Appendix G

Statistical Comparison of Water Flow Rates for San Joaquin Valley Drainages and the San Joaquin 60-20-20 Water Supply Index for 2000 – 2006

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Objective & Hypothesis

The objective of this report is to analyze temporal (year to year and seasonal) trends in water flow for major agricultural drainages in the San Joaquin River (SJR) Watershed and to compare flow trends in agricultural drainages to flow conditions in the San Joaquin River and to the Water Supply Index (WSI) calculated by the California Department of Water Resources (DWR). The WSI for the SJR is a measure of annual water availability in the SJR watershed and is used by DWR to classify water years (wet, dry, normal, etc.) and provides a basis for water management in the region.

The following hypotheses were tested:

1. Year to year trends in summertime flow from drainages dominated by irrigated agriculture do not correspond to WSI.
2. Year to year trends in wintertime flow from drainages dominated by irrigated agriculture will correspond to WSI.
3. Year to year trends in both winter and summer flows in the San Joaquin River mainstem will correspond to WSI.
4. Summertime flows from agricultural drainages would be constant across water years, independent of water year WSI.
5. Water conservation best management practices, including drip irrigation and water recycling, implemented between 2000 and 2006 would be manifest in declining return flows as a function of year in agricultural drains.

Sites used for this study were chosen based upon their location in the San Joaquin basin and the availability of data for 2000 to 2006 (Table 1). The sites consisted of two SJR sites (Vernalis and Crows Landing), one site located east of the SJR (Harding Drain), and five sites located west of the SJR (San Luis Drain, Orestimba Creek, Salt Slough, Mud Slough, and Del Puerto Creek).

Introduction

The water flows in the San Joaquin Basin are dependent on both natural factors such as rainfall and snowmelt, and artificial water manipulations such as water storage, diversions, and irrigation return flows. Just how much of an effect these artificial manipulations have on drainage flow rates has not been studied in-depth. This study investigated the impact of artificial manipulations on flow rate by examining how well the San Joaquin Region 60-20-20 Water Supply Index (WSI) correlates with the flow rates of drainages in the San Joaquin Basin in the winter (when agricultural activities and other artificial manipulations are at a minimum) and in summer (when artificial manipulations are at a maximum).

The WSI is an assessment of water availability and storage conditions in the San Joaquin Basin. The WSI is calculated by combining water supply data from the previous year with the amount of runoff forecast for the rainy season and for the rest of the water year. It is used to analyze undiverted flows so a determination can be made of when and how much water may be available for irrigation and other uses throughout the San Joaquin basin. San Joaquin Valley unimpaired runoff is defined as the sum of unimpaired inflow to New Melones

Reservoir (from the Stanislaus River), Don Pedro Reservoir (from the Tuolumne River), New Exchequer Reservoir (from the Merced River), and Millerton Lake (from the San Joaquin River).

The WSI was developed by the State Water Resources Control Board for the San Joaquin basin to classify types of hydrologic years. This system defines one "wet" classification, two "normal" classifications (above and below normal), and two "dry" classifications (dry and critical), for a total of five water year types, and assigns a numerical indicator to each (Table 2). The SJR 60-20-20 Water Supply Index is computed from these assigned numerical indicators as a weighted average of the current water year's April-July unimpaired runoff forecast (60 percent), the current water year's October-March unimpaired runoff forecast (20 percent), and the previous water year's index (20 percent). The WSI classifications are similar to the San Joaquin Region basin classifications, with a numerical indicator range assigned to each (Table 3). This index has been in use since 1995, and is defined in SWRCB Decision 1641 (http://www.waterrights.ca.gov/baydelta/d1641.htm).

In this report, average daily flow for several San Joaquin Basin drainages for a two month time period from January/February and for a two month time period from July/August are compared with the WSI for the water years 2000 through 2006. A direct correlation between the WSI and the mean water flow for San Joaquin River drainages during January/February is expected since artificial manipulations are minimal at this time of year. However, we expect to see a much lower amount of correlation between the WSI and the mean water flow for San Joaquin River drainages during July/August, depending on how manipulated the flow of the water body is. For example, the San Joaquin River (SJR) should correlate closely with the WSI throughout the year, as its flow rates are dependent upon the amount of water originating in the San Joaquin Basin. However, drainages dependent on agricultural water management activities should not correlate as well with the WSI during July/August, as their flow rates are dependent on return flows from irrigation, and how much of that water subsequently drains back into the SJR.

Approach

Statistical analyses of flow rates were made using data from water years 2000 through 2006, with January-February representing winter flows when the water flow manipulations are minimal, and July-August representing summer flows when agricultural water flow manipulations occur. As shown in Table 3, each water year type is represented over the time period analyzed, with 2 “critical” years, one “dry” year, one “ below normal” year, one “above normal” year, and 2 “wet” years.

Site data were grouped for analysis by water year and by WSI type. Trends in flow by water year were analyzed. Note that each water year begins on October 1 of the previous calendar year (i.e. water year 2000 begins on Oct. 1, 1999) and ends on September 30. A comparison was made between the WSI and the mean flow rates to test the hypothesis that flow was or was not dependent on WSI. The “critical” and “dry” years were placed into a single “dry” category for the analysis, as the WSI of both “critical” years was on the borderline between “critical” and “dry” classifications. Water year data were placed into one of four groups by water year types: dry (2001, 2002, 2004); below average (2003); above average (2000); and wet (2005, 2006).

Analyses for each drainage are divided into separate sections of this report, with the results depicted in 3 tables and 3 figures for each section as described below:

Daily water flow means

Depicts the daily water flow means for water years 2000 – 2006. January/February (representing non-manipulated water flow) and July/August (representing manipulated water flow) time periods are highlighted.

Descriptive statistics

Descriptive statistics including the water flow mean, median, and standard deviation for all drainages are listed by water year for both the January/February and the July/August time periods.

Paired t- test comparisons

To compare average (mean) water flows, two-sample unpaired t-tests (assuming unequal variances) were performed for all drainages, comparing all possible water year/water year type subsets over the same two month period for each site. The hypotheses for these comparisons are:

H_0: Mean water flow rates are not significantly different for different water years/water year types.

H_1: Mean water flow rates are significantly different for different water years/water year types.

The results of all analyses are reported in terms of the probability (P) that H_0 is true. For results where $P \geq 0.05$ (where there is a greater than or equal to 95% probability that H_0 is true), data is shown grouped together with a letter designation (A, B, C, D, or E), with different letters assigned to means that are statistically different. While the letters A, B, C, D, and E are used to designate statistically different water flow means for every analysis, only the same drainages over the same time periods are directly compared, so the same letter designations between different groups do not suggest statistically similar means. Two-tailed P values are used, even when one-tailed P values are available, as the two-tailed P is more conservative.

Seasonal water flow mean and WSI trends

A comparison of the WSI and the mean water flow at each site for January/February and July/August for water years 2000 – 2006 was made by plotting each trendline on the same chart, with a separate linear scale used for the WSI and for the water body flow means. In this way, similarities/differences in the overall trends of both can be seen over the 2000 – 2006 time period. This technique is also useful for comparing overall trends between different sites. A second chart compares only the July/August water flow trend with the WSI trend so similarities/differences between July/August and WSI trends are more obvious.

July/August daily mean flow box plots

A box plot series of July/August daily mean flow data for each site was made, with the data grouped together by water year type. Water year types are plotted from highest to lowest WSI classification, with the leftmost box plot in each series representing the "wet" water year type, the next box plot representing the "above average" water year type, etc. If the data correlate with the WSI, the box plots should also indicate the highest to lowest daily flow means, from left to right. Because January/February site data correlated fairly well with the WSI for most drainages, no box plots were made for this time period.

Other data were also considered for correlation to the water body flow data. The average and the maximum daily air temperatures from water years 2000 – 2006 were analyzed, to see if there were any unusually high or low temperature spikes over the relevant time periods that might correlate with some of the daily mean water flow data. Air temperatures were obtained from the California Irrigation Management Information System (CIMIS) Los Banos station. The amount of water discharged from the Tracy pumping plant into the SJR was also analyzed for correlation to the mean water flow data. The results of these analyses are included as separate sections

Materials and Methods

Data sources

The primary water flow data source was the archive of federal surface water data for the nation maintained by the United States Geological Survey at http://waterdata.usgs.gov/nwis/sw. Quality assured, approved for publication daily mean flow data were used for these sites: SJR near Vernalis (USGS 11303500); SJR near Crows Landing (USGS 11274550); Orestimba Creek at River Road near Crows Landing (USGS 11274538); San Luis Drain Site B near Stevinson (USGS 11262895); Del Puerto Creek near Patterson (USGS 11274630); Salt Slough at Highway 165 near Stevinson (USGS 11261100); and Mud Slough near Gustine (USGS 11262900). Quality assured, approved for publication, daily mean discharge data were used for the Tracy Pumping Plant (USGS 11313000).

SJR Data Atlas daily mean flow data were used for Harding Drain (USGS 11274560), as USGS data was not available for the time periods analyzed. Quality assured, approved for publication daily mean and daily maximum air temperature data were used for Los Banos Weather station #56, California Irrigation Management Information System (CIMIS), Department of Water Resources, Office of Water Use Efficiency (http://www.cimis.water.ca.gov/cimis/welcome.jsp)

Statistical analyses

Data were analyzed using either Excel 2004 (Microsoft Corp.) or JMP 7 software (SAS Institute, Cary, NC). Flow rates for water years 2000 – 2006 were analyzed, with January-February representing the time period when the artificial water flow rate manipulations are minimal, and July-August representing the time period when agricultural water flow rate manipulations are frequent. To compare average (mean) water flows, two-sample unpaired t-tests (assuming unequal variances) were performed for all drainages, comparing all possible two year subsets over the same two month period for each site. The hypothesis tested in these comparisons is:

H_0: Mean water flow rates are not significantly different for different water years/water year types.

H_1: Mean water flow rates are significantly different for different water years/water year types.

The results of all analyses are reported in terms of the probability (P) that H_0 is true. For results where $P \geq 0.05$ (where there is a greater than or equal to 5% probability that H_0 is true), data is shown grouped together with a letter designation (A, B, C, D, or E), with different letters assigned to means that are statistically different. While the letters A, B, C, D, and E are used to designate statistically different water flow means for each analysis, only the same drainages over the same time periods are directly compared, so the same letter designations between different groups do not suggest statistically similar means. Two-tailed P values are used, even when one-tailed P values are available, as the two-tailed P is more conservative.

Average water flow mean charts for each water year, and site vs. WSI trendline charts were generated using Excel. Box plots of water year type for each site were generated using JMP 7 software.

Results

An analysis of the correspondence between WSI year type and seasonal flow from the flow monitoring locations (listed in Table 1) is presented in Table 4. In January/February, flow at all sites except Harding drain correlate well with water year type. In July/August, SJR at Vernalis, SJR at Crows Landing, and Mud Slough correlate with WSI year type, while Harding Drain, San Luis Drain, Orestimba Creek, and Salt Slough do not correlate with WSI year type. Del Puerto Creek correlates with the WSI in July/August, but as it has little to no water flow during that time of year.

Figure 1 shows the two general trends seen in July/August water body average flow rates, and how they compare to the WSI trend over the same 2000-2006 period. SJR at Vernalis has an upward trend from 2000-2006, and correlates quite well with the WSI trend. Other sites with this overall upward trend include SJR at Crows Landing and Mud Slough. Orestimba Creek has a general downward trend from 2000-2006, and flow is following the WSI trend. Other sites with an overall downward trend in July/August include Harding Drain, San Luis Drain and Salt Slough. Del Puerto Creek had little to no flow for the July/August time period.

Figure 2A shows a site (SJR at Vernalis) where the July/August average daily flow data, grouped by water year type, correlate with the WSI. Other sites that correlate with the WSI during July/August include SJR at Crows Landing, and, to a lesser extent, Mud Slough. Figure 2B shows a site (Orestimba Creek) where the July/August average daily flow data, grouped by water year type, do not correlate with the WSI. Other sites that do not correlate with the WSI during July/August include Harding Drain, San Luis Drain, and to a lesser extent, Salt Slough. Del Puerto Creek had little to no flow for the July/August time period.

Conclusions

A statistical comparison of daily flow means for various San Joaquin basin drainages with the WSI suggests that differences exist for some drainages when water flow is heavily manipulated, compared to when less artificial manipulation occurs. For drainages with comparable trends there may be implications for water quality as well. Future work should include determining if sites that have similar water flow patterns (whether similar to the WSI or not) also share similarities in water quality indicators. Some conclusions can be made based on the analyses in this report, including:

1. The average flow rates for the SJR sites (Vernalis and Crows Landing) correlated well with the WSI during both January/February and July/August. This is consistent with the SJR water flow being primarily dependent on the amount of water available in the SJR basin, and not severely affected by local agricultural manipulations.
2. For all other drainages except for San Luis Drain and Harding Drain (discussed below), the two or three highest water flow means were from “wet” or “above normal” years (2000, 2005, 2006) for January/February. For San Luis Drain (which had no data for 2006), the highest water flow mean was also from a “wet” year (2005). Since little agricultural irrigation/drainage and plenty of rainfall occurs during this time of year, this suggests that San Joaquin River tributary flow rates correlate well with the WSI in the absence of artificial water manipulations. One interesting similarity was seen between Orestimba Creek, Mud Slough, and San Luis Drain. The top three flow means for these sites from highest to lowest were: 2005; 2000; 2006; with no statistically significant difference between 2000 and 2006.
3. Harding Drain January/February flow data show no correlation with the WSI. The Harding Drain site is location on the eastern side of the San Joaquin River – all other sites are either on the SJR or west of the SJR – such that it is subject to different flow inputs than the other sites.
4. Two distinct trends are found in the July/August flow rate data:
    a. A general upward trend from 2000 to 2006, which correlates quite well with the WSI trend over the same time period. Sites showing an upward trend include both SJR sites (Vernalis and Crows Landing), and to a lesser extent, Mud Slough. While Del Puerto Creek has a definite upward trend it also has little to no flow during this time of year.
    b. A general downward trend from 2000 to 2006, which does not correlate with the WSI trend over the same time period. Sites showing a downward trend include Orestimba Creek, Harding Drain, San Luis Drain, and to a lesser extent, Salt Slough. There is considerable similarity in the flow rate trends of the first three sites, with 2000 (above normal) having a flow mean significantly higher than all other years analyzed, and 2005/2006 (wet) having a combined flow mean similar to or lower than all other year types. Similar to the other sites, Salt Slough’s highest flow mean is from water year 2000 (above normal). However, unlike the other sites, Salt Slough’s 2005 and 2006

flow means are also significantly higher than the “dry” and “below normal” years.

5. While Mud Slough and Salt Slough were grouped as described in conclusion 4, based on the general upward/downward trend of their July/August flow data from 2000-2006, neither showed the same degree of correlation with the WSI as other sites in the respective groups. Unlike the other sites in the upward trend group, July/August data for Mud Slough showed little correlation with the WSI except for 2006 (wet), which had the highest average flow and was responsible for the general upward trend of the flow data. Unlike the other sites in the downward trend group, July/August data for Salt Slough correlated fairly well with the WSI except for 2000 (above normal), which had the highest average flow and was responsible for the general downward trend of the flow data.
6. Air temperature data were evaluated for potential correlation with water flow rates. While fluctuations were seen, the overall air temperature averages for 2000-2006 for both January/February and July/August were less than 5˚F apart. No correlation was seen between higher/lower temperature averages and changes in water flow.
7. The amount of water discharged from the Tracy Pumping Plant into the SJR was considered for correlation to the water flow data. For January/February, mean discharge data showed no correlation with the WSI or with any water body flow data (which except for Harding Drain, do correlate with the WSI). For July/August, some correlation with the WSI was seen. However, since there was little variability in the discharge averages in July/August for all water years (the highest was 4396 cfs; the lowest was 4133 cfs), this is unlikely to account for either of the trends discussed in conclusion 4. This lack of a correlation in July/August between Tracy Pumping Plant discharge and water flow rate trends suggests that the year-to-year changes seen are due to more localized water management activities.

Table 1: Sites used for this study.

Full USGS Site Name (site name in report)	USGS Site No.	Location
San Joaquin River near Vernalis (Vernalis)	11303500	Lat. 37°40'34" Long. 121°15'55"
San Joaquin River near Crows Landing (Crows Landing)	11274550	Lat. 37°25'55" Long. 121°00'46"
Harding Drain at Carpenter Rd. near Patterson (Harding Drain)	11274560	Lat. 37°27'52" Long. 121°01'52"
San Luis Drain Site B near Stevinson (San Luis Drain)	11262895	Lat. 37°14'27" Long. 120°52'37"
Orestimba Creek at River Rd. near Crows Landing (Orestimba Creek)	11274538	Lat. 37°24'49" Long. 121°00'54"
Salt Slough at Hwy. 165 near Stevinson (Salt Slough)	11261100	Lat. 37°14'52" Long. 120°51'04"
Mud Slough near Gustine (Mud Slough)	11262900	Lat. 37°15'45" Long. 120°54'20"
Del Puerto Creek near Patterson (Del Puerto Creek)	11274630	Lat. 37°29'12" Long. 121°12'29"
Delta Mendota Canal at Tracy Pumping Plant (Tracy Pumping Plant)	11313000	Lat. 37°47'49" Long. 121°35'03"
CIMIS Weather Station at Los Banos (Los Banos)	Station #56	Lat. 37°05'36" Long. 120°45'39"

Table 2: Hydrologic classifications (taken from the State of California State Water Resources Control Board Decision 1641).

San Joaquin Region Basin Classification	Indicator
Wet	5
Above Normal	4
Below Normal	3
Dry	2
Critical	1

Table 3: WSI Classification for water years 2000 – 2006.

	San Joaquin Region 60-20-20	
Water Year	**Water Supply Index**	**Classification**
2000	3.38	Above Normal (> 3.1; < 3.8)
2001	2.2	Critical (≤ 2.1)
2002	2.34	Dry (> 2.1; ≤ 2.5)
2003	2.81	Below Normal (> 2.5; ≤ 3.1)
2004	2.21	Critical (≤ 2.1)
2005	4.75	Wet (≥ 3.8)
2006	5.9	Wet (≥ 3.8)

Table 4: Statistical analysis of the daily average water flow of all sites for 2000 – 2006, student t-test comparison of all pairs of water year types. Statistically similar means for each time period are grouped by letter designation.

Site Name	Year(s)	WSI Classification	January/ February	July/ August
San Joaquin River near Vernalis	2005, 2006	Wet	A	A
	2000	Above Normal	B	B
	2003	Below Normal	C	C
	2001, 2002, 2004	Dry/Critical	C	C
San Joaquin River near Crows Landing	2005, 2006	Wet	A	A
	2000	Above Normal	B	B
	2003	Below Normal	C	C
	2001, 2002, 2004	Dry/Critical	C	C
Harding Drain at Carpenter Rd. near Patterson	2005, 2006	Wet	C	D
	2000	Above Normal	A	A
	2003	Below Normal	B	B
	2004	Dry/Critical	B	C
San Luis Drain Site B near Stevinson	2005	Wet	A	C
	2000	Above Normal	B	A
	2003	Below Normal	B	B
	2001, 2002, 2004	Dry/Critical	B	B
Orestimba Creek at River Rd. near Crows Landing	2005, 2006	Wet	A	C
	2000	Above Normal	A	A
	2003	Below Normal	B	B
	2001, 2002, 2004	Dry/Critical	B	C
Salt Slough at Hwy. 165 near Stevinson	2005, 2006	Wet	A	B
	2000	Above Normal	B	A
	2003	Below Normal	B	C
	2001, 2002, 2004	Dry/Critical	B	C
Mud Slough near Gustine	2005, 2006	Wet	A	A
	2000	Above Normal	B	C
	2003	Below Normal	C	C
	2001, 2002, 2004	Dry/Critical	C	B
Del Puerto Creek near Patterson	2005, 2006	Wet	A	A
	2000	Above Normal	A	B
	2003	Below Normal	B	B
	2001, 2002, 2004	Dry/Critical	B	B

Figure 1: Water flow trends by water year (2000-2006) for SJR sites and the WSI.

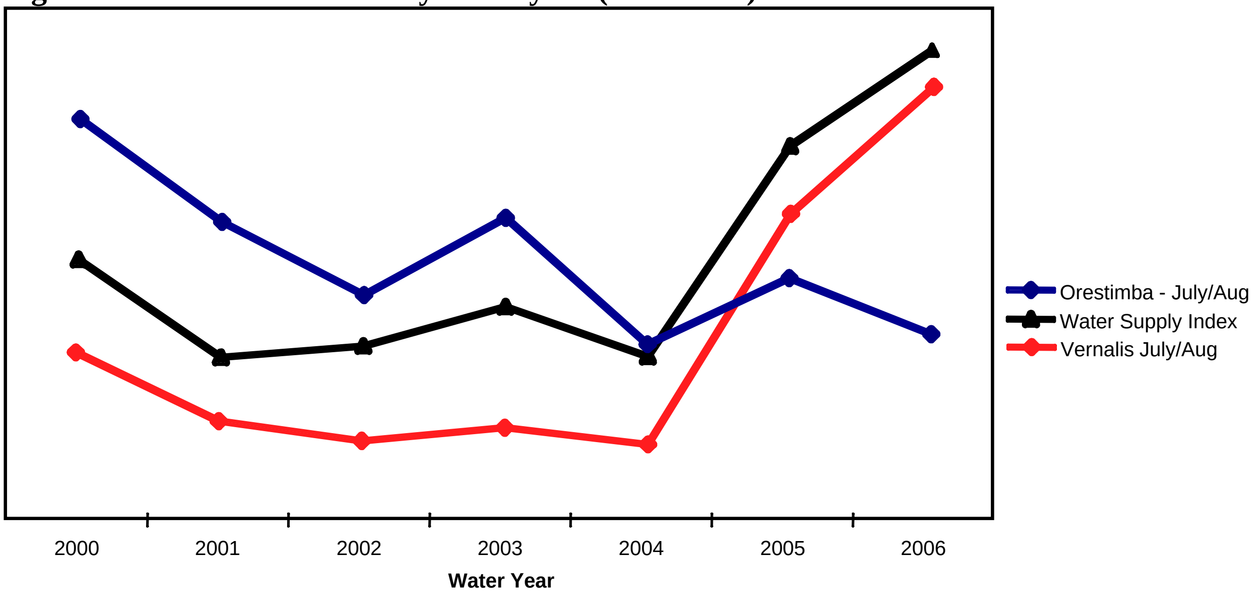
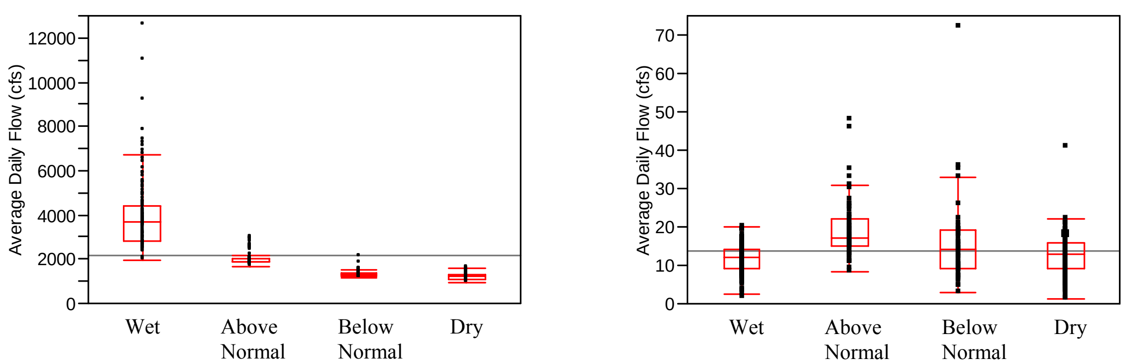


Figure 2: Relationship between water year type and July/August flow at two representative sites.

A. San Joaquin River at Vernalis July/August

B. Orestimba Creek at River Road Near Crows Landing July/August



Analyses 1 - 10

Results from the Statistical Comparison of Water Flow Rates for San Joaquin Valley Drainages and the San Joaquin Region 60-20-20 Water Supply Index for 2000 – 2006

Analysis 1: San Joaquin River near Vernalis

Data analysis by water year:

Figure 1-1: San Joaquin River near Vernalis average daily flow for water years 2000 – 2006. January/February and July/August, the months for which flow was analyzed for this study, are highlighted.

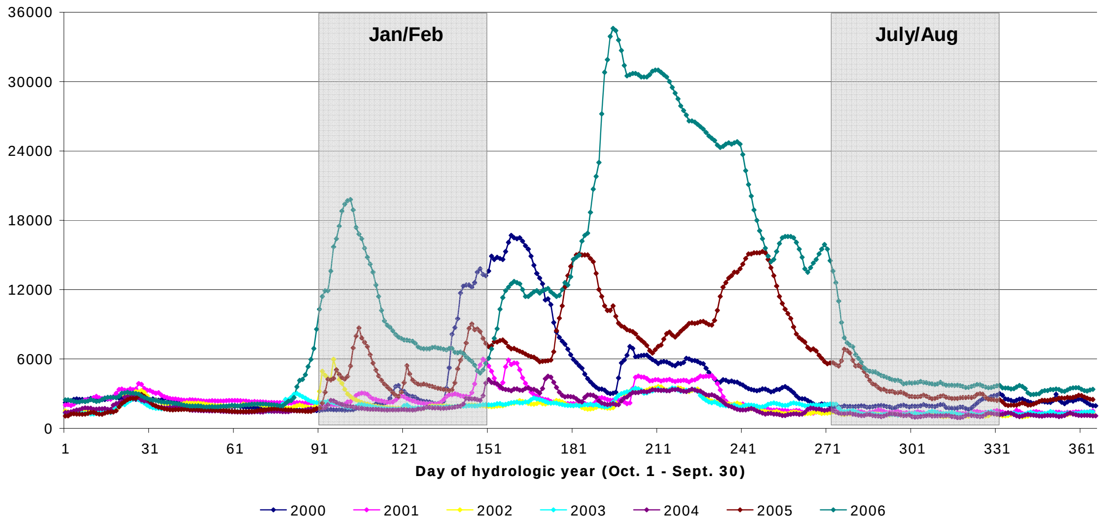


Table 1-1: San Joaquin River near Vernalis flow descriptive statistics.

Water Year	Water year classification	January / February			July / August		
		Average	Median	Std. dev.	Average	Median	Std. dev.
2000	Above Normal	4757.00	2335	4451.97	2034.52	1910	329.67
2001	Critical	2750.34	2470	928.41	1364.84	1360	87.87
2002	Dry	2298.98	1940	937.59	1171.94	1170	88.61
2003	Below Normal	1896.78	1880	152.58	1300.65	1270	157.47
2004	Critical	1989.83	1785	568.70	1135.95	1110	107.56
2005	Wet	5100.85	4320	1859.44	3385.48	2795	1232.60
2006	Wet	9985.08	7620	4587.43	4621.94	3925	1783.17

Table 1-2: Statistical analysis of San Joaquin River near Vernalis flow averages, student's t-test comparison of all pairs of water years. Statistically similar averages for each time period are grouped by letter designation.

Table 1-2A: January-February

Year				Average	Classification
2006	A			9985.08	Wet
2005		B		5100.85	Wet
2000		B		4757.00	Above Normal
2001			C	2750.34	Critical
2002			C	2298.98	Dry
2004			C	1989.83	Critical
2003			C	1896.78	Below Normal

Table 1-2B: July-August

Year					Average	Classification
2006	A				4621.94	Wet
2005		B			3385.48	Wet
2000			C		2034.52	Above Normal
2001				D	1364.84	Critical
2003				D	1300.65	Below Normal
2002				D	1171.94	Dry
2004				D	1135.95	Critical

Figure 1-2A: Trendlines for the WSI (black), and for San Joaquin River near Vernalis average yearly flow for January/February (pink) and July/August (blue), by water year.

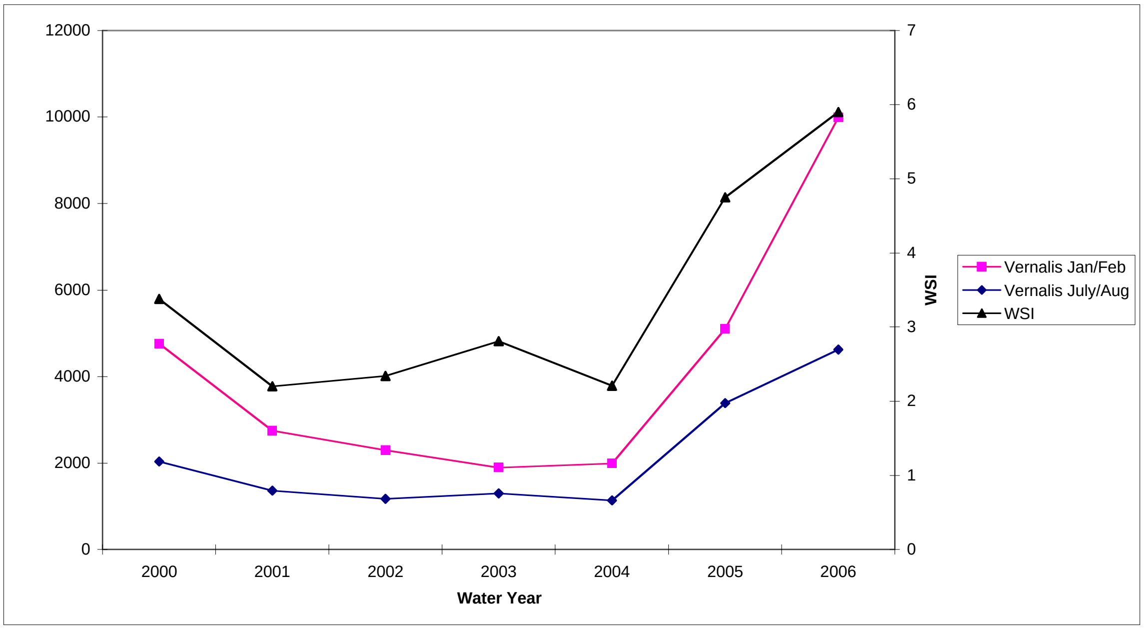
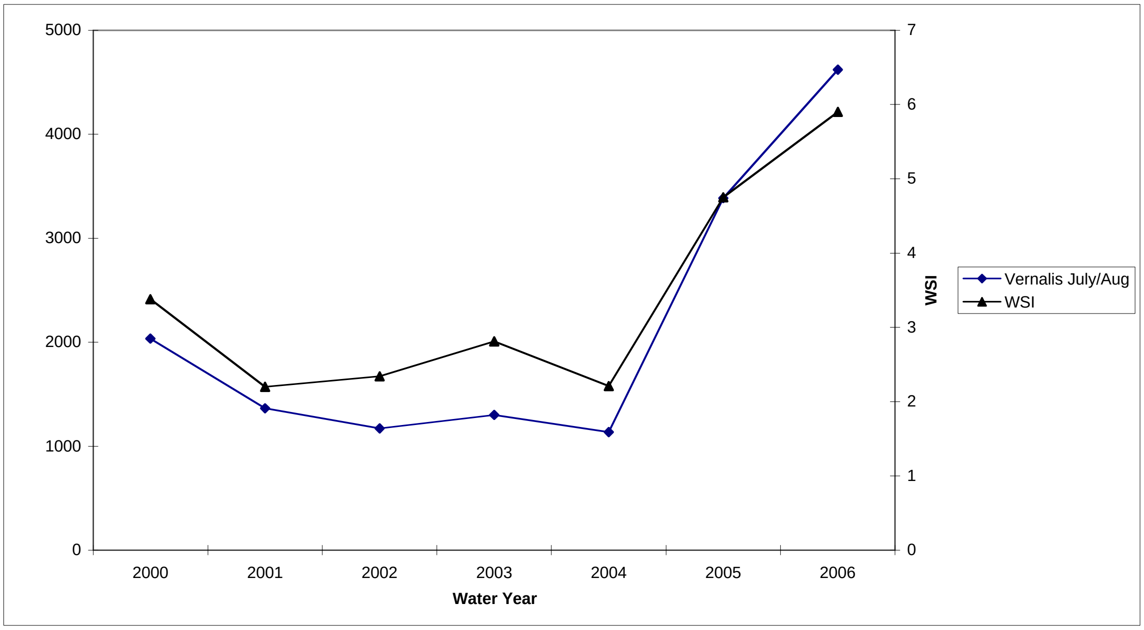


Figure 1-2B: Trendlines for the WSI (black), and for San Joaquin River near Vernalis average yearly flow for July/August (blue), by water year.



Data analysis by water year type:

Table 1-3: Statistical analysis of Vernalis flow averages for 2000 – 2006, student's t-test comparison of all pairs of water year types. Statistically similar averages for each time period are grouped by letter designation.

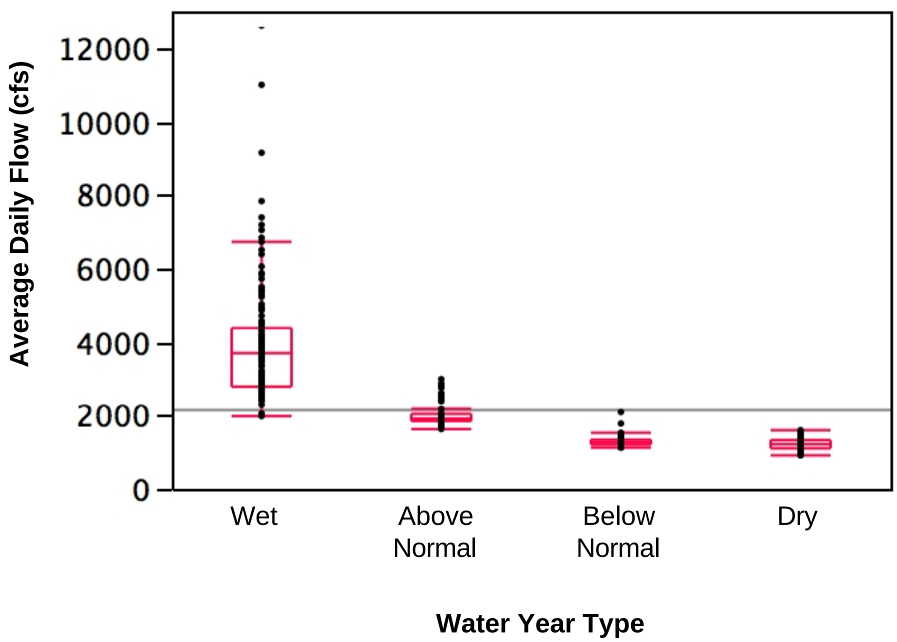
Table 1-3A: January-February

Classification				Average
Wet	A			7542.97
Above Normal		B		4757.00
Dry			C	2344.38
Below Normal			C	1896.78

Table 1-3B: July-August

Classification				Average
Wet	A			4003.71
Above Normal		B		2034.52
Below Normal			C	1300.65
Dry			C	1224.24

Figure 1-3: Box plots of San Joaquin River near Vernalis daily flow averages in July/August for 2000 – 2006 by water year type.



Data was analyzed for all water years for San Joaquin River near Vernalis. Average water flow rates correlate well with the WSI for both January/February and July/August (Figures 1-2 & 1-3). As both Table 1-2 and Table 1-3 show, statistically significant differences are seen between wet and dry water year flow rates. "Wet" and "above normal" water flow rates (2000, 2005, and 2006) are significantly higher than "below normal", "dry", and "critical" year water flow rates (2001, 2002, 2003, and 2004). This is an expected result for the San Joaquin River, which is dependent on the amount of water originating in the San Joaquin basin.

Analysis 2: San Joaquin River at Crows Landing

Data analysis by water year:

Figure 2-1: San Joaquin River at Crows Landing average daily flow for water years 2000 – 2006. January/February and July/August, the months for which flow was analyzed for this study, are highlighted.

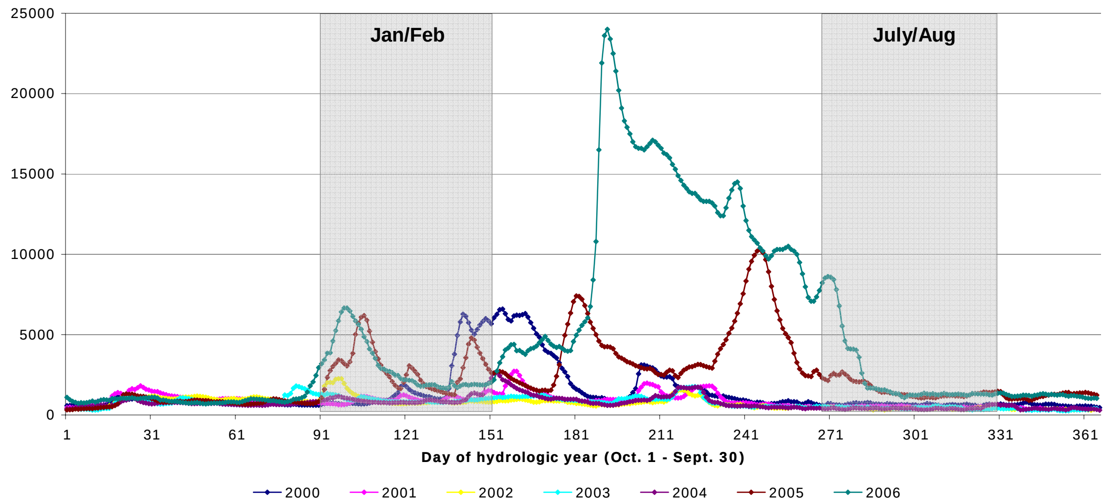


Table 2-1: San Joaquin River at Crows Landing flow descriptive statistics.

Water Year	Water year classification	January / February Average	Median	Std. dev.	July / August Average	Median	Std. dev.
2000	Above Normal	2191.68	1120	2019.63	653.87	645	50.44
2001	Critical	989.71	963	199.16	510.35	516.5	42.01
2002	Dry	1010.22	812	448.95	410.63	416	44.87
2003	Below Normal	938.42	904	142.32	440.95	445.5	63.03
2004	Critical	1000.80	863.5	369.58	440.00	409.5	91.47
2005	Wet	2996.61	2850	1296.23	1449.98	1325	418.36
2006	Wet	3019.66	2160	1595.56	1789.19	1320	1172.74

Table 2-2: Statistical analysis of San Joaquin River at Crows Landing flow averages, student's t-test comparison of all pairs of water years. Statistically similar averages for each time period are grouped by letter designation.

Table 2-2A: January-February

Year				Average	Classification
2006	A			3019.66	Wet
2005	A			2996.61	Wet
2000		B		2191.68	Above Normal
2002			C	1010.22	Dry
2004			C	1000.80	Critical
2001			C	989.71	Critical
2003			C	938.42	Below Normal

Table 2-2B: July-August

Year					Average	Classification
2006	A				1789.19	Wet
2005		B			1449.98	Wet
2000			C		653.87	Above Normal
2001			C	D	510.35	Critical
2003				D	440.95	Below Normal
2004				D	440.00	Critical
2002				D	410.63	Dry

Figure 2-2A: Trendlines for the WSI (black), and for San Joaquin River at Crows Landing average yearly flow for January/February (pink) and July/August (blue), by water year.

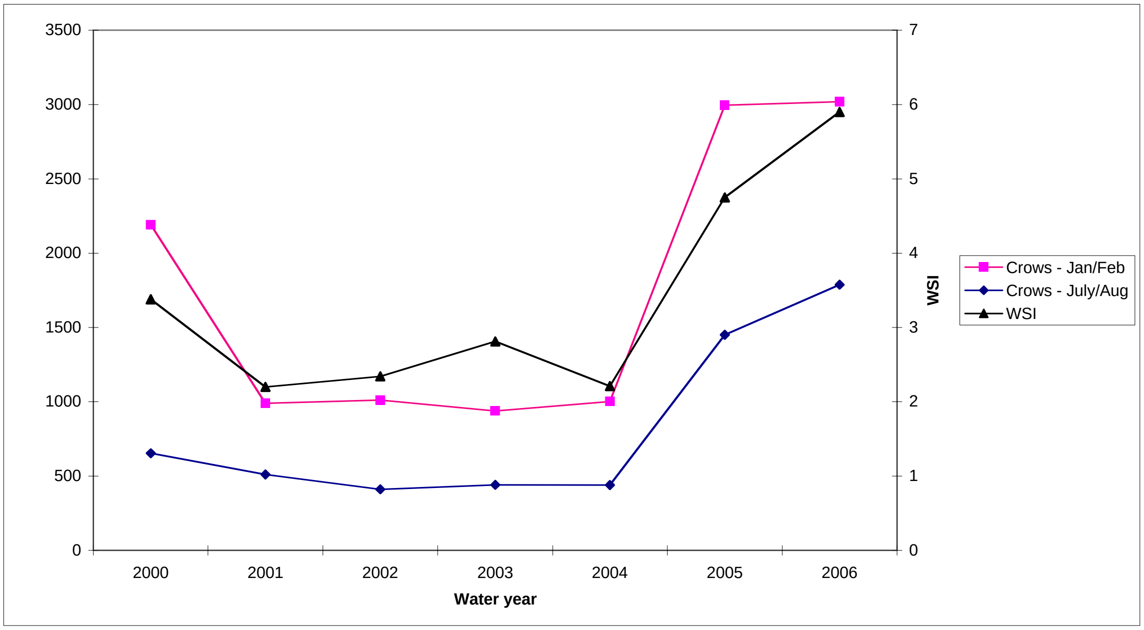
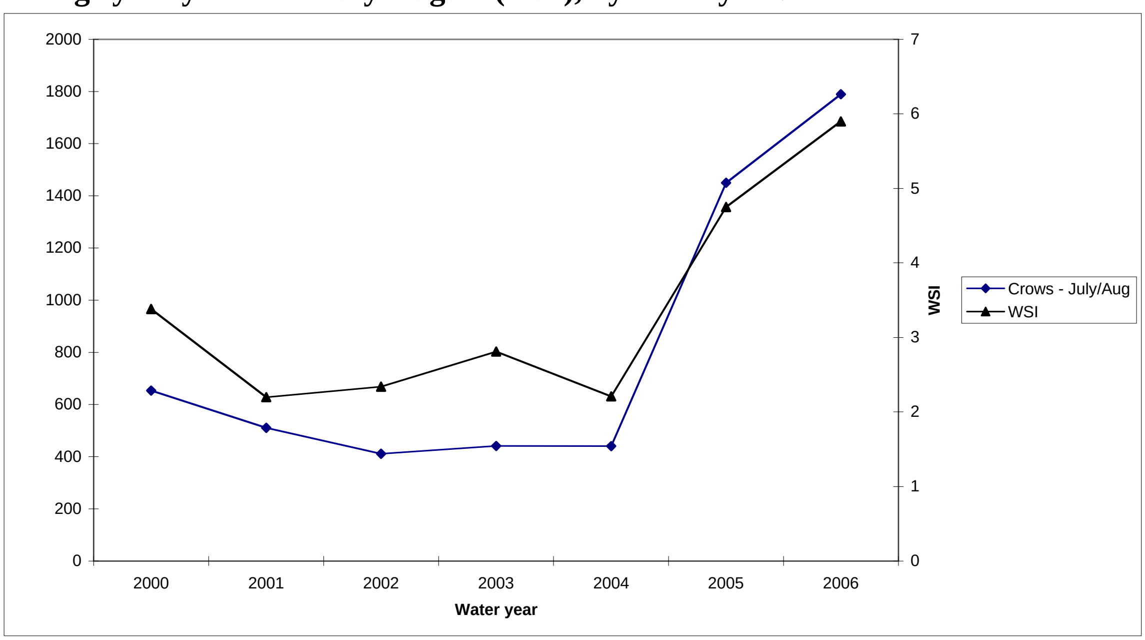


Figure 2-2B: Trendlines for the WSI (black), and for San Joaquin River at Crows Landing average yearly flow for July/August (blue), by water year.



Data analysis by water year type:

Table 2-3: Statistical analysis of San Joaquin River at Crows Landing flow averages for 2000 – 2006, student's t-test comparison of all pairs of water year types. Statistically similar averages for each time period are grouped by letter designation.

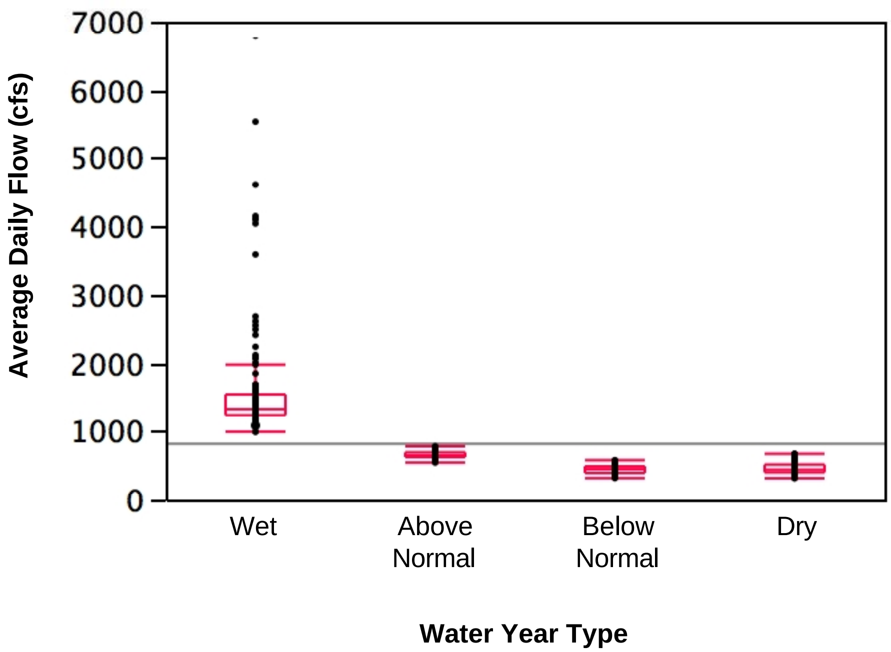
Table 2-3A: January-February

Classification				Average
Wet	A			3008.14
Above Normal		B		2191.68
Dry			C	1000.25
Below Normal			C	938.42

Table 2-3B: July-August

Classification				Average
Wet	A			1619.59
Above Normal		B		653.87
Dry			C	453.66
Below Normal			C	440.95

Figure 2-3: Box plots of San Joaquin River at Crows Landing daily flow averages in July/August for 2000 – 2006 by water year type.



Data was analyzed for all water years for San Joaquin River at Crows Landing. Average water flow rates correlate well with the WSI for both January/February and July/August (Figures 2- 2 & 2-3). As both Table 2-2 and Table 2-3 show, statistically significant differences are seen between wet and dry water year flow rates. "Wet" and "above normal" water flow rates (2000, 2005, and 2006) are significantly higher than "below normal", "dry", and "critical" year water flow rates (2001, 2002, 2003, and 2004), with one exception – there is no significant difference between July/August 2000 (above normal) and 2001 (critical). This is an expected result for the San Joaquin River, which is dependent on the amount of water originating in the San Joaquin basin.

Analysis 3: Harding Drain at Carpenter Road near Patterson

Data analysis by water year:

Figure 3-1: Harding Drain average daily flow for water years 2000 – 2006. January/February and July/August, the months for which flow was analyzed for this study, are highlighted.

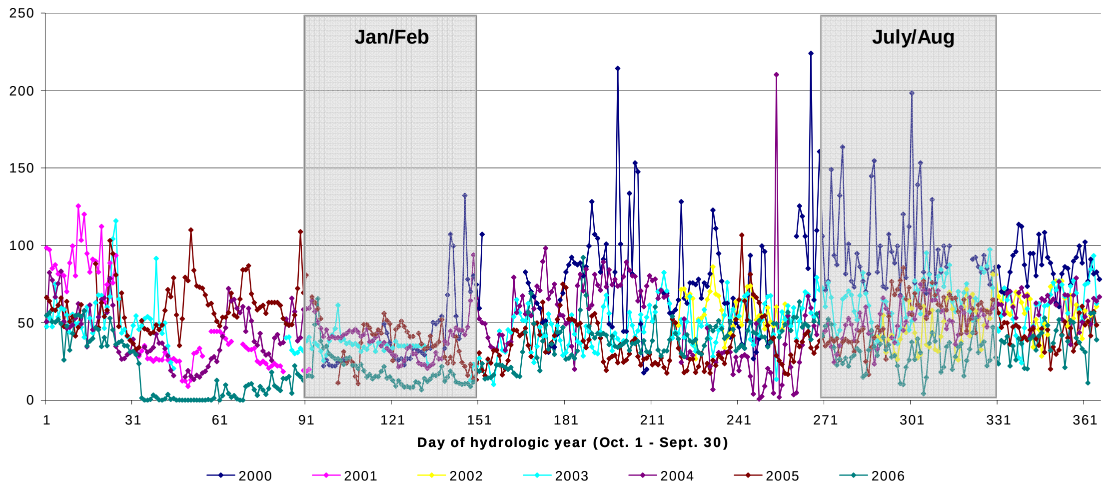


Table 3-1: Harding Drain flow descriptive statistics.

Water Year	Water year classification	January / February			July / August		
		Average	Median	Std. dev.	Average	Median	Std. dev.
2000	Above Normal	46.17	33.46	26.96	95.28	86.21	27.23
2002	Dry				49.05	48.25	15.33
2003	Below Normal	34.38	35.00	6.94	63.74	64.98	15.00
2004	Critical	39.77	40.48	12.75	53.45	55.21	11.04
2005	Wet	36.46	37.04	13.68	53.53	56.44	14.91
2006	Wet	18.62	15.45	10.36	29.99	29.83	10.18

Table 3-2: Statistical analysis of Harding Drain flow averages, student's t-test comparison of all pairs of water years. Statistically similar averages for each time period are grouped by letter designation.

Table 3-2A: January-February

Year				Average	Classification
2000	A			46.17	Above Normal
2004		B		39.77	Critical
2005		B		36.46	Wet
2003		B		34.38	Below Normal
2006			C	18.62	Wet

Table 3-2B: July-August

Year					Average	Classification
2000	A				95.28	Above Normal
2003		B			63.74	Below Normal
2005			C		53.53	Wet
2004			C		53.45	Critical
2002			C		49.05	Dry
2006				D	29.99	Wet

Figure 3-2A: Trendlines for the WSI (black), and for Harding Drain average yearly flow for January/February (pink) and July/August (blue), by water year.

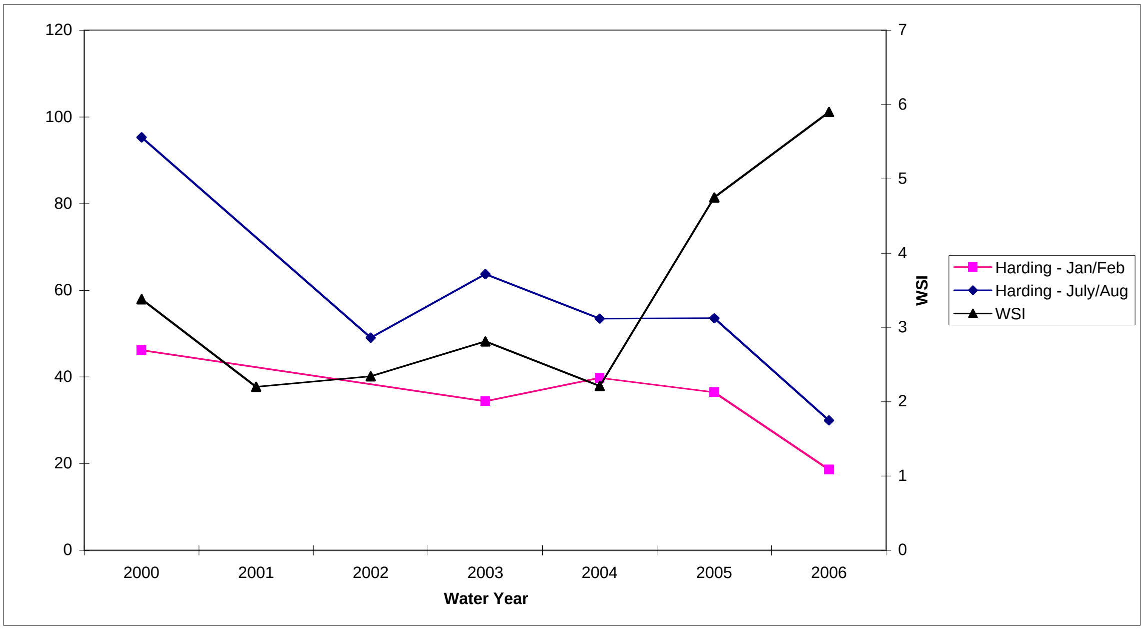
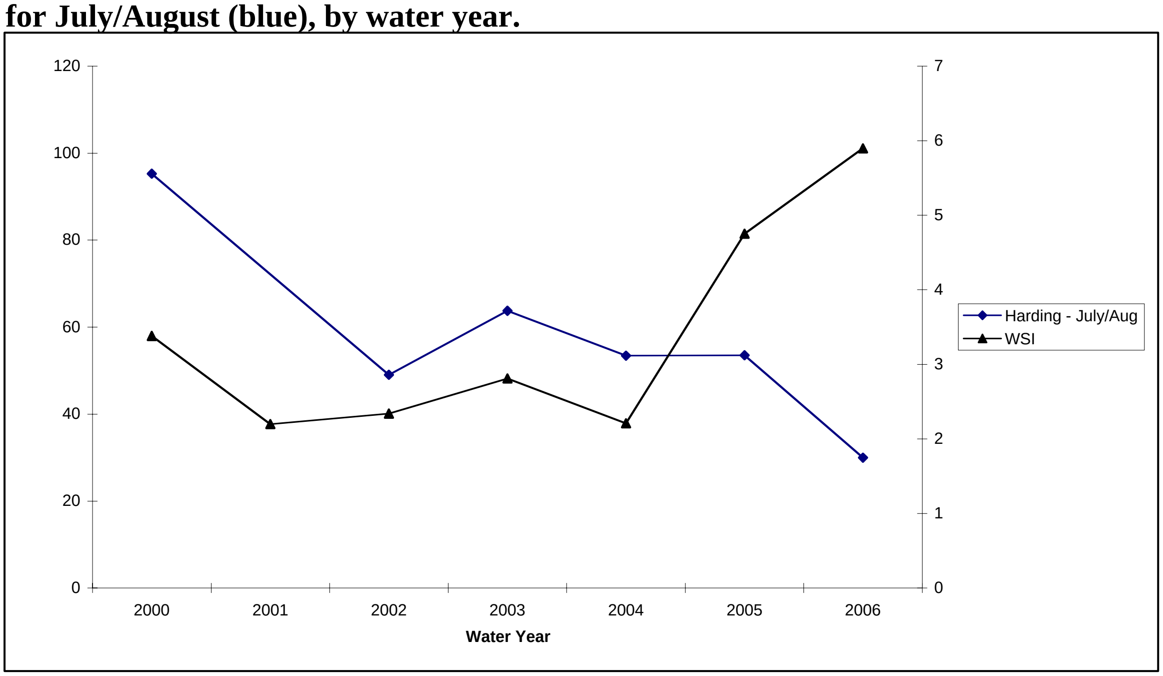


Figure 3-2B: Trendlines for the WSI (black), and for Harding Drain average yearly flow for July/August (blue), by water year.



Data analysis by water year type:

Table 3-3: Statistical analysis of Harding Drain flow averages for 2000 – 2006, student's t-test comparison of all pairs of water year types. Statistically similar averages for each time period are grouped by letter designation.

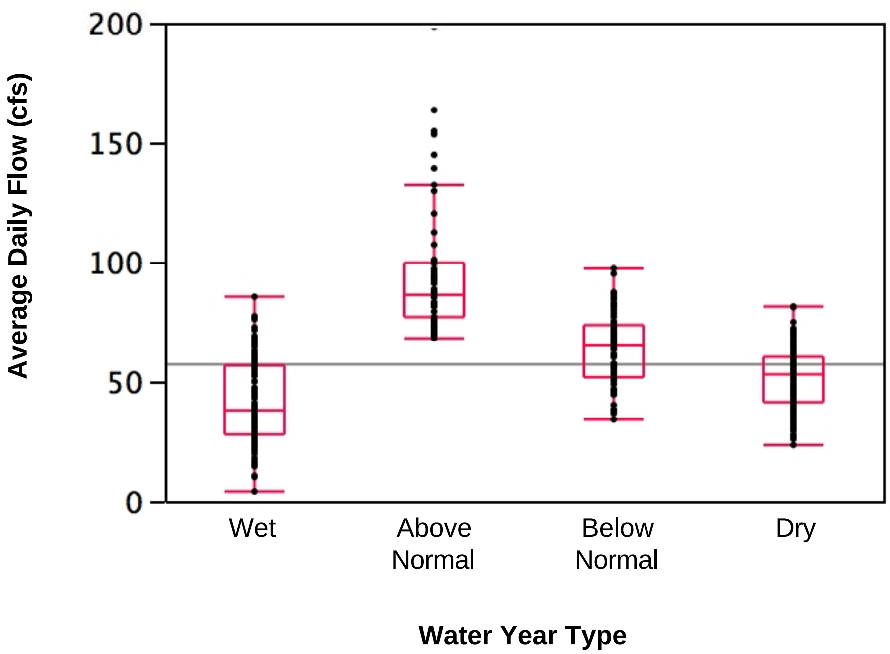
Table 3-3A: January-February

Classification				Average
Above Normal	A			46.17
Dry		B		39.77
Below Normal		B		34.38
Wet			C	27.06

Table 3-3B: July-August

Classification					Average
Above Normal	A				95.28
Below Normal		B			63.74
Dry			C		51.55
Wet				D	41.76

Figure 3-3: Box plots of Harding Drain daily flow averages in July/August for 2000 – 2006 by water year type.



Flow data were incomplete for Harding drain for water years 2001 and 2002, so only July/August 2002 was included in the analysis. Flow data for all other water years was analyzed. No correlation between the WSI and flow rate is seen for Harding drain for either January/February or July/August (Figures 3-2 & 3-3). As both Table 3-2 and Table 3-3 show, statistically significant differences are seen between different water year flow rates, but there is no correlation with water year type. Note that in July/August, 2000 has the highest average flow, while the average flow of the "wet" years (2005/2006) was either similar to or less than "dry" and "critical" years (Table 3-2).

Analysis 4: San Luis Drain near Stevinson

Data analysis by water year:

Figure 4-1: San Luis Drain average daily flow for water years 2000 – 2005. January/February and July/August, the months for which flow was analyzed for this study, are highlighted.

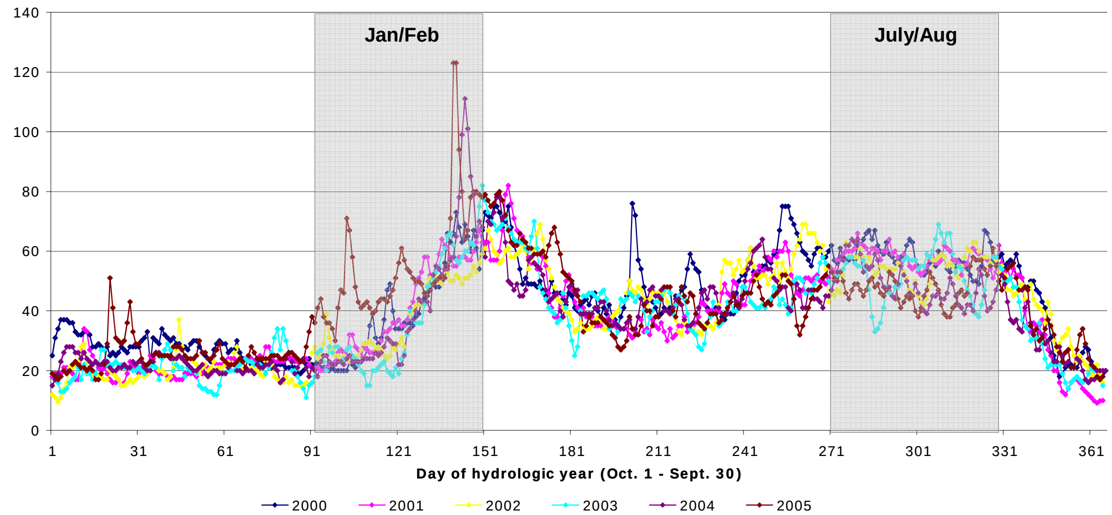


Table 4-1: San Luis Drain flow descriptive statistics.

Water Year	Water year classification	January / February			July / August		
		Average	Median	Std. dev.	Average	Median	Std. dev.
2000	Above Normal	41.23	37.5	17.40	57.97	57	4.29
2001	Critical	41.24	36	15.35	56.89	57	3.48
2002	Dry	37.59	31	12.09	54.23	55	5.11
2003	Below Normal	38.03	28	18.85	52.26	54	7.99
2004	Critical	41.68	30.5	22.88	47.87	46	7.30
2005	Wet	55.34	50	19.06	48.21	47	5.48

Table 4-2: Statistical analysis of San Luis Drain flow averages, student's t-test comparison of all pairs of water years. Statistically similar averages for each time period are grouped by letter designation.

Table 4-2A: January-February

Year			Average	Classification
2005	A		55.34	Wet
2004		B	41.68	Critical
2001		B	41.24	Critical
2000		B	41.23	Above Normal
2003		B	38.03	Below Normal
2002		B	37.59	Dry

Table 4-2B: July-August

Year				Average	Classification
2000	A			57.97	Above Normal
2001	A			56.89	Critical
2002		B		54.23	Dry
2003		B		52.26	Below Normal
2005			C	48.21	Wet
2004			C	47.87	Critical

Figure 4-2A: Trendlines for the WSI (black), and for San Luis Drain average yearly flow for January/February (pink) and July/August (blue), by water year.

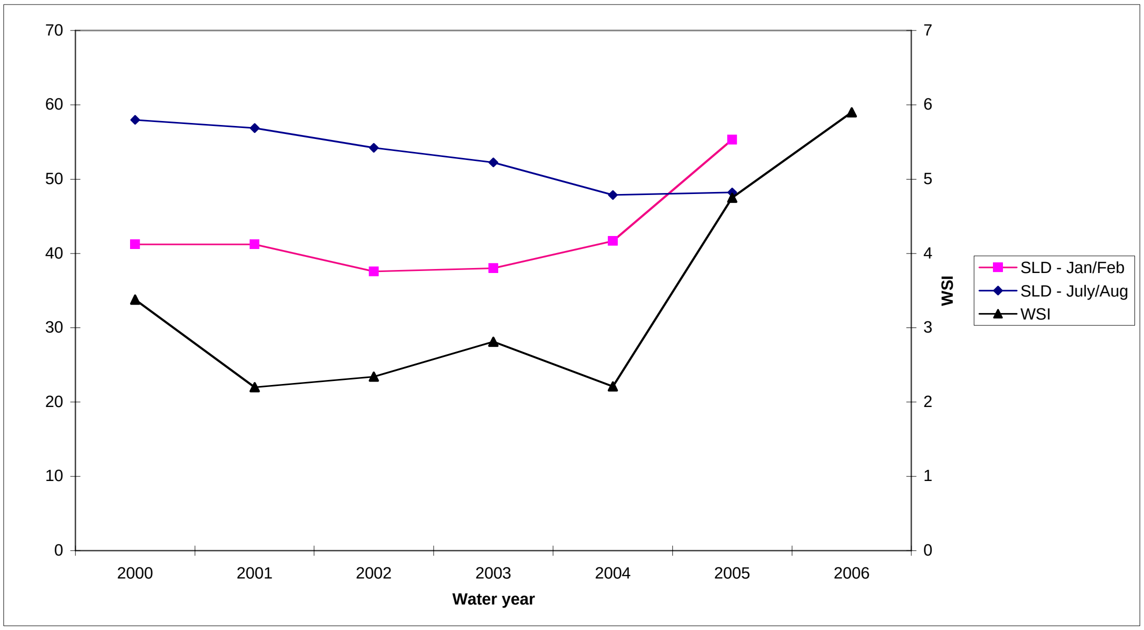
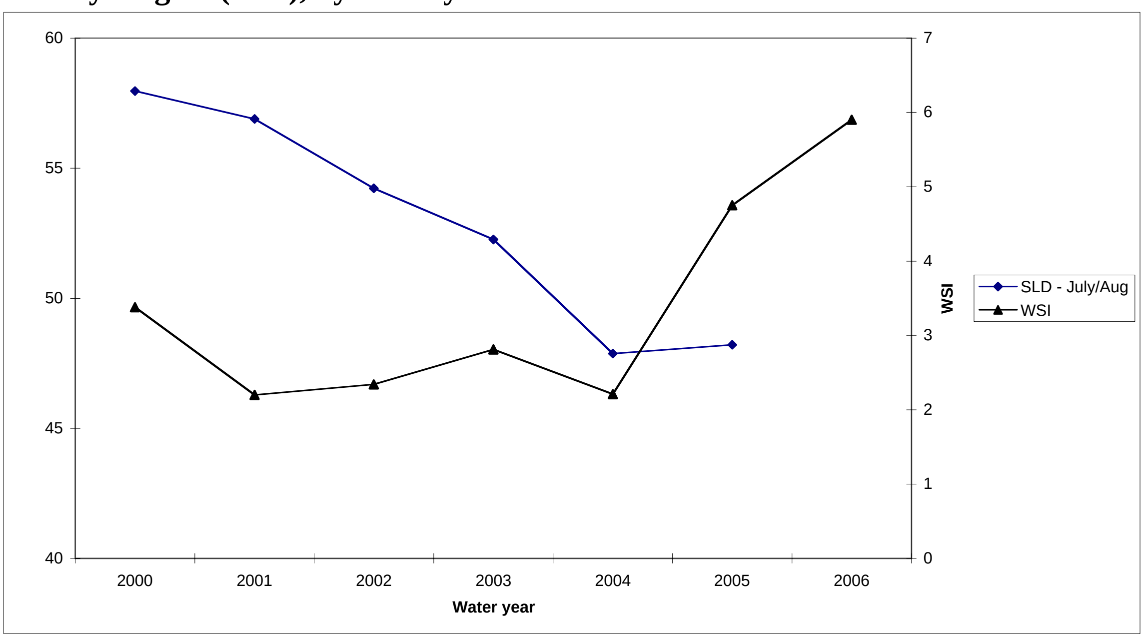


Figure 4-2B: Trendlines for the WSI (black), and for San Luis Drain average yearly flow for July/August (blue), by water year.



Data analysis by water year type:

Table 4-3: Statistical analysis of San Luis Drain flow averages for 2000 – 2005, student's t-test comparison of all pairs of water year types. Statistically similar averages for each time period are grouped by letter designation.

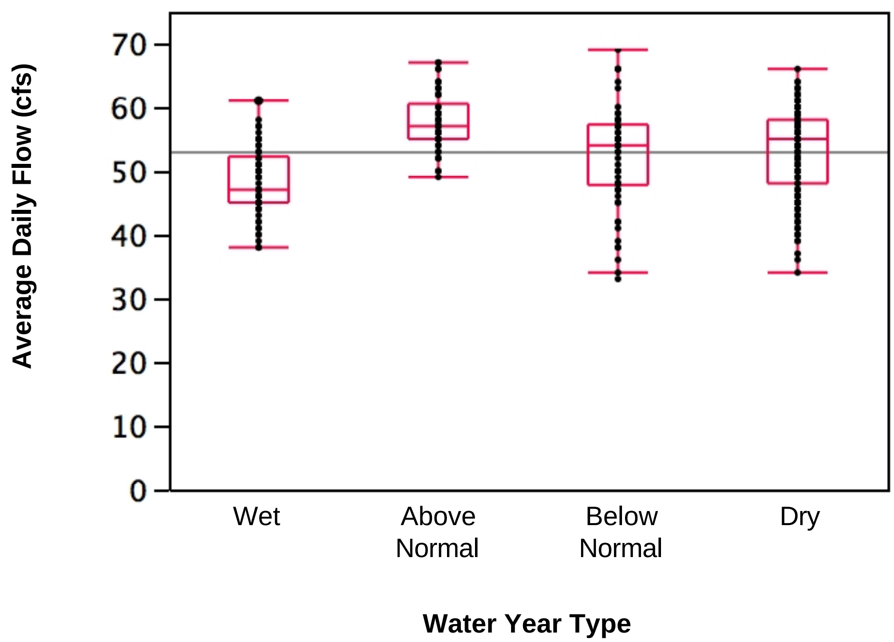
Table 4-3A: January-February

Classification			Average
Wet	A		55.34
Above Normal		B	41.23
Dry		B	40.18
Below Normal		B	38.03

Table 4-3B: July-August

Classification				Average
Above Normal	A			57.97
Dry		B		52.99
Below Normal		B		52.26
Wet			C	48.21

Figure 4-3: Box plots of San Luis Drain daily flow averages in July/August for 2000 – 2005 by water year type.



No USGS data for 2006 was available for San Luis Drain, so only 2000 through 2005 were analyzed. Relatively little variation in water flow data from year to year was seen, particularly for July/August. Some correlation between flow rates and the WSI is seen for January/February but not for July/August (Figures 4-2 & 4-3). As both Table 4-2 and Table 4-3 show, the January/February 2005 "wet" year flow rate is significantly higher than the flow rate of all other water year types. Note that for July/August, 2000 has the highest average flow, while the average flow of the 2005 "wet" year was either similar to or less than "dry" and "critical" years (Table 4-2).

Analysis 5: Orestimba Creek at River Road near Crows Landing

Data analysis by water year:

Figure 5-1: Orestimba Creek average daily flow for water years 2000 – 2006. January/February and July/August, the months for which flow was analyzed for this study, are highlighted.

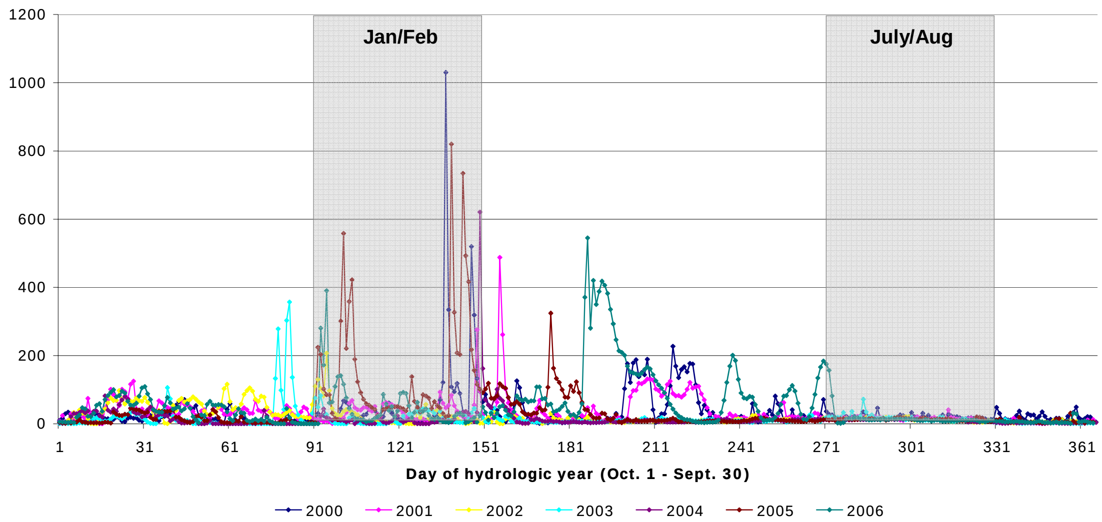


Table 5-1: Orestimba Creek flow descriptive statistics.

		January / February			July / August		
Water Year	Water year classification	Average	Median	Std. dev.	Average	Median	Std. dev.
2000	Above Normal	70.56	24.5	153.21	19.08	17	7.65
2001	Critical	7.47	17	0.45	15.09	16.5	5.68
2002	Dry	22.88	12	33.24	12.24	13	4.54
2003	Below Normal	15.97	8.5	17.12	15.24	14	10.03
2004	Critical	25.81	9.95	81.63	10.33	12	3.79
2005	Wet	142.08	72	172.38	12.90	12.9	3.36
2006	Wet	50.33	28	66.53	10.73	11	3.69

Table 5-2: Statistical analysis of Orestimba Creek flow averages, student's t-test comparison of all pairs of water years. Statistically similar averages for each time period are grouped by letter designation.

Table 5-2A: January-February

Year				Average	Classification
2005	A			142.08	Wet
2000		B		70.56	Above Normal
2006		B	C	50.33	Wet
2001		B	C	37.82	Critical
2004			C	25.81	Critical
2002			C	22.88	Dry
2003			C	15.97	Below Normal

Table 5-2B: July-August

Year					Average	Classification
2000	A				19.08	Above Normal
2003		B			15.24	Below Normal
2001		B			15.09	Critical
2005			C		12.90	Wet
2002			C	D	12.24	Dry
2006				D	10.73	Wet
2004				D	10.33	Critical

Figure 5-2A: Trendlines for the WSI (black), and for Orestimba Creek average yearly flow for January/February (pink) and July/August (blue), by water year.

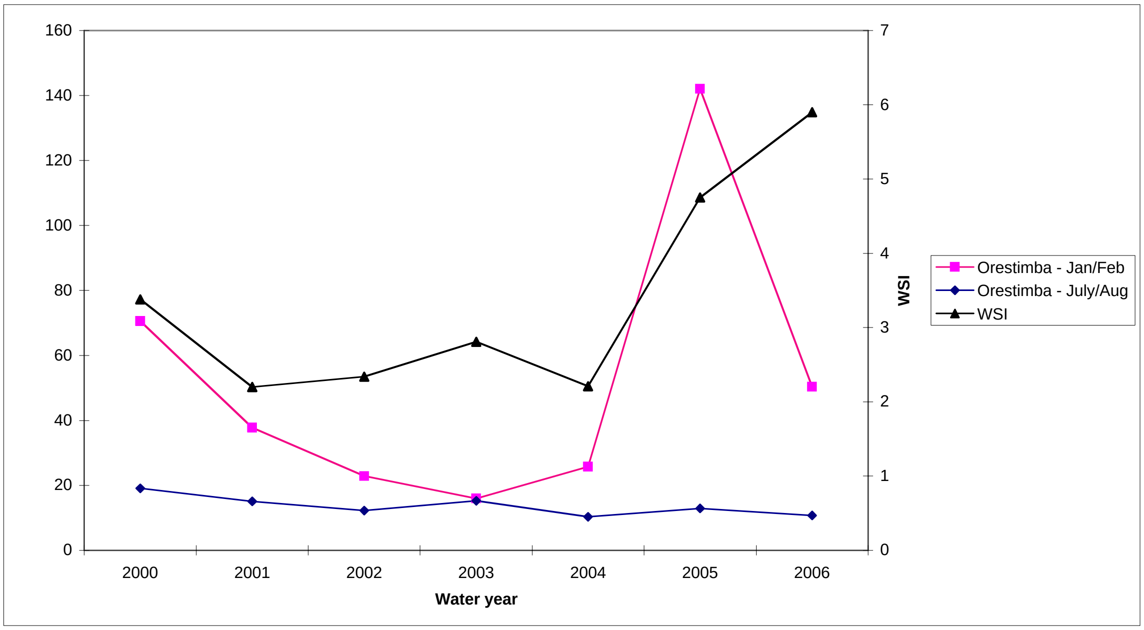
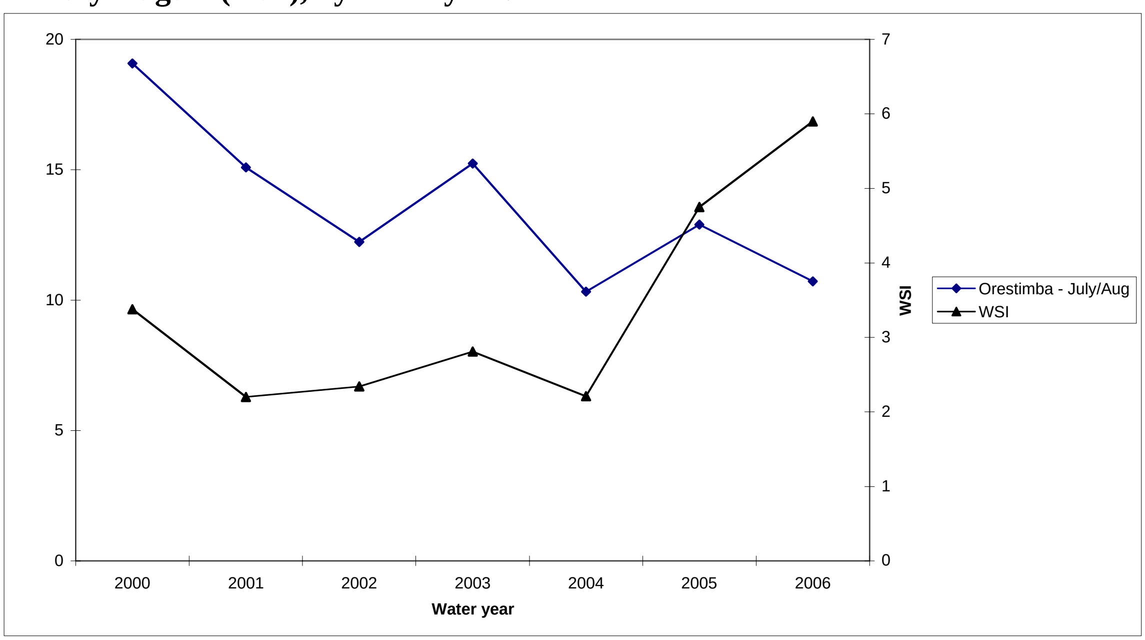


Figure 5-2B: Trendlines for the WSI (black), and for Orestimba Creek average yearly flow for July/August (blue), by water year.



Data analysis by water year type:

Table 5-3: Statistical analysis of Orestimba Creek flow averages for 2000 – 2006, student's t-test comparison of all pairs of water year types. Statistically similar averages for each time period are grouped by letter designation.

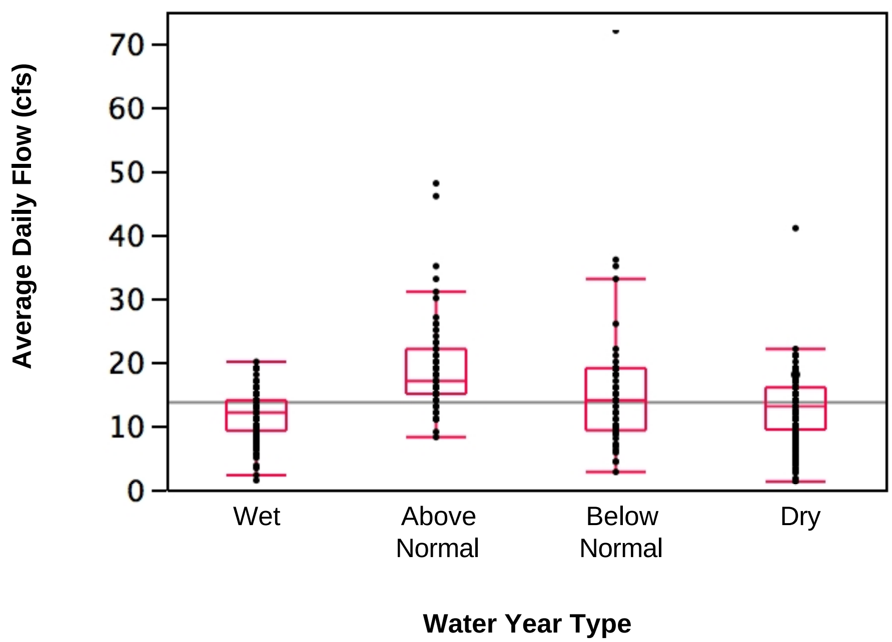
Table 5-3A: January-February

Classification			Average
Wet	A		96.21
Above Normal	A		70.56
Dry		B	28.82
Below Normal		B	15.97

Table 5-3B: July-August

Classification				Average
Above Normal	A			19.08
Below Normal		B		15.24
Dry			C	12.55
Wet			C	11.81

Figure 5-3: Box plots of Orestimba Creek daily flow averages in July/August for 2000 – 2006 by water year type.



Data was analyzed for all water years for Orestimba Creek. Good correlation between flow rates and the WSI is seen for January/February but not for July/August (Figures 5-2 & 5-3). As both Table 5-2 and Table 5-3 show, January/February "wet" and "above normal" water flow rates (2000, 2005, and 2006) are significantly higher than "below normal", "dry", and "critical" year water flow rates (2001, 2002, 2003, and 2004), with one exception – there is no significant difference between 2006 (wet) and 2001 (critical). Note that for July/August, 2000 has the highest average flow, while the average flow of "wet" years (2005/2006) was either similar to or less than "dry" and "critical" years (Table 5-2).

Analysis 6: Salt Slough at Hwy. 165 near Stevinson

Data analysis by water year:

Figure 6-1: Salt Slough average daily flow for water years 2000 – 2006. January/February and July/August, the months for which flow was analyzed for this study, are highlighted.

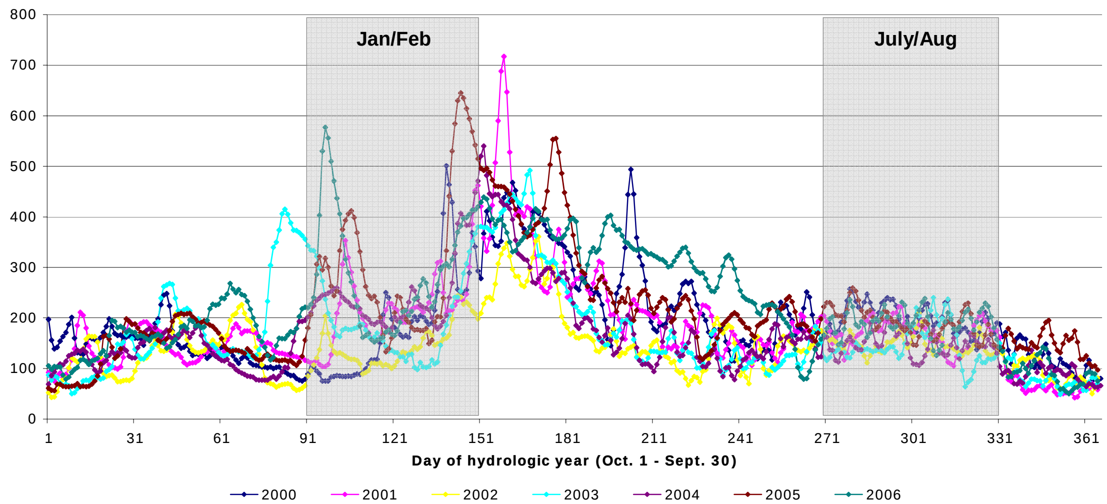


Table 6-1: Salt Slough flow descriptive statistics.

Water Year	Water year classification	January / February			July / August		
		Average	Median	Std. dev.	Average	Median	Std. dev.
2000	Above Normal	192.82	184	107.32	196.63	195.5	32.09
2001	Critical	227.25	218	78.74	165.60	170.5	34.22
2002	Dry	148.27	135	42.63	144.34	143	21.00
2003	Below Normal	191.29	176	77.99	145.63	136.5	38.45
2004	Critical	255.42	224.5	88.42	142.90	144.5	27.72
2005	Wet	313.58	253	148.59	186.61	186.5	28.34
2006	Wet	291.83	269	113.50	185.16	191	34.35

Table 6-2: Statistical analysis of Salt Slough flow averages, student's t-test comparison of all pairs of water years. Statistically similar averages for each time period are grouped by letter designation.

Table 6-2A: January-February

Year						Average	Classification
2005	A					313.58	Wet
2006	A					291.83	Wet
2004		B				255.42	Critical
2001		B	C			227.25	Critical
2000			C	D		192.82	Above Normal
2003				D		191.29	Below Normal
2002					E	148.27	Dry

Table 6-2B: July-August

Year					Average	Classification
2000	A				196.63	Above Normal
2005	A	B			186.61	Wet
2006		B			185.16	Wet
2001			C		165.60	Critical
2003				D	145.63	Below Normal
2002				D	144.34	Dry
2004				D	142.90	Critical

Figure 6-2A: Trendlines for the WSI (black), and for Salt Slough average yearly flow for January/February (pink) and July/August (blue), by water year.

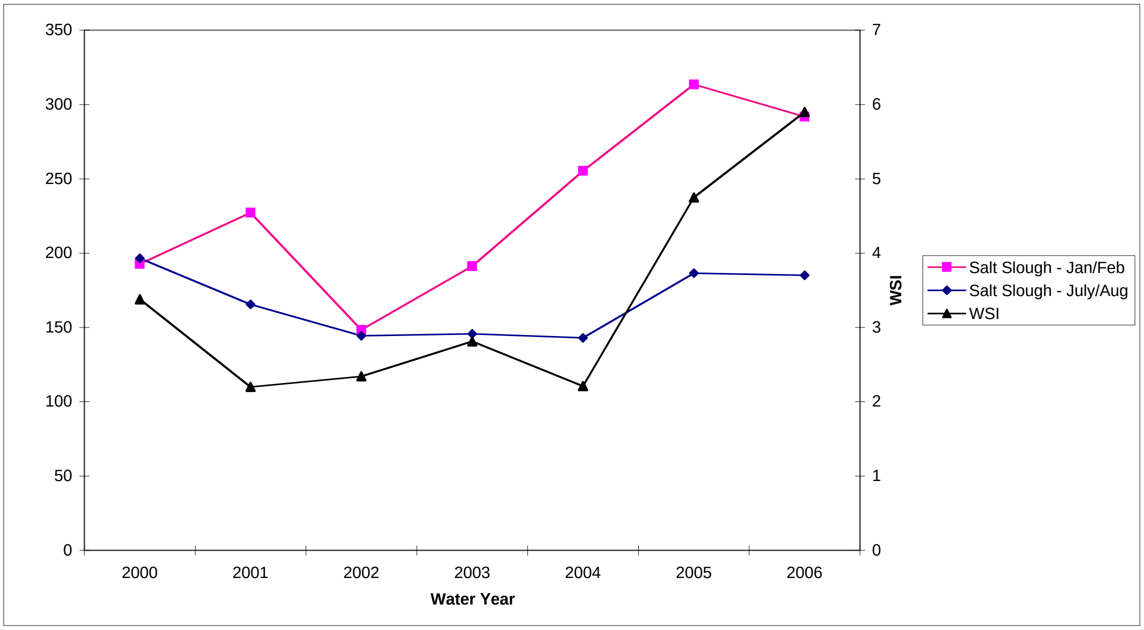
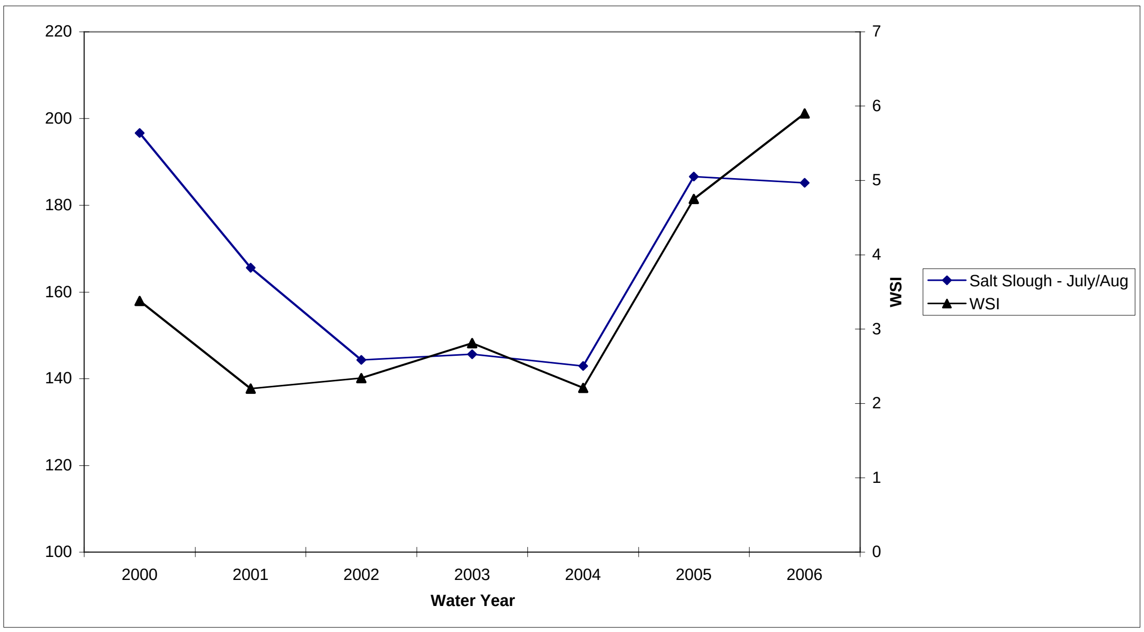


Figure 6-2B: Trendlines for the WSI (black), and for Salt Slough average yearly flow for July/August (blue), by water year.



Data analysis by water year type:

Table 6-3: Statistical analysis of Salt Slough flow averages for 2000 – 2006, student's t-test comparison of all pairs of water year types. Statistically similar averages for each time period are grouped by letter designation.

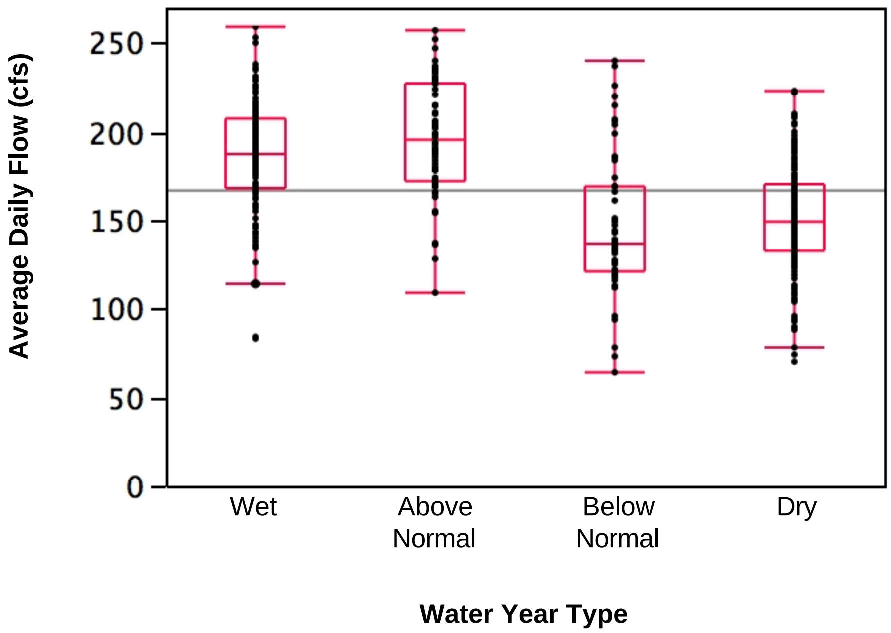
Table 6-3A: January-February

Classification			Average
Wet	A		302.70
Dry		B	210.57
Above Normal		B	192.82
Below Normal		B	191.29

Table 6-3B: July-August

Classification				Average
Above Normal	A			196.63
Wet		B		185.89
Dry			C	150.95
Below Normal			C	145.63

Figure 6-3: Box plots of Salt Slough daily flow averages in July/August for 2000 – 2006 by water year type.



Data was analyzed for all water years for Salt Slough. Some correlation between flow rates and the WSI is seen for both January/February and July/August (Figures 6-2 & 6-3). As both Table 6-2 and Table 6-3 show, the January/February 2005/2006 ("wet") flow rates are significantly higher than the flow rate of all other water year types. For July/August, 2000 has the highest average flow, the average flow of both "wet" years (2005/2006) are similar to 2000, and "below normal", "dry" and "critical" year average flows are significantly lower (Table 6-2).

Analysis 7: Mud Slough near Gustine

Data analysis by water year:

Figure 7-1: Mud Slough average daily flow for water years 2000 – 2006. January/February and July/August, the months for which flow was analyzed for this study, are highlighted.

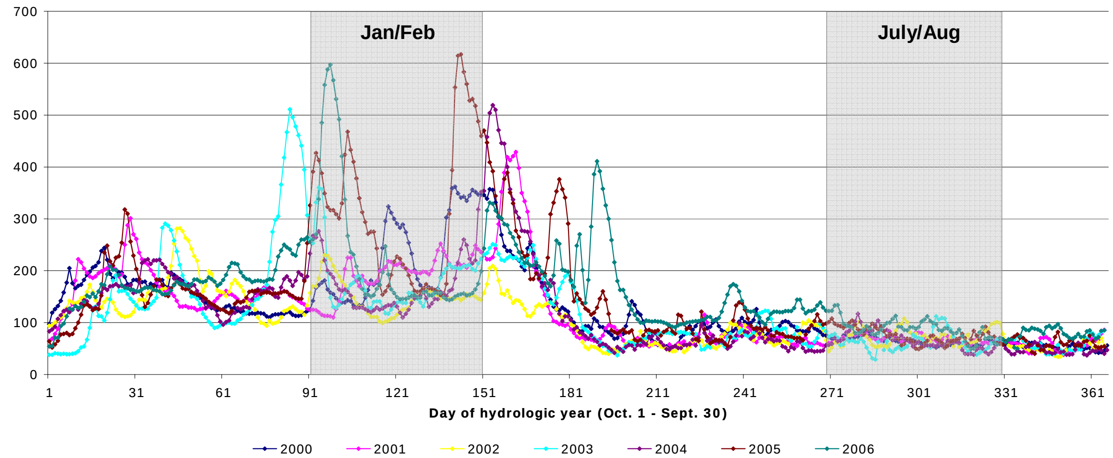


Table 7-1: Mud Slough flow descriptive statistics.

Water Year	Water year classification	January / February			July / August		
		Average	Median	Std. dev.	Average	Median	Std. dev.
2000	Above Normal	230.17	185.5	82.10	63.60	63	7.14
2001	Critical	193.47	201	37.14	68.10	67	6.98
2002	Dry	149.05	147	31.42	73.03	71	16.10
2003	Below Normal	177.03	157	54.11	62.65	62	18.28
2004	Critical	177.20	152	68.49	63.81	61	18.82
2005	Wet	313.10	301	141.14	73.50	72	13.46
2006	Wet	224.59	158	131.02	82.82	86	16.46

Table 7-2: Statistical analysis of Mud Slough flow averages, student's t-test comparison of all pairs of water years. Statistically similar averages for each time period are grouped by letter designation.

Table 7-2A: January-February

Year						Average	Classification
2005	A					313.10	Wet
2000		B				230.17	Above Normal
2006		B	C			224.59	Wet
2001			C	D		193.47	Critical
2004				D	E	177.20	Critical
2003				D	E	177.03	Below Normal
2002					E	149.05	Dry

Table 7-2B: July-August

Year						Average	Classification
2006	A					82.82	Wet
2005		B				73.50	Wet
2002		B	C			73.03	Dry
2001			C	D		68.10	Critical
2004				D	E	63.81	Critical
2000				D	E	63.60	Above Normal
2003					E	62.65	Below Normal

Figure 7-2A: Trendlines for the WSI (black), and for Mud Slough average yearly flow for January/February (pink) and July/August (blue), by water year.

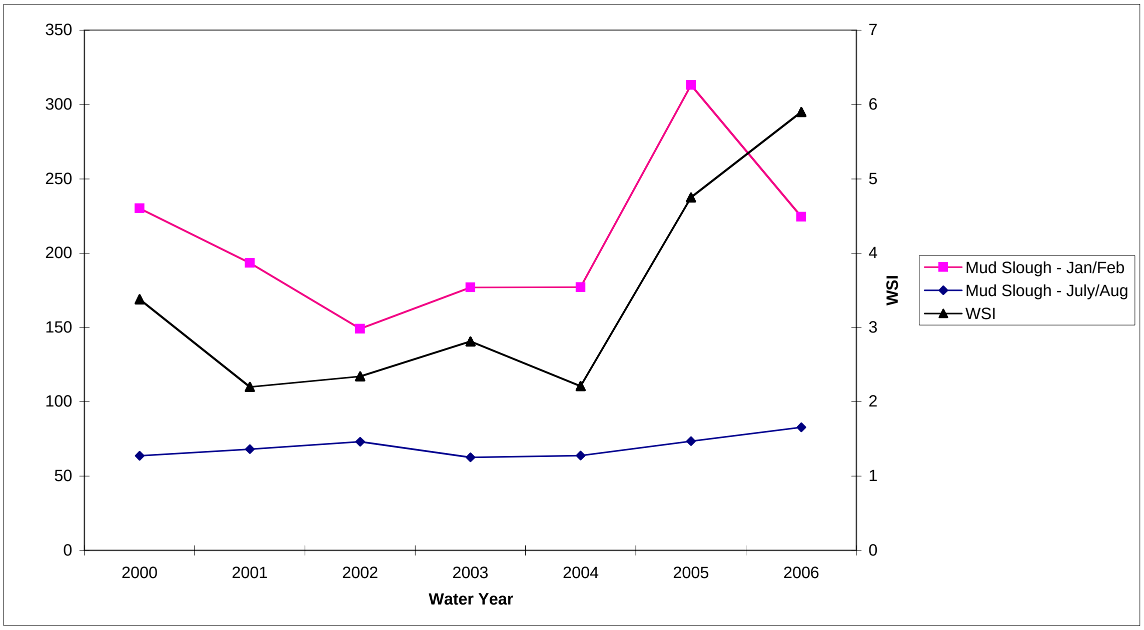
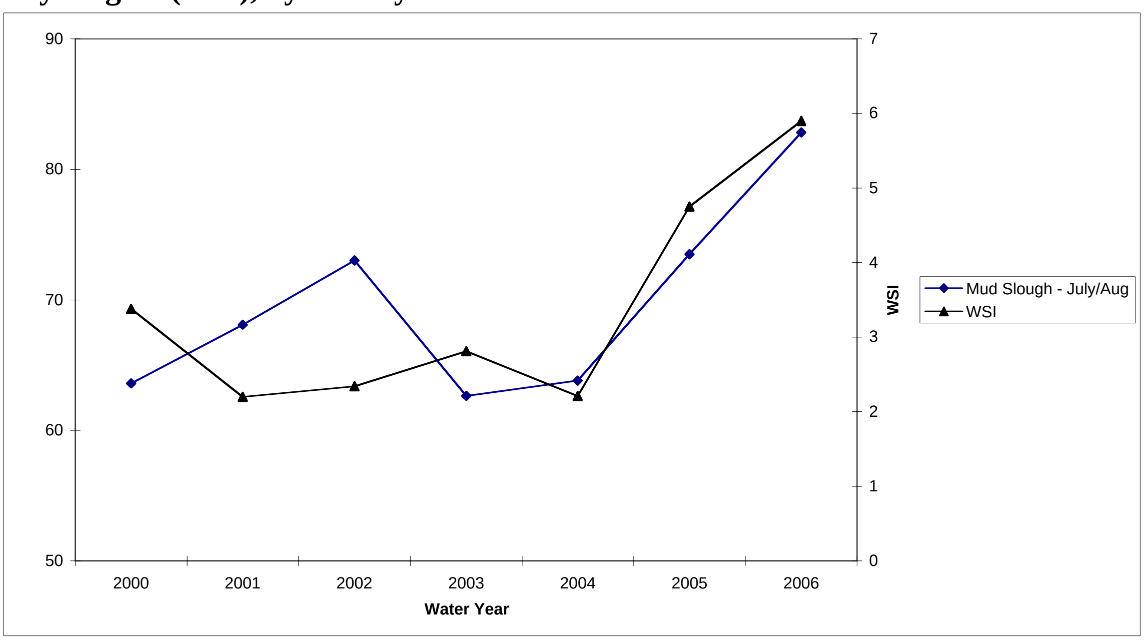


Figure 7-2B: Trendlines for the WSI (black), and for Mud Slough average yearly flow for July/August (blue), by water year.



Data analysis by water year type:

Table 7-3: Statistical analysis of Mud Slough flow averages for 2000 – 2006, student's t-test comparison of all pairs of water year types. Statistically similar averages for each time period are grouped by letter designation.

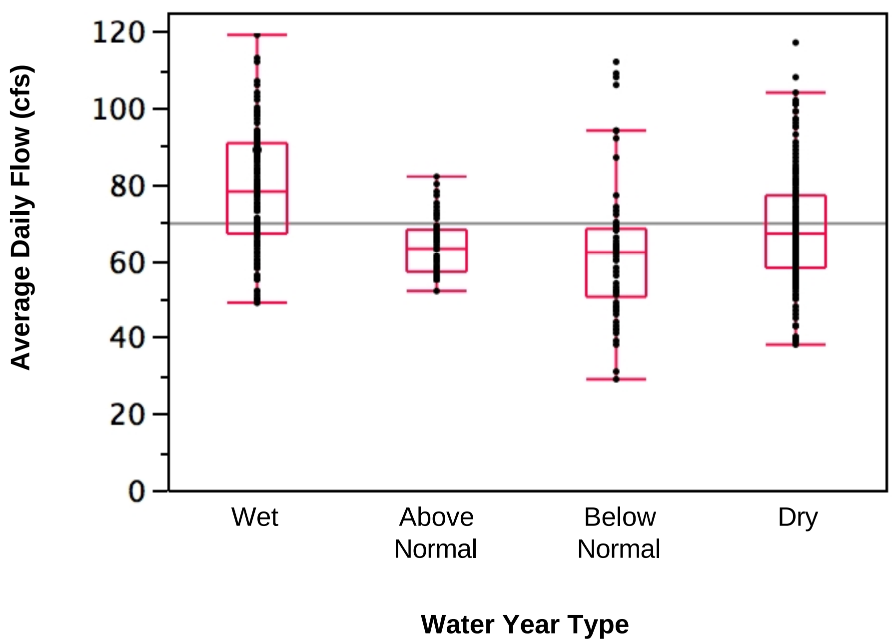
Table 7-3A: January-February

Classification				Average
Wet	A			268.85
Above Normal		B		230.17
Below Normal			C	177.03
Dry			C	173.26

Table 7-3B: July-August

Classification				Average
Wet	A			78.16
Dry		B		68.31
Above Normal			C	63.60
Below Normal			C	62.65

Figure 7-3: Box plots of Mud Slough daily flow averages in July/August for 2000 – 2006 by water year type.



Data was analyzed for all water years for Mud Slough. Good correlation between flow rates and the WSI is seen for January/February and a fair correlation between flow rates and the WSI is seen for July/August (Figures 7-2 & 7-3). As both Table 7-2 and Table 7-3 show, January/February "wet" and "above normal" water flow rates (2000, 2005, and 2006) are significantly higher than "below normal", "dry", and "critical" year water flow rates (2001, 2002, 2003, and 2004), with one exception – there is no significant difference between 2006 (wet) and 2001 (critical). Note that this is identical to the January/February flow rate pattern seen at Orestimba Creek. While there is little variation in any of the July/August flow means, 2005/2006 ("wet") flow means are significantly higher than the flow means of all other water year types, except 2002 (dry), which is not significantly different from 2005 (wet) (Table 7-2).

Analysis 8: Del Puerto Creek near Patterson

Data analysis by water year:

Figure 8-1: Del Puerto Creek average daily flow for water years 2000 – 2006. January/February and July/August, the months for which flow was analyzed for this study, are highlighted.

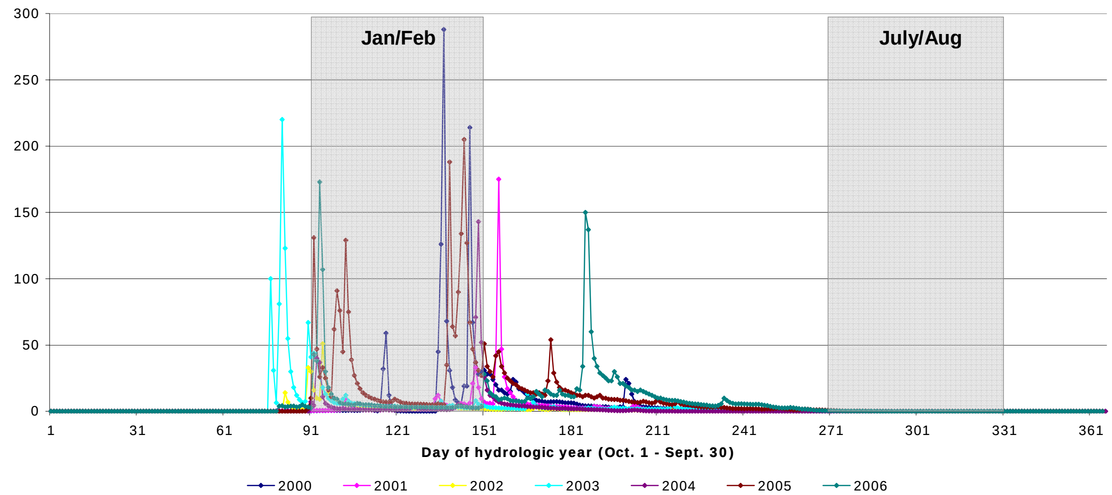


Table 8-1: Del Puerto Creek flow descriptive statistics.

		January / February			July / August		
Water Year	Water year classification	Average	Median	Std. dev.	Average	Median	Std. dev.
2000	Above Normal	19.99	0.77	49.30	< 0.1	0	< 0.1
2001	Critical	4.14	1.9	5.51	0	0	0
2002	Dry	4.82	3	7.12	0	0	0
2003	Below Normal	5.87	4	5.90	< 0.1	0	< 0.1
2004	Critical	8.31	1.6	21.92	0	0	0
2005	Wet	35.70	14	44.92	< 0.1	0	< 0.1
2006	Wet	10.42	3.7	26.11	< 0.1	0	< 0.1

Table 8-2: Statistical analysis of Del Puerto Creek flow averages, student's t-test comparison of all pairs of water years. Statistically similar averages for each time period are grouped by letter designation.

Table 8-2A: January-February

Year				Average	Classification
2005	A			35.70	Wet
2000		B		19.99	Above Normal
2006		B	C	10.42	Wet
2004			C	8.31	Critical
2003			C	5.87	Below Normal
2002			C	4.82	Dry
2001			C	4.14	Critical

Table 8-2B: July-August

Year			Average	Classification
2005	A		0.0495	Wet
2006	A		0.0447	Wet
2000		B	0.0087	Above Normal
2003		B	0.00065	Below Normal
2001		B	0	Critical
2004		B	0	Critical
2002		B	0	Dry

Figure 8-2A: Trendlines for the WSI (black), and for Del Puerto Creek average yearly flow for January/February (pink) and July/August (blue), by water year.

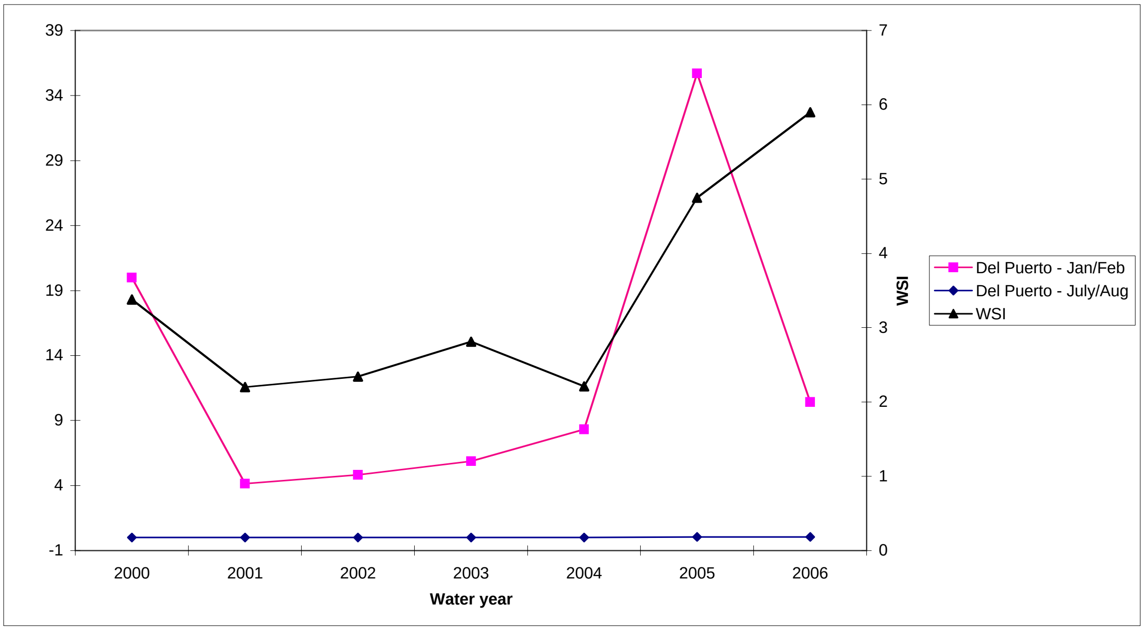
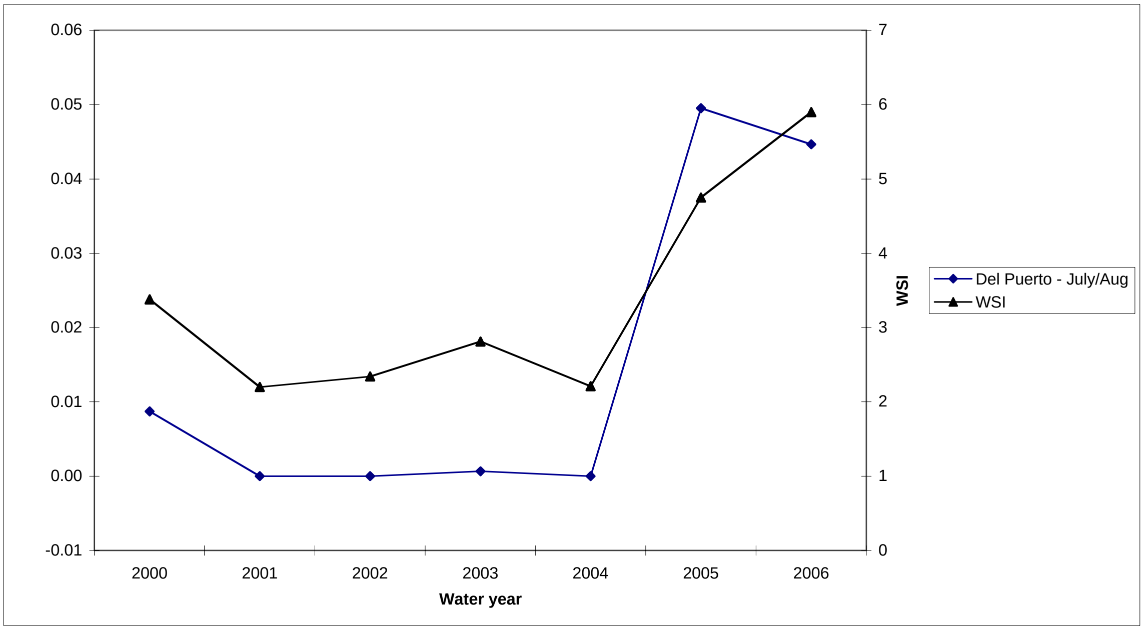


Figure 8-2B: Trendlines for the WSI (black), and for Del Puerto Creek average yearly flow for July/August (blue), by water year.



Data analysis by water year type:

Table 8-3: Statistical analysis of Del Puerto Creek flow averages for 2000 – 2006, student's t-test comparison of all pairs of water year types. Statistically similar averages for each time period are grouped by letter designation.

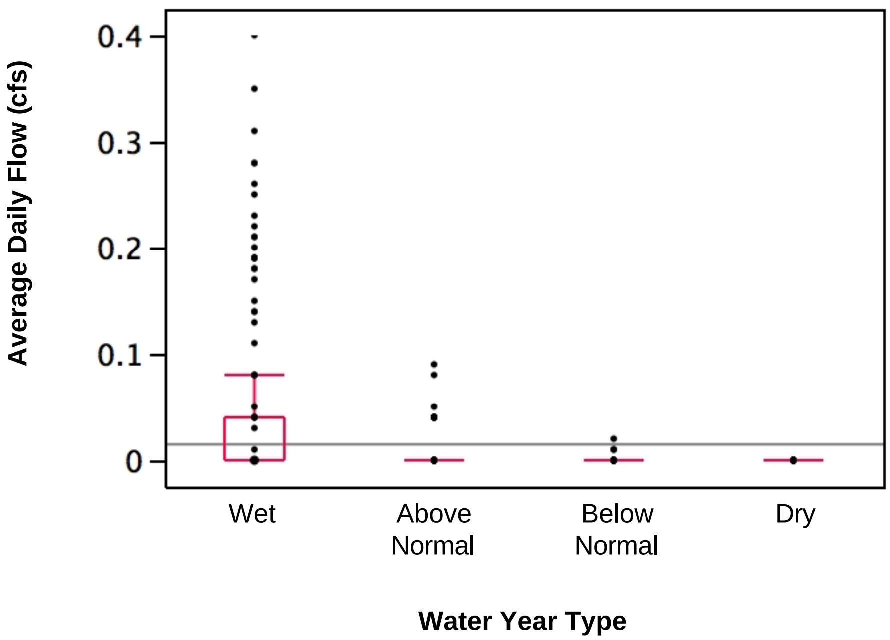
Table 8-3A: January-February

Classification			Average
Wet	A		23.06
Above Normal	A		19.99
Below Normal		B	5.87
Dry		B	5.77

Table 8-3B: July-August

Classification			Average
Wet	A		0.0471
Above Normal		B	0.0087
Below Normal		B	0.0006
Dry		B	0.0000

Figure 8-3: Box plots of Del Puerto Creek daily flow averages in July/August for 2000 – 2006 by water year type.



Data was analyzed for all water years for Del Puerto Creek. Good correlation between flow rates and the WSI is seen for both January/February and for July/August (Figures 8-2 & 8-3), although the July/August data is open to interpretation (discussed below). As both Table 8-2 and Table 8-3 show, January/February "wet" and "above normal" water flow rates (2000, 2005, and 2006) are significantly higher than "below normal", "dry", and "critical" year water flow rates (2001, 2002, 2003, and 2004), with one exception – there is no significant difference between 2006 (wet) and 2004 (critical). This is similar to the January/February flow rate pattern seen at Orestimba Creek and Mud Slough. While there is little variation in any of the July/August flow averages, 2005/2006 ("wet") flow averages are significantly higher than the flow averages of all other water year types (Table 8-2). However, the relevance of the correlation between the WSI and the July/August results is questionable, as all water flow means for July/August are quite low (Table 8-2).

Analysis 9: Delta Mendota Canal at the Tracy Pumping Plant

Figure 9-1: Tracy Pumping Plant average daily discharge for water years 2000 – 2006. January/February and July/August, the months for which flow was analyzed for this study, are highlighted.

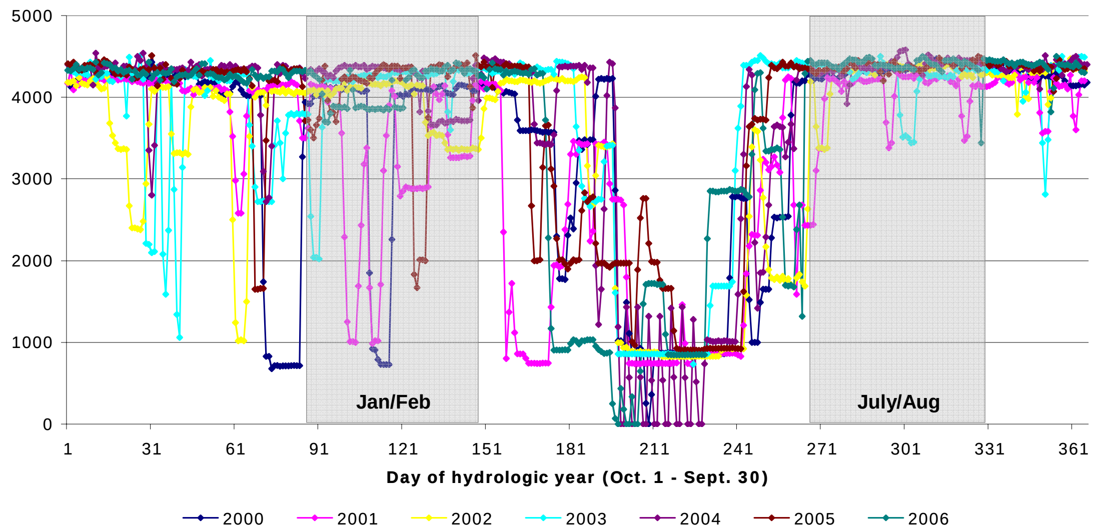


Table 9-1: Tracy Pumping Plant discharge descriptive statistics.

Water Year	Water year classification	January / February Average	Median	Std. dev.	July / August Average	Median	Std. dev.
2000	Above Normal	3640.92	4090	1109.17	4352.42	4350	52.16
2001	Critical	3108.41	3260	996.30	4133.23	4200	207.84
2002	Dry	3881.36	4100	339.92	4338.06	4355	60.13
2003	Below Normal	4260.17	4280	115.38	4246.45	4330	245.43
2004	Critical	4162.33	4335	293.02	4394.35	4405	94.55
2005	Wet	4061.19	4330	687.10	4390.81	4390	51.42
2006	Wet	4102.20	4210	233.05	4396.13	4410	131.86

Table 9-2: Statistical analysis of Tracy Pumping Plant discharge averages, student's t-test comparison of all pairs of water years. Statistically similar averages for each time period are grouped by letter designation.

Table 9-2A: January-February

Year					Average
2003	A				4260.17
2004	A				4162.33
2006	A	B			4102.20
2005	A	B			4061.19
2002		B			3881.36
2000			C		3640.92
2001				D	3108.41

Table 9-2B: July-August

Year					Average
2006	A				4396.13
2004	A				4394.35
2005	A				4390.81
2000	A	B			4352.42
2002		B			4338.06
2003			C		4246.45
2001				D	4133.23

No apparent correlation between the WSI and January/February discharge rates is seen. Some correlation between WSI and July/August discharge rates is seen, as "wet" and "above normal" years are significantly higher than "below normal", "dry" and "critical" years, except for 2004 (critical), which is similar to "wet" and "above normal" years, and 2002 (dry), which is similar to 2000 (above normal).

Analysis 10: Los Banos Weather Station

Figure 10-1: Los Banos CIMIS weather station average daily air temperatures for water years 2000 – 2006. January/February and July/August, the months for which air temperature was analyzed for this study, are highlighted.

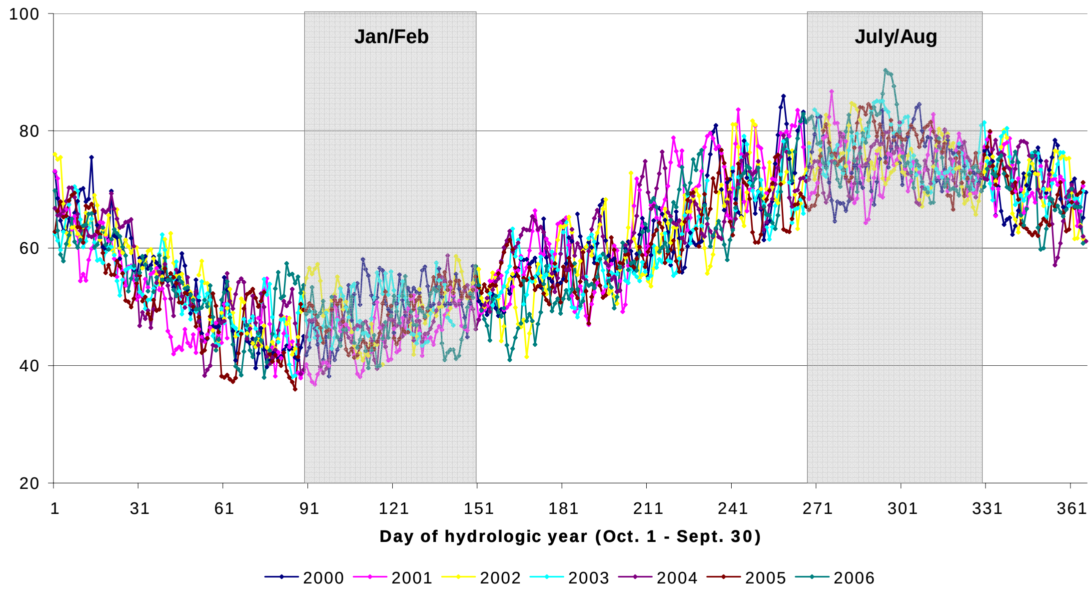


Table 10-1: Los Banos CIMIS weather station descriptive statistics.

Water Year	Water year classification	January / February Average	July / August Average
2000	Above Normal	50.47	73.91
2001	Critical	45.60	74.09
2002	Dry	49.57	74.58
2003	Below Normal	49.17	76.29
2004	Critical	47.46	74.74
2005	Wet	48.73	77.01
2006	Wet	47.30	75.62

While some sharp changes in air temperature are seen in both the January/February and July/August time periods (particularly for daily maximum air temperatures), they do not result in significantly higher or lower air temperatures than the averages for a sustained period of time for the water years analyzed.