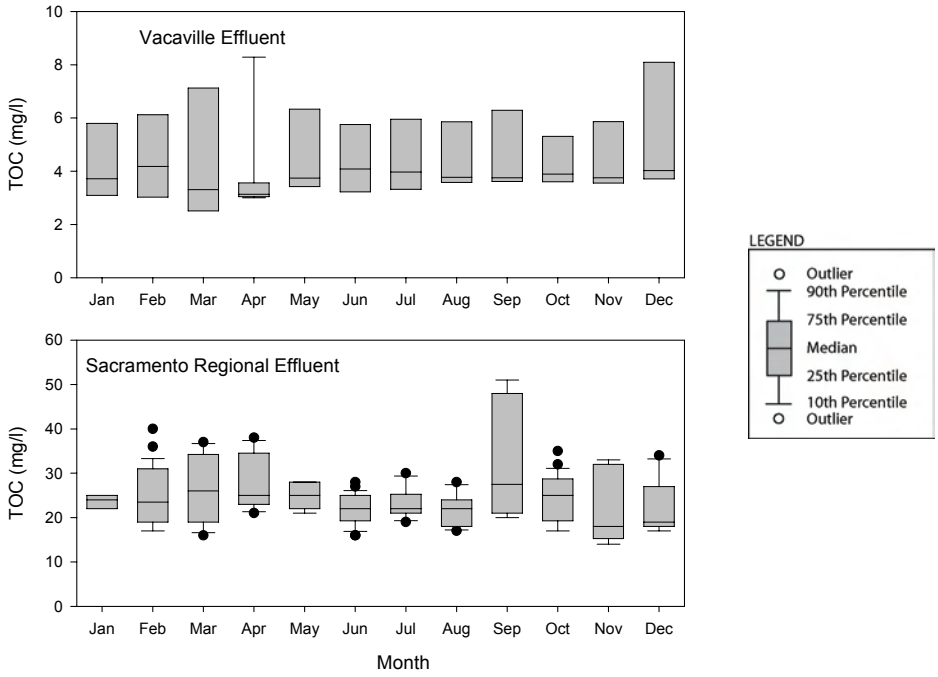

Figure 4-34. Seasonal patterns in wastewater effluent concentrations at Vacaville and Sacramento Regional Wastewater Treatment Plant. Data at Davis were insufficient for a comparison across months.

4.5.3 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 4-35. 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 4-36 and 4-37, organic carbon load estimates based on in-stream measurements of flow and concentration are compared with the export rate estimate of loads for each subwatershed. 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 Table 4-3 (outflows). Tables 4-9 and 4-10 tabulate this information. In several cases, including tributary

stations near the Delta, the loads estimated by two very different approaches are comparable. In other cases, such as the San Joaquin River at Sack Dam (during dry years), the estimates are off by a factor of 9. In general, the greatest discrepancies occur at the locations that have the least amount of organic carbon 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 4-38. 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 4-36 and 4-37 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 in Figures 4-39 and 4-40 for average wet and dry years.

A key observation from these calculations is that the background loads, primarily from land uses such as forests and shrubland, dominate in the overall annual loads in the Sacramento Basin. This occurs because the annual loads are dominated by the high wet weather flows, which originate in large part from the less-developed watersheds in the Sacramento River basin. Agricultural loads dominate in the San Joaquin Basin, particularly in dry years. A key data gap in these calculations is the limited quantity of directly measured organic carbon from background areas. The importance of this source in the overall load calculation highlights the need for this export rate to be better quantified. Additionally, better characterization of agricultural export rates, particularly in the San Joaquin Basin, would help reduce the uncertainty of this loading source.

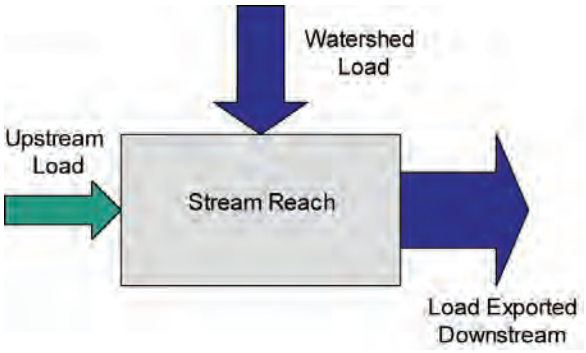

Figure 4-35. The relationship between upstream loads, watershed loads corresponding to a stream reach, and downstream exported loads. These three load values are compared in Figures 4-36 and 4-37.

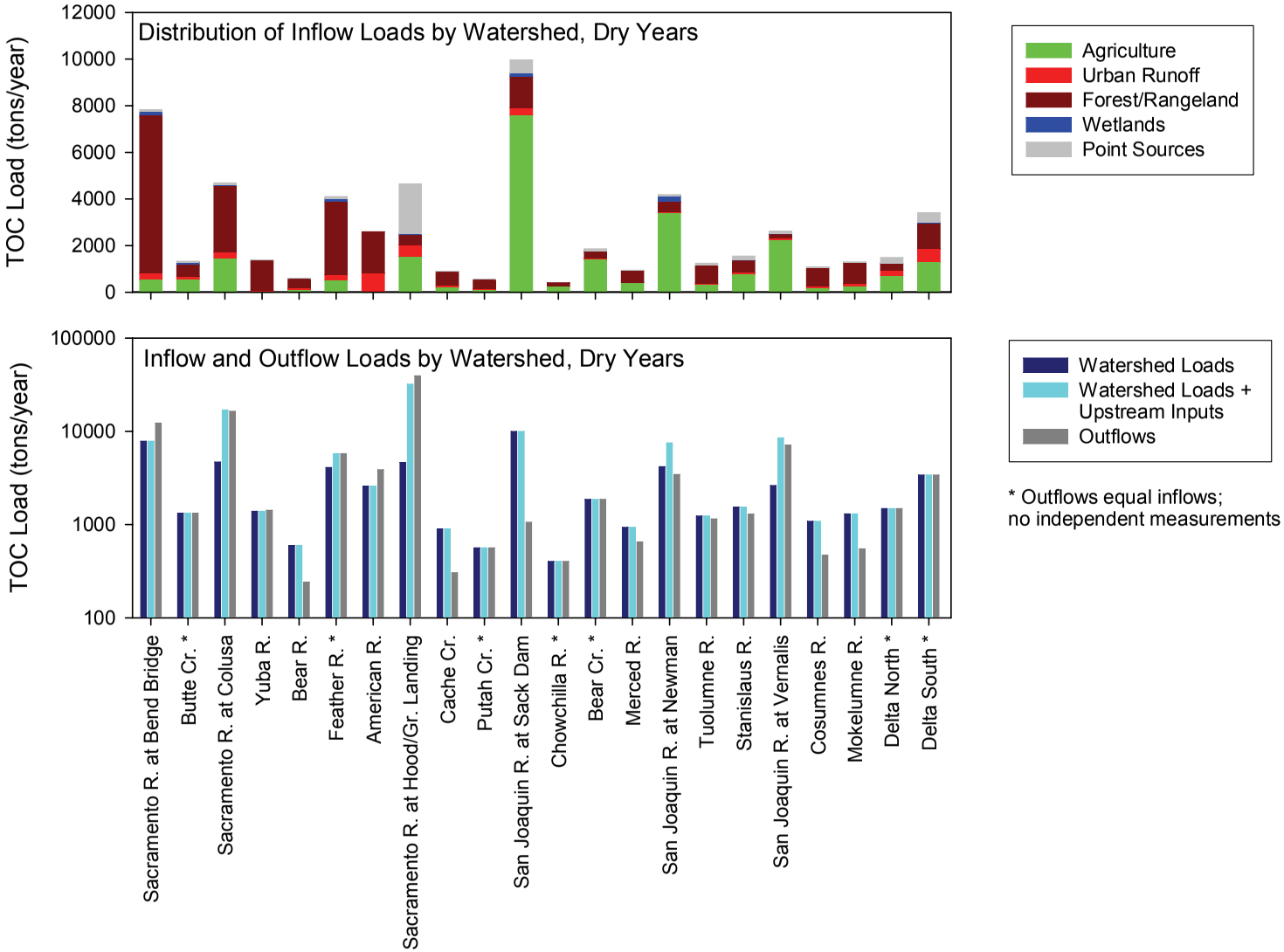

Figure 4-36. Distribution of organic carbon watershed loads by source, and loads flowing out of stream locations are compared with the loads originating from their watersheds for dry years.

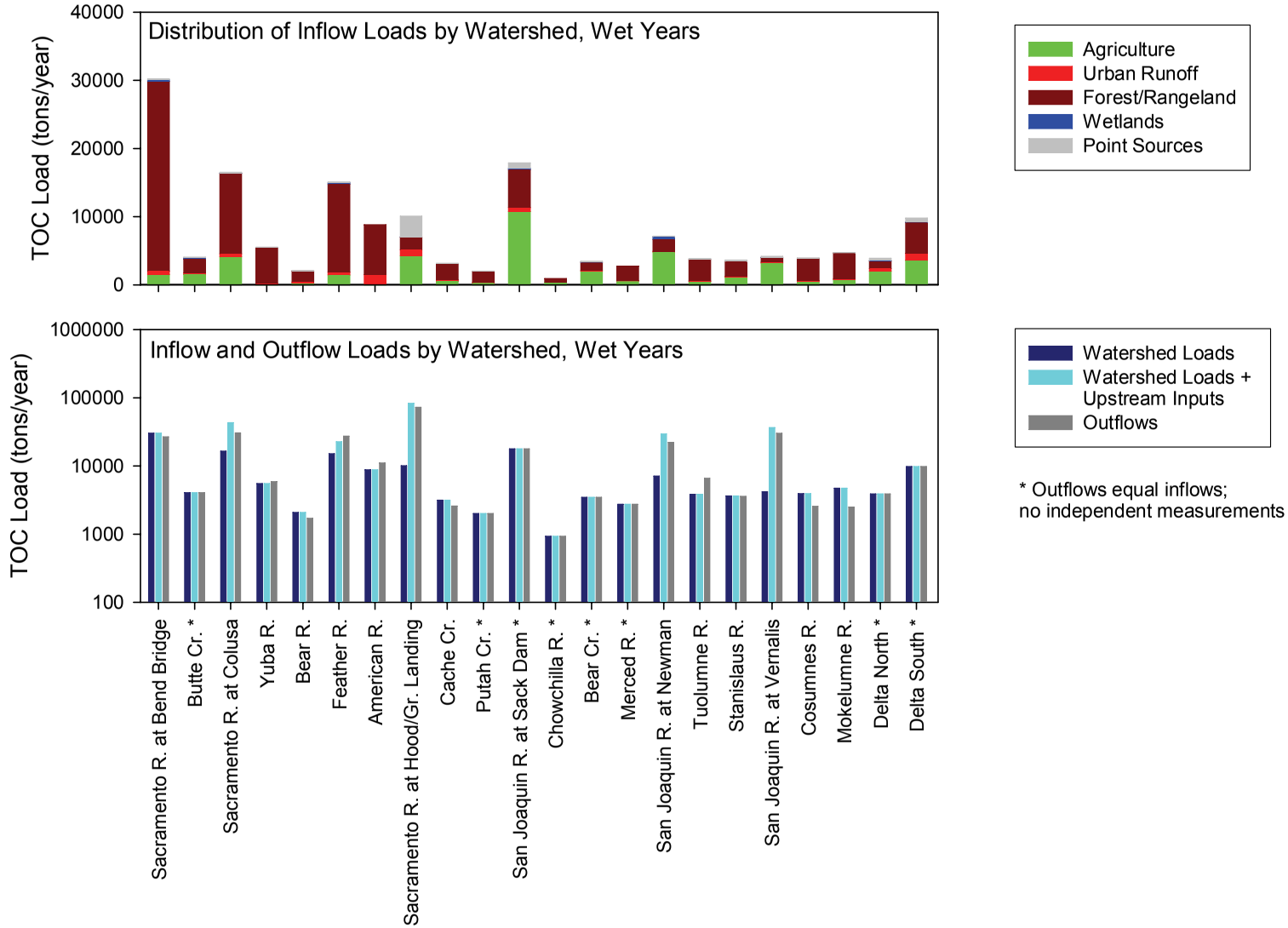

Figure 4-37. Distribution of organic carbon watershed loads by source, and loads flowing out of stream locations are compared with the loads originating from their watersheds for wet years.

Table 4-9.
Comparison of upstream load, watershed loads, and downstream exports for dry years.

Watershed ID	Watershed Name	Load (tons/year)							
		Agriculture	Urban Runoff	Forest / Rangeland	Wetlands	Point Sources	Sum of Watershed Loads	Watershed Loads + Upstream Inflows	Outflows
1	Sacramento River above Bend Bridge	528	299	6,747	156	99	7,829	7,829	12,242
2	Butte Creek	556	113	499	106	54	1,327	1,327	*
3	Sacramento River at Colusa	1,469	250	2,858	13	100	4,689	16,932	16,394
4	Yuba River	25	55	1,292	0	17	1,389	1,389	1,424
5	Feather River	514	224	3,138	132	88	4,097	5,762	*
6	Cache Creek	199	95	578	0	27	899	899	304
7	American River	25	786	1,775	0		2,585	2,585	3,878
8	Sacramento River at Hood/Greene's Landing	1,528	495	450	14	2,147	4,634	31,994	39,313
9	Cosumnes River	161	98	788	0	38	1,085	1,085	471
10	San Joaquin River at Newman	3,400	47	431	246	59	4,183	7,501	3,444
11	Stanislaus River	769	82	524	7	164	1,546	1,546	1,301
12	Tuolumne River	319	57	767	0	94	1,237	1,237	1,147
13	Merced River	407	9	520	0	1	937	937	653
14	Bear Cr/Owens Cr/Mariposa Cr/Deadmans Cr	1,397	59	298	20	83	1,857	1,857	*
15	Chowchilla River	261	6	131	0	5	403	403	*
16	San Joaquin River at Sack Dam	7,586	325	1,354	124	561	9,950	9,950	1,057
17	Mokelumne River	273	83	914	0	33	1,303	1,303	550
18	Bear River	94	81	395	0	26	596	596	242
19	Putah Creek	97	48	392	0	27	564	564	*
20	Delta North	702	239	269	37	237	1,485	1,485	*
21	Delta South	1,293	565	1,100	27	415	3,399	3,399	*
22	San Joaquin River at Vernalis	2,250	72	163	21	114	2,620	8,511	7,130

* Flow and concentration data are not available to calculate an outflow load.

Table 4-10.
Comparison of upstream load, watershed loads, and downstream exports for wet years.

Watershed ID	Watershed Name	Load (tons/year)							
		Agriculture	Urban Runoff	Forest / Rangeland	Wetlands	Point Sources	Sum of Watershed Loads	Watershed Loads + Upstream Inflows	Outflows
1	Sacramento River above Bend Bridge	1,474	542	27,812	230	138	30,196	30,196	26,717
2	Butte Creek	1,553	204	2,055	156	75	4,044	4,044	*
3	Sacramento River at Colusa	4,100	453	11,779	19	140	16,492	43,209	30,490
4	Yuba River	70	100	5,327	0	23	5,520	5,520	5,904
5	Feather River	1,434	406	12,935	195	124	15,095	22,702	27,437
6	Cache Creek	556	172	2,382	0	38	3,148	3,148	2,574
7	American River	69	1,424	7,315	0		8,808	8,808	11,081
8	Sacramento River at Hood/Greene's Landing	4,265	897	1,855	20	3,034	10,072	83,124	72,598
9	Cosumnes River	450	177	3,248	0	53	3,929	3,929	2,555
10	San Joaquin River at Newman	4,816	86	1,776	363	83	7,123	29,395	22,148
11	Stanislaus River	1,090	149	2,159	10	230	3,637	3,637	3,587
12	Tuolumne River	452	102	3,163	0	132	3,849	3,849	6,612
13	Merced River	577	16	2,144	0	1	2,738	2,738	*
14	Bear Cr/Owens Cr/Mariposa Cr/Deadmans Cr	1,979	106	1,229	30	116	3,461	3,461	*
15	Chowchilla River	370	11	541	0	7	928	928	*
16	San Joaquin River at Sack Dam	10,744	589	5,581	182	787	17,883	17,883	*
17	Mokelumne River	761	150	3,769	0	47	4,727	4,727	2,492
18	Bear River	263	147	1,626	0	37	2,074	2,074	1,703
19	Putah Creek	271	87	1,614	0	38	2,010	2,010	*
20	Delta North	1,961	433	1,110	55	332	3,891	3,891	*
21	Delta South	3,608	1,023	4,533	40	581	9,785	9,785	*
22	San Joaquin River at Vernalis	3,187	130	671	30	160	4,179	36,526	30,059

* Flow and concentration data are not available to calculate an outflow load.

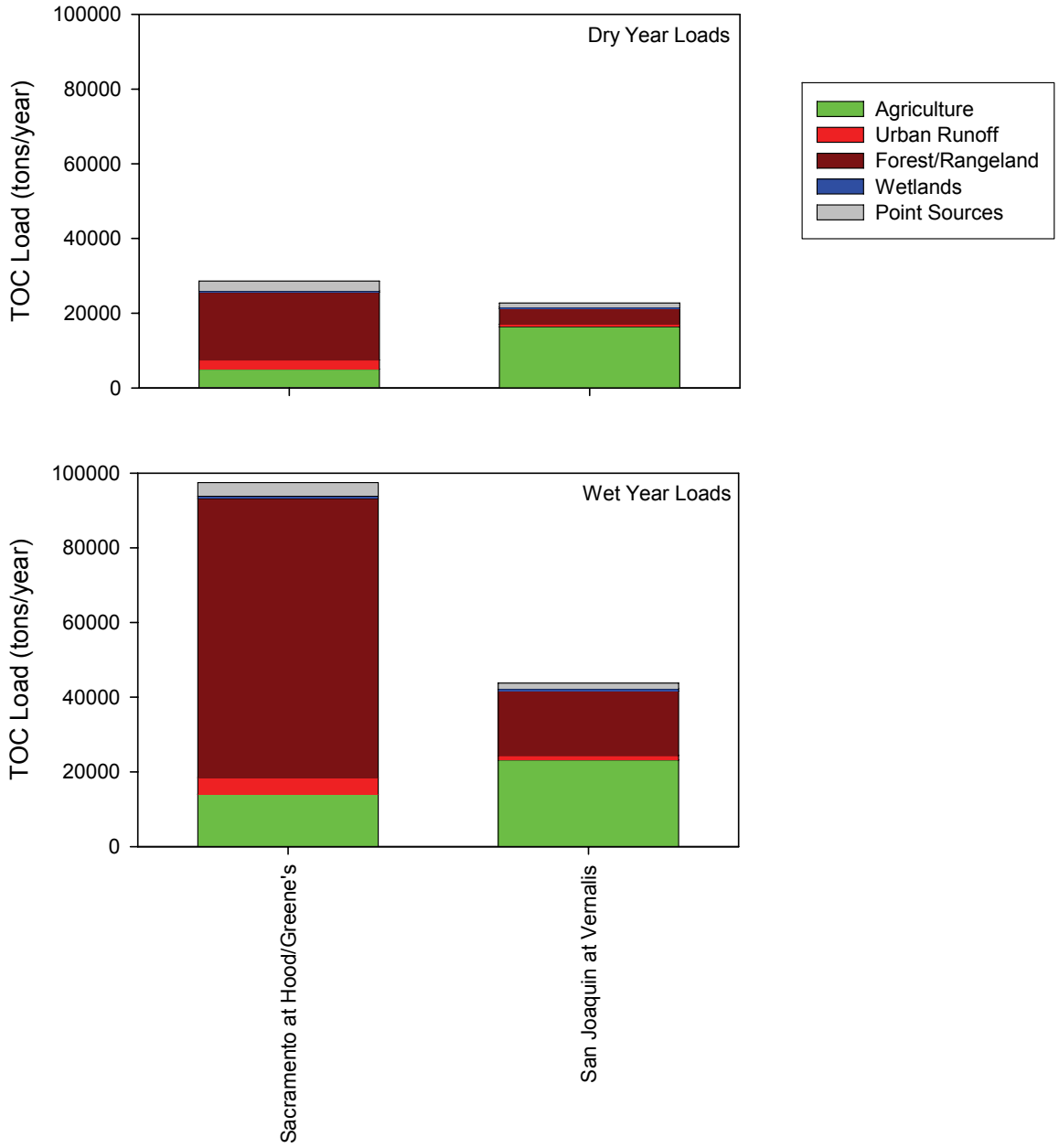

Figure 4-38. Distribution of organic carbon watershed loads by source for the Sacramento and San Joaquin Rivers.

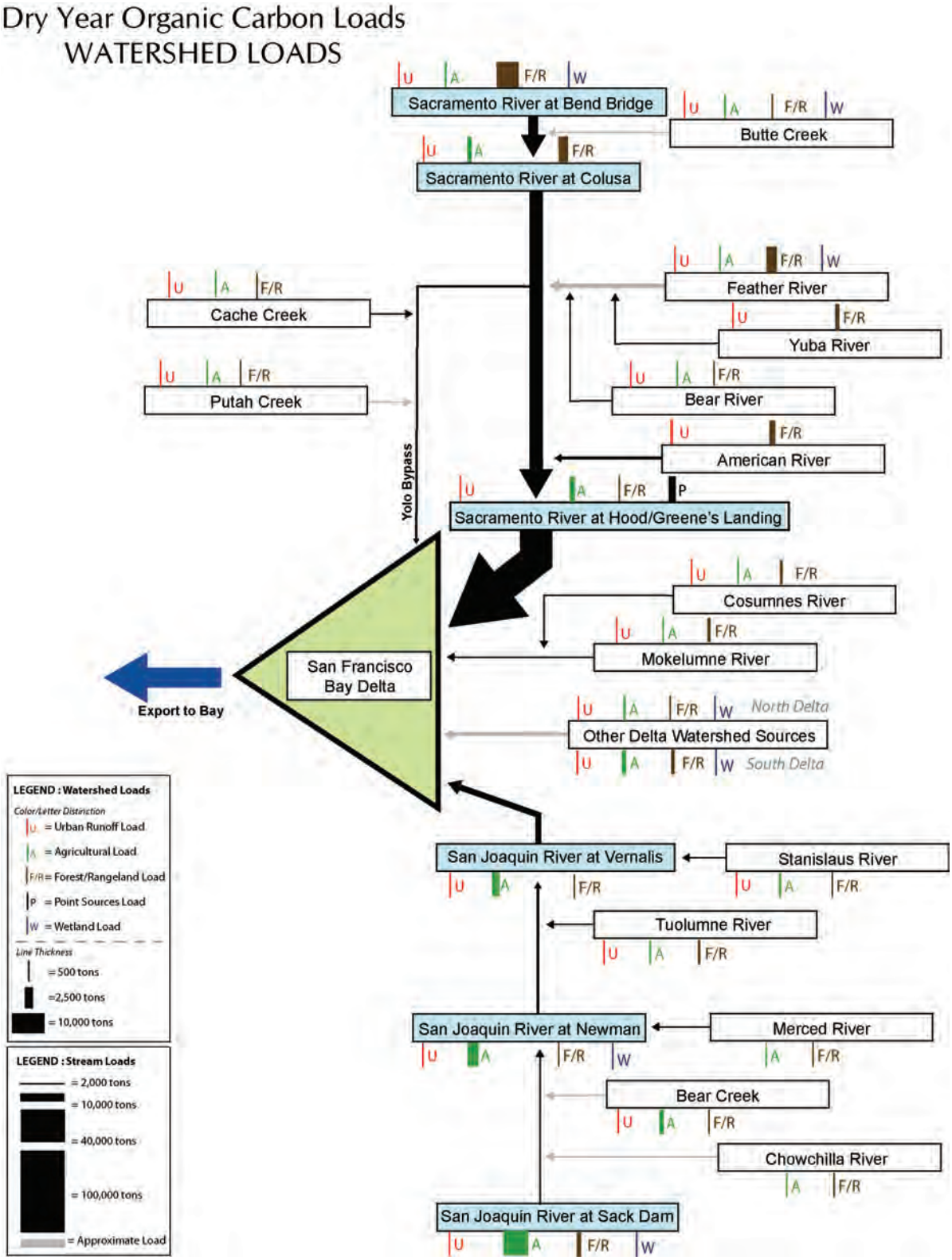

Figure 4-39. Watershed and outflow loads for the Central Valley and Delta for average dry years. This figure and the next use the same linear scales to represent stream loads. Watershed loads are shown with a different scale to show some of the smaller load contributions.

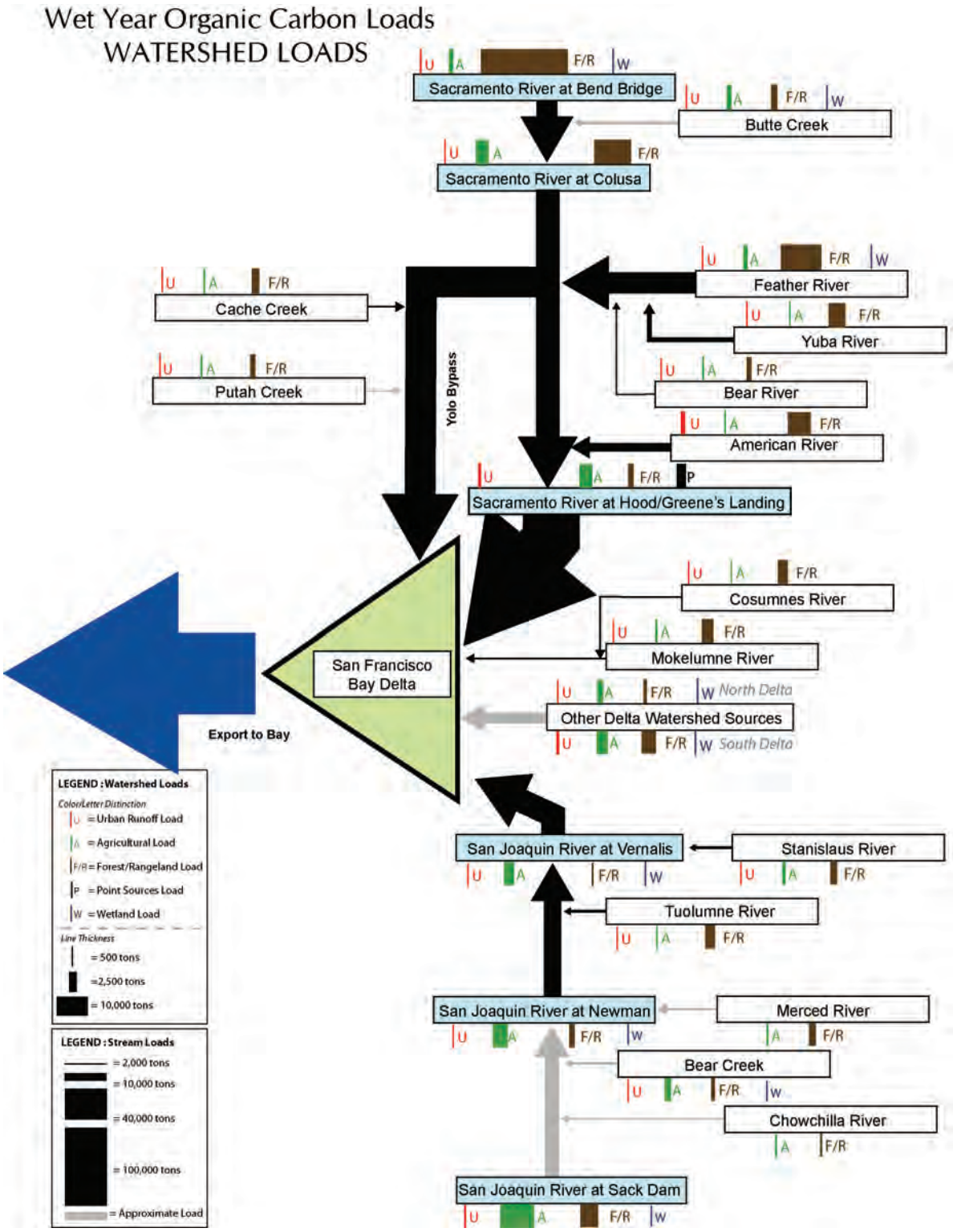

Figure 4-40. Watershed and outflow loads for the Central Valley and Delta for average wet years. This figure and the preceding one use the same linear scales to represent stream loads. Watershed loads are shown with a different scale to show some of the smaller load contributions.

4.6 MAJOR FINDINGS

Flows in Central Valley rivers are highly variable, especially in winter months, even though they are controlled by a large number of reservoirs At most stream sampling locations there are limited concentration data, whereas there are daily flow data, Loads are therefore estimated using monthly average concentration and flow values. At the Sacramento River at Hood/Greene's Landing, where daily flow and concentration data were available, the load estimated by this approach was comparable to loads estimated in previous studies.

Tributary organic carbon loads are substantially greater in the wet season than in the dry season. Tributary loads were found to vary significantly between wet and dry years. Although the organic carbon concentrations in the Sacramento River are lower than the concentrations in the San Joaquin River, the Sacramento River load to the Delta exceeds the San Joaquin River load by a factor of more than two.

It was not possible to calculate export rates for each type of land use present in the Central Valley and Delta. A limited amount of organic carbon data have been collected from watersheds with one particular type of land use. Most of the data available for this analysis were collected at locations that have mixed land uses. Export rates of organic carbon (mass of carbon exported per unit area per year) were estimated for several land uses: urban land, agricultural land, wetlands, and natural areas (including forests, shrubland, and rangeland) based on the limited data. The calculated total watershed exports are comparable to the stream loads at key locations (such as Sacramento River at Hood/Greene's Landing and San Joaquin River at Vernalis). There were considerable differences in the estimated loads derived from the two methods at locations where there were limited organic carbon concentration data. Export rates, as currently approximated, could be improved through focused flow and concentration data collection in small, relatively homogenous watersheds.