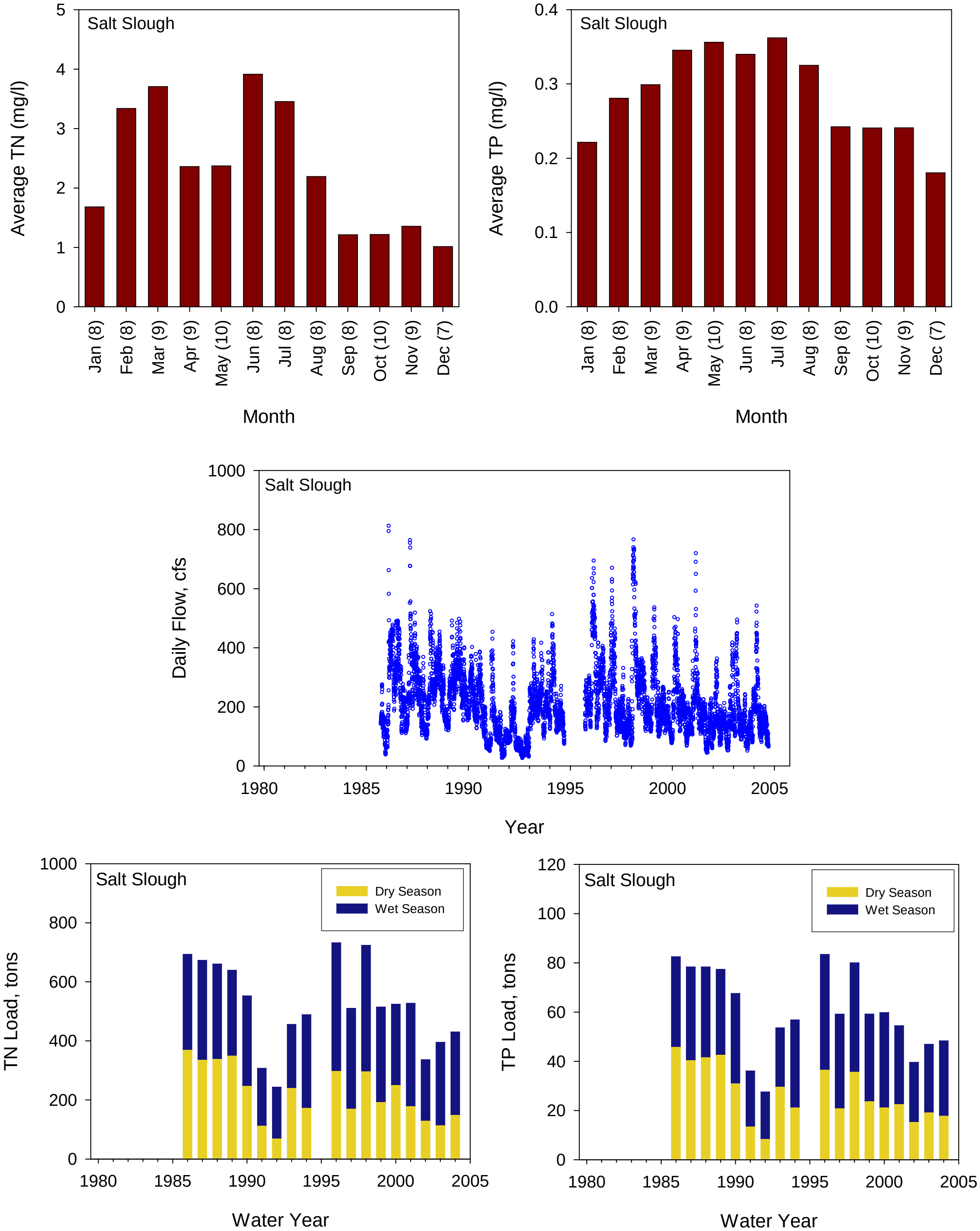

Figure 4-29. Monthly average concentration, daily discharge, and estimated wet and dry season loads by water year for Salt Slough. These data were used to estimate the nutrient export rate from wetlands in the San Joaquin River basin.

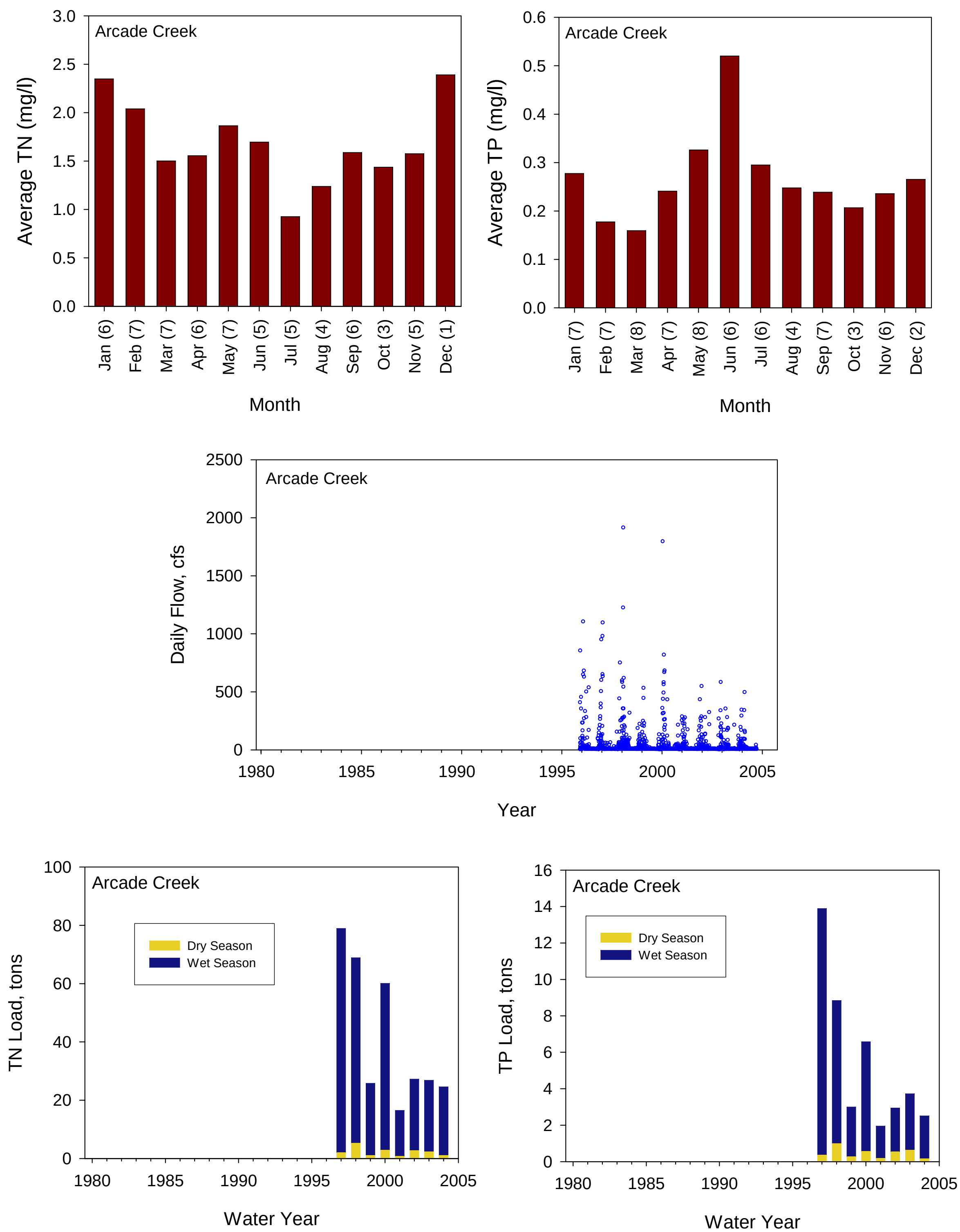

Figure 4-30. Monthly average concentration, daily discharge, and estimated wet and dry season loads by water year for Arcade Creek, used to estimate the urban runoff export rate for nutrients from the Sacramento River basin.

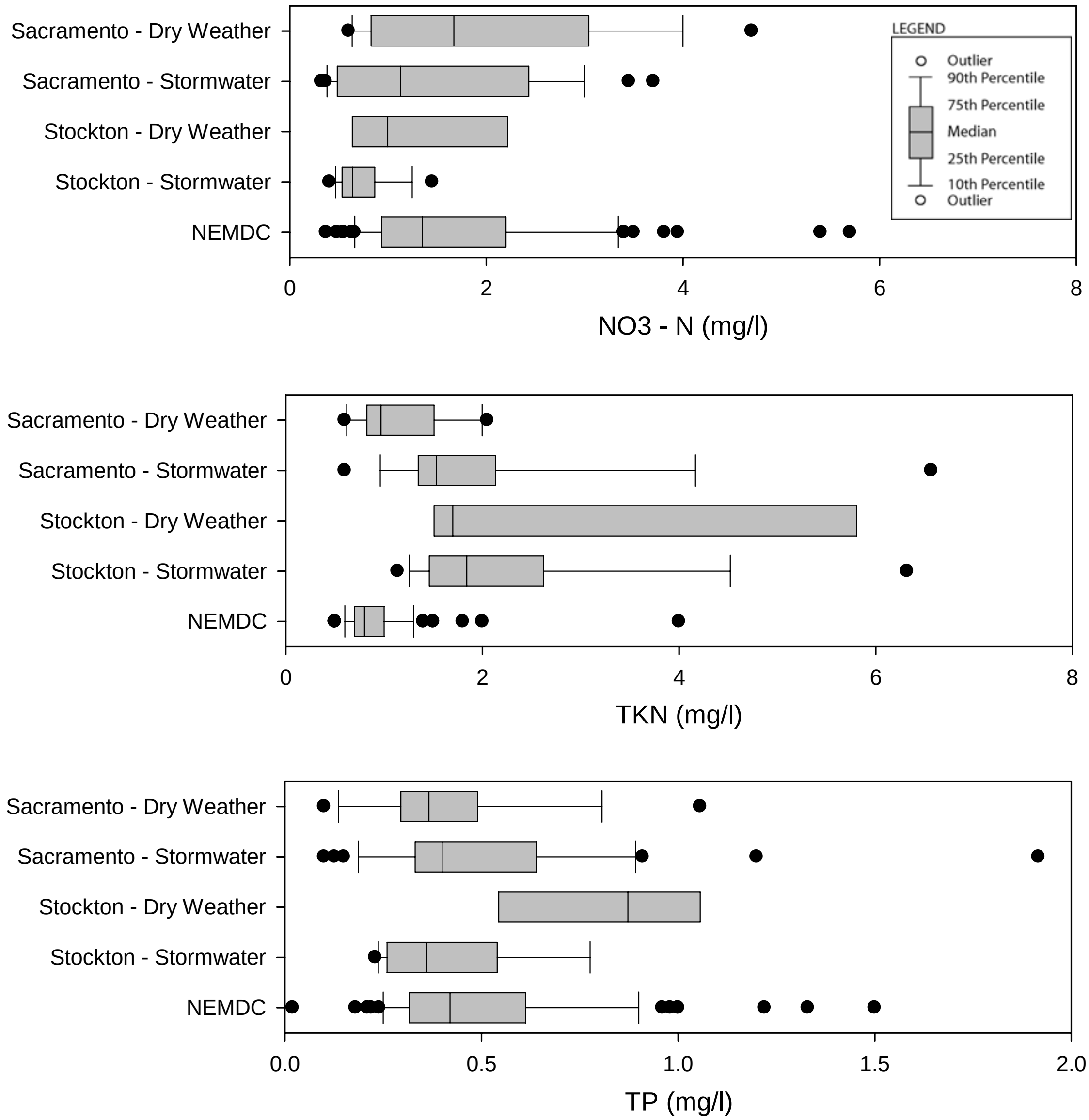

Figure 4-31. Urban runoff nutrient concentration data from Sacramento, Stockton, and the Natomas East Main Drainage Canal (NEMDC).

Table 4-7.
Export rates of nutrients from major land uses in the Central Valley.

NITROGEN

Land Use	Dry Year Loads ($tons/km^2/yr$)		Wet Year Loads ($tons/km^2/yr$)		Source	
	Sacramento	*San Joaquin*	*Sacramento*	*San Joaquin*	*Sacramento*	*San Joaquin*
Agriculture[1]	0.082	0.41	0.27	0.82	Colusa Basin Drain	Mud Slough
Urban Runoff	0.26	0.13	0.60	0.30	Arcade Creek	Calculated from Sacramento value
Forest/Rangeland	0.047	0.024	0.20	0.10	Yuba River	Calculated from Sacramento value
Wetland-Dominated[2]	0.75	0.37	0.93	0.47	Calculated from San Joaquin value	Salt Slough

PHOSPHORUS

Land Use	Dry Year Loads ($tons/km^2/yr$)		Wet Year Loads ($tons/km^2/yr$)		Source	
	Sacramento	*San Joaquin*	*Sacramento*	*San Joaquin*	*Sacramento*	*San Joaquin*
Agriculture[1]	0.015	0.012	0.052	0.023	Colusa Basin Drain	Mud Slough
Urban Runoff	0.028	0.014	0.083	0.041	Arcade Creek	Calculated from Sacramento value
Forest/Rangeland	0.0052	0.0026	0.021	0.010	Yuba River	Calculated from Sacramento value
Wetland-Dominated[2]	0.087	0.044	0.11	0.054	Calculated from San Joaquin value	Salt Slough

[1]Available data do not allow separation into crop types.

[2]Wetland-dominated land may include a portion that is agricultural land.

4.4.2 POINT SOURCES

Point source discharges in the Central Valley watershed include municipal wastewater treatment plants, industrial discharges, and fish hatcheries. There were no nutrient concentration data for discharges from fish hatcheries or industrial facilities available for this study. The major municipal wastewater dischargers are shown in Table 4-8 and on Figure 4-32. Nutrient concentration and flow data were available for the majority of plants listed in Table 4-8. The available nutrient concentration data, ammonia-N, NO3-N, and TP, are presented in Figures 4-33 through 4-35, respectively. Effluent flow data are presented in Figure 4-36. Ammonia-N and NO3-N concentrations were added to estimate total nitrogen for the point source loads. TP data were used directly. Annual average data were used in all cases.

Available flow and concentration data for each subwatershed and the resultant load calculations are presented in Table 4-9 and described below. For each subwatershed, the wastewater plants in the basin and the available nutrient data (TN and/or TP) are presented in column 3 of the table. Wastewater plants only appear in this column for TN if both ammonia-N and NO3-N data are available. For example, Chico has ammonia-N data (Figure 4-33) but not NO3-N data (Figure 4-34) and thus does not appear in Table 4-9. Column 4 presents available per capita flow data. Even though plant effluent flow is available for most of the treatment plants (Figure 4-38), the per capita flow can be calculated only for plants for which population-served data are available. Population-served data are readily available (i.e., through an internet search) for Davis (60,300), Vacaville (88,200) and Sacramento Regional (1,128,000). Columns 5 and 6 of the table present subwatershed specific TN and TP concentration data where available, calculated through flow-weighted averaging over all plants in the subwatershed. The load per person per year was calculated using available per capita flow and concentration data (columns 7 and 8). Where these data were not available for a particular subwatershed, data averaged over all subwatersheds were used (per capita flow = 38,400 gal/year; TN = 14.5 mg/l; TP = 2.5 mg/l). The final loads per person vary from 1.3 to 4.2 kg/person/yr for TN and 0.30 to 0.48 kg/person/yr for TP. For each subwatershed, the load per person per year was multiplied by the basin population (column 9) to determine the average annual load for TN and TP (columns 10 and 11).

Table 4-8.
Wastewater treatment plants in the Central Valley and Delta.

Wastewater Treatment Plant	**Treatment**	**Design Flow (MGD)**
Sacramento Basin		
Sacramento Regional	Secondary	181
Roseville-Dry Creek	Tertiary	18
Roseville-Pleasant Grove Creek	Tertiary	12
Vacaville	Secondary	10
Chico	Secondary	9
Redding Clear Creek	Secondary	9
Woodland	Secondary	8
West Sacramento	Secondary	8
Davis	Secondary	8
Yuba City	Secondary	7
Redding Stillwater	Advanced Secondary	4
Total Flow to Sacramento		*273*
San Joaquin Basin		
Modesto	Secondary	70
Stockton (Nov-Jun)	Secondary	55
Stockton (July-Oct)	Advanced Secondary	55
Turlock	Secondary	20
Merced	Secondary	10
Manteca	Secondary	10
Total Flow to San Joaquin		*165*
Delta		
Tracy	Secondary	9
Lodi	Advanced Secondary	7
Brentwood	Advanced Secondary	5
Discovery Bay	Secondary	2
Total Flow to Delta		*23*
Total Watershed Flow		**461**

Figure 4-32. Point source discharge locations in the database developed by Central Valley Drinking Water Policy Workgroup.

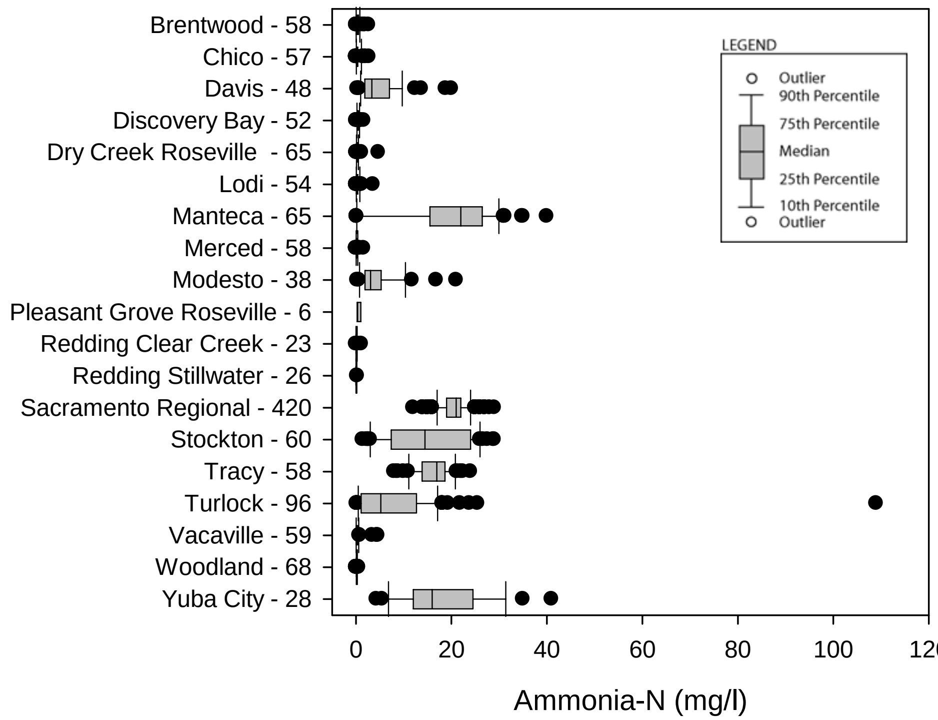

Figure 4-33. Ammonia-N concentration data for wastewater treatment plants in the Central Valley. The number of data points is shown after each plant.

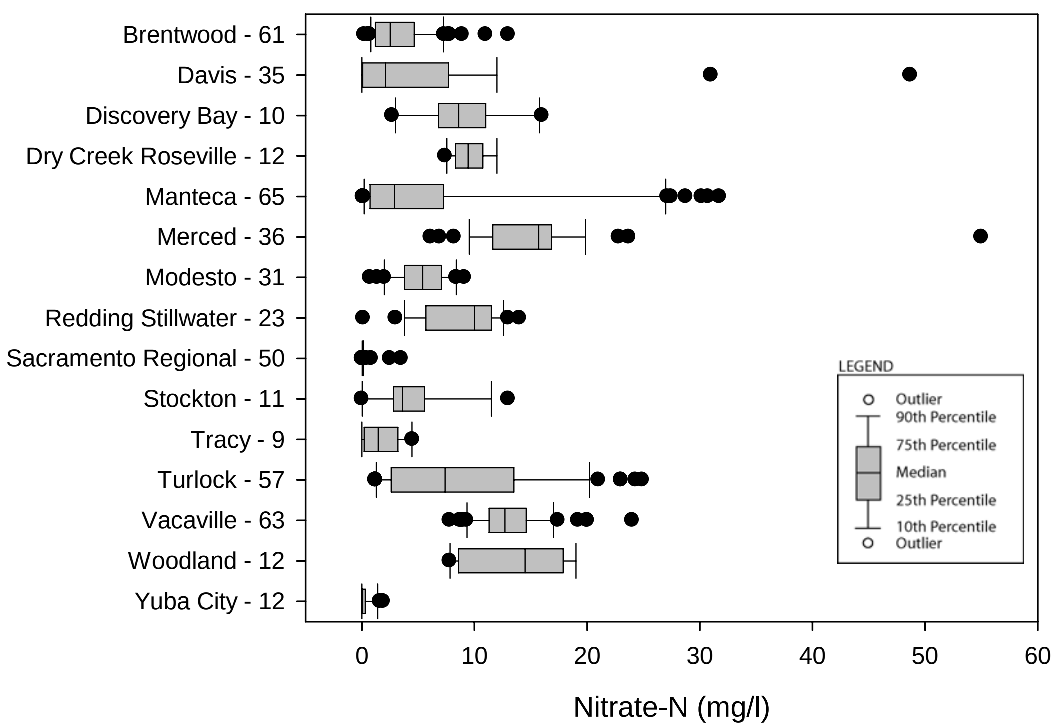

Figure 4-34. NO3-N concentration data for wastewater treatment plants in the Central Valley. The number of data points is shown after each plant.

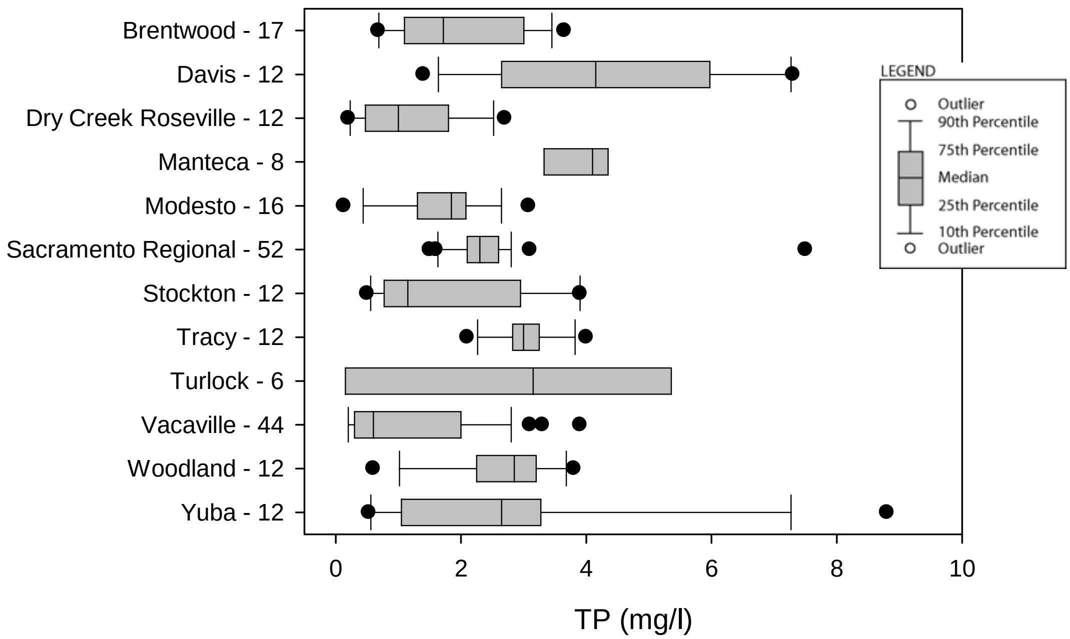

Figure 4-35. TP concentration data for wastewater treatment plants in the Central Valley. The number of data points is shown after each plant.

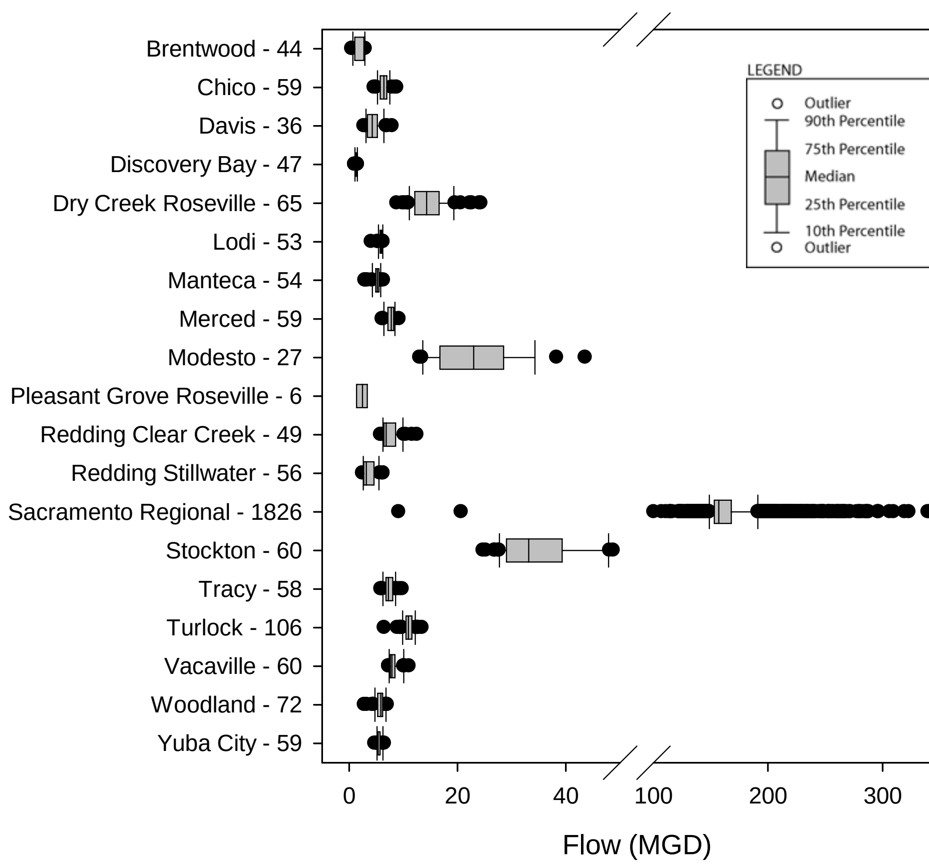

Figure 4-36. Flow data for wastewater treatment plants in the Central Valley. The number of data points is shown after each plant.

Table 4-9.
Average concentrations and loads from wastewater dischargers in the Central Valley and Delta.

				Basin specific concentrations (flow weighted averages, mg/l)		Load summary (kg/person/yr)			Load (tons/yr)	
ID	Watershed Name	Plants in Basin with Data[1]	Per capita flow (gal/year)	TN[2]	TP	TN	TP	Population[3]	TN	TP
1	Sacramento River above Bend Bridge	Redding Stillwater (N)	-	8.7	-	1.3	0.36	118,282	165	47
2	Butte Creek	None	-	-	-	2.1	0.36	64,361	150	25
3	Sacramento River at Colusa	None	-	-	-	2.1	0.36	119,638	278	47
4	Yuba River	None	-	-	-	2.1	0.36	19,879	46	8
5	Feather River	Yuba City (N, P)	-	18.7	2.8	2.7	0.40	106,178	318	47
6	Cache Creek	None	-	-	-	2.1	0.36	32,946	77	13
7	American River	None	-	-	-	2.1	0.36	879,576	To Sac R	To Sac R
8	Sacramento River at Hood/Greene's	Sacramento Regional (N, P); Roseville-Dry Creek (N, P)	53,391	20.0	2.3	4.2	0.48	485,552	6,342	724
9	Cosumnes River	None	-	-	-	2.1	0.36	45,600	106	18
10	San Joaquin River at Newman	None	-	-	-	2.1	0.36	70,825	165	28
11	Stanislaus River	None	-	-	-	2.1	0.36	197,194	459	78
12	Tuolumne River	None	-	-	-	2.1	0.36	113,101	263	45
13	Merced River	None	-	-	-	2.1	0.36	1,238	3	0
14	Bear Creek	Merced (N)	-	15.8	-	2.3	0.36	99,300	251	39
15	Chowchilla River	None	-	-	-	2.1	0.36	5,603	13	2
16	San Joaquin River at Sack Dam	None	-	-	-	2.1	0.36	673,960	1568	267
17	Mokelumne River	None	-	-	-	2.1	0.36	39,876	93	16
18	Bear River	None	-	-	-	2.1	0.36	31,355	73	12
19	Putah Creek	None	-	-	-	2.1	0.36	32,250	75	13
20	Delta North	Vacaville (N, P); Davis (N, P); Woodland (N, P)	30,883	13.1	2.4	1.5	0.30	284,376	460	93
21	Delta South	Brentwood (N, P); Discovery Bay (N); Manteca (N, P); Stockton (N, P); Tracy (N, P)	-	19.5	2.1	2.8	0.31	497,805	1553	169
22	San Joaquin River at Vernalis	Modesto (N, P); Turlock (N, P)	-	12.3	2.1	1.8	0.31	136,680	268	46

Basin-wide average data:

Per capita flow (gal/yr) = 38,400
Average TN (mg/l) = 14.5
Average TP (mg/l) = 2.5

Notes:

1. Plants will only be listed here if they have TP data or *both* Ammonia-N and NO3-N (for N).
2. TN = Ammonia-N + NO3-N.
3. Census 2000 data (**http://casil.ucdavis.edu/casil/gis.ca.gov/census/**)

4.4.3 COMPARISON OF WATERSHED AND OUTFLOW LOADS

The relationship between upstream loads, watershed loads corresponding to a stream reach, and downstream exported loads is shown schematically in Figure 4-37. If instream transformation processes are not dominant, the sum of the upstream loads and the watershed loads should be approximately equal to the downstream exported loads. Because instream loads and export rate based watershed loads were computed independently in the previous sections, the comparison of these loads provides a useful check on the calculations so far, and discrepancies are one indication of uncertainties or inaccuracies in the load calculations.

In Figures 4-38 and 4-39 for nitrogen and Figures 4-40 and 4-41 for phosphorus, nutrient load estimates based on in-stream measurements of flow and concentration (termed outflow loads here) are compared with the export rate estimate of loads for each subwatershed for wet years and dry years. The upper portion of each figure illustrates the loads estimated using export rates for each of the landuse categories for each subwatershed. The lower portion of each figure compares the sum of the watershed loads as presented in the upper portion (watershed loads), these watershed loads added to the upstream instream component (watershed loads + upstream inputs), and the outflow loads as computed using instream data, previously presented in Tables 4-3 and 4-4 (outflows). This information is tabulated in Tables 4-10 and 4-11 for nitrogen and Tables 4-12 and 4-13 for phosphorus. The point source category in these tables and figures refers to wastewater effluent only, as this was the only point source quantified for this study.

In general, the load estimates by the two very different approaches are more comparable in wet years than dry years. In several cases, including tributary stations near the Delta, the loads estimated are comparable. In other cases, the load estimates are off by a larger factor, such as the Mokelumne River and American River during dry years, where the estimates are off by a factor of approximately five or greater for both nitrogen and phosphorus. In general, the greatest discrepancies occur at the locations that have the least amount of nutrient concentration data.

Total watershed loads entering the Delta at the major tributary input locations, Sacramento River at Hood/Greene's Landing and San Joaquin River at Vernalis, are presented in Figure 4-42. These load components are based solely on export rates as applied to the entire watersheds upstream of each location, and thus will be different from loads presented on the top portion of Figures 4-38 to 4-41 for Hood/Greene's Landing and Vernalis, which present loads from the individual subwatersheds for these locations (i.e., subwatersheds 8 and 22). The watershed and outflow loads are shown in a graphical schematic for nitrogen in Figures 4-43 and 4-44 for average wet and dry years and for phosphorus in Figures 4-45 and 4-46 for average wet and dry years.

Several observations are possible from this first attempt at watershed load estimates, as shown in Figure 4-42. For nitrogen, forest/rangeland loads may dominate the overall loads for the Sacramento Basin and agricultural loads may dominate in the overall loads to the San Joaquin Basin, particularly for wet years. Point source loads from wastewater discharges may contribute nearly half or more of the overall nitrogen and phosphorus loads during dry years in both basins, and possibly during wet years for phosphorus in the San Joaquin Basin.

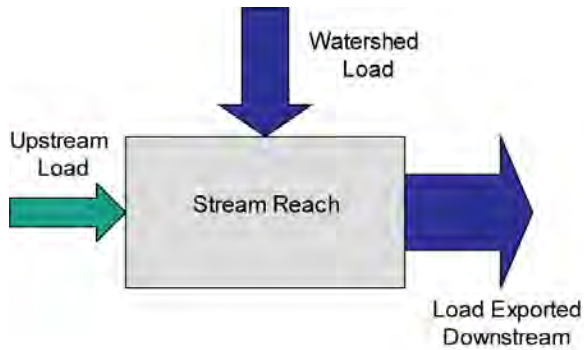

Figure 4-37. The relationship between upstream loads, watershed loads corresponding to a stream reach, and downstream exported loads. These three load values are compared in Figures 4-38 through 4-41.