GRASSLAND BYPASS PROJECT

QUARTERLY NARRATIVE AND GRAPHICAL SUMMARY

October - December 1997

May 24, 2001

A cooperative effort of:
U.S. Bureau of Reclamation
Central Valley Regional Water Quality Control Board
U.S. Fish and Wildlife Service
California Department of Fish and Game
San Luis & Delta-Mendota Water Authority
U.S. Environmental Protection Agency
U.S. Geological Survey

Report prepared by San Francisco Estuary Institute

I. INTRODUCTION

The Grassland Bypass Project (GBP) intercepts agricultural irrigation return flows south of the Grassland Water District and conveys them through the northernmost 28 miles of the San Luis Drain to a discharge point in Mud Slough, a tributary of the San Joaquin River. The location of the project and the Grassland Drainage Service Area are shown in Figure 1. A schematic of the GBP showing the hydrology of the project and sampling locations is provided in Figure 2. The GBP has removed agricultural drainage from wetland water supply channels in the Grassland Water District and from Salt Slough, but has increased quantities of agricultural drainage in the six miles of Mud Slough that receives the re-routed drainage water. A detailed monitoring program, the Grassland Bypass Project Compliance Monitoring Program (GBPCMP) has been established to evaluate whether the terms and conditions of the project are being met. Specific conditions for the project include monthly and annual selenium load values from the San Luis Drain into Mud Slough, selenium load reductions over the long term, removal of subsurface agricultural drainage from the wetland water supply channels, the prevention of significant adverse environmental impacts, and the prevention of significant adverse effects on human health. Detailed background information on the GBP is documented in the "Finding of No Significant Impact and Supplemental Environmental Assessment (FONSI)" and the Interim Use Permit (USBR 1995). The comprehensive monitoring plan (USBR 1996) and the Quality Assurance Project Plan (Entrix 1997) contain detailed descriptions of the sampling and analytical methods employed in the GBPCMP. The effect of major storm events in January 1997 on the GBP has been discussed in Grassland Area Farmers (1997).

The purpose of the Quarterly Narrative and Graphical Data Summary series is to provide an overview of the data collected in the most recent quarter of the GBP. Complete listings of the data are provided in Monthly Data Reports and Quarterly Data Reports. The data and detailed background information on the GBP are also available on the Internet at the following address:
www.mp.usbr.gov/mp400/irrdrn/grasslnd/grasslnd.html.

II. FLOW MONITORING

Flow data in the GBPCMP are measured to allow computation of selenium load discharge, to establish seasonal flow patterns, and to determine the influence of the discharge from the San Luis Drain on the hydrology of Mud Slough. According to the Interim Use Permit, discharge flows into Mud Slough from the San Luis Drain may not exceed 150 cfs (USBR 1995).

Flows near the inlet of agricultural drainage into the San Luis Drain (station A), which averaged 18.6 cfs for the quarter, were lower than flows at the point of discharge of the San Luis Drain into Mud Slough (station B), which averaged 25.9 cfs (Figure 3). Maximum flow for the quarter was 47.0 cfs on December 6 at station A and 52.8 cfs on December 7 at station B. Of the two monitoring stations in Mud Slough above and below

the GBP discharge (stations C and D, respectively) flow is measured only at station D. The average flow at station D for the quarter was 164 cfs. The discharge from the SLD (station B) accounted for an average of 16% of the total flow in Mud Slough (station D). Flows in Salt Slough (station F) were of a similar magnitude as those in Mud Slough, averaging 131 cfs for the quarter. The highest flow in Salt Slough (220 cfs) occurred on November 16.

Station N flows during the quarter averaged 774 cfs and were relatively constant for the entire quarter. The maximum flow measured was 1250 cfs on December 9.

III. WATER QUALITY MONITORING

Water quality data in the GBP are collected to evaluate compliance with selenium load values given in the FONSI and the Interim Use Permit (USBR 1995), to evaluate compliance with the commitment to not discharge drainage to the wetland channels, and to evaluate potential adverse effects of the GBP discharge and of waters in Mud Slough below the discharge on test organisms.

Chemical Monitoring

Selenium

Daily Selenium Measurements

Daily selenium concentrations are measured at stations B and N using autosamplers (USBR 1996). Monthly total selenium load discharge is computed at Station B. Monthly totals are shown in the Table 1 and illustrated in Figure 4a.

Selenium load discharge from the GBP (discharge from the terminus of the Drain as measured at station B) averaged 6.9 lbs/day for the quarter. The maximum daily selenium load discharge (17.8 lbs/day) occurred on December 8. Flow at station B increased sharply from 34.8 cfs on December 5 to 46.8 cfs on December 6, reached the maximum for the quarter on December 7 (52.8 cfs), and remained relatively high until a distinct drop to 11.3 cfs on December 13. Selenium concentrations at station B also exhibited distinct fluctuations at during early December, with relatively low concentrations from December 1 to December 7, relatively high concentrations on December 8 and December 9, moderate concentrations from December 10 to December 22, and increased concentrations once again after December 23. The relatively high selenium load discharge observed on December 8 and December 9 was therefore due to a combination of elevated flows and elevated selenium concentrations. The cumulative selenium load discharge for the quarter was 633 lbs.

Selenium concentrations at station N (San Joaquin River at Crow's Landing) averaged 2.2 ug/l for the quarter. The highest concentration was measured on October 9 (4.1 ug/l). Relatively high concentrations were also observed on October 28 (3.5 ug/l)

and on December 10 and 11 (3.3 and 3.2 ug/l, respectively).

Weekly Selenium Measurements

Selenium concentrations are measured in weekly grab samples collected at 12 stations (Figures 6-8). Average selenium concentrations were higher near the inlet to the San Luis Drain (station A) than near the point of discharge into Mud Slough (station B) (Figure 6). The average concentration at station A was 68 ug/l compared to 50 ug/l at station B.

Selenium concentrations in Mud Slough upstream of the GBP discharge (station C) from October-March averaged 0.6 ug/l, with a maximum concentration of 0.8 ug/l (Figure 6). Concentrations were higher in Mud Slough downstream of the GBP discharge (station D) than upstream at station C (note differences in scales). Concentrations at station D averaged 9.2 ug/l, with a maximum of 15.4 ug/l on October 30.

Selenium concentrations in Salt Slough (station F) and the wetland water supply channels (stations J, K, L, and M) were generally below 2 ug/l (Figure 7). Concentrations above 2 ug/l were measured in December at stations J (three samples), K (one sample), L (one sample) and M (one sample). High conductivity readings at station J in late December (Figure 10) provide further evidence that water quality at this station was unusual at this time. Flow data for stations J and K are available for March 1997-December 1997 (these data are provided in the October, November & December 1997 Quarterly Data Report). December flows were relatively low at both station J (averaging 5 cfs) and station K (averaging 13 cfs), so the relatively high concentrations detected at these stations were not indicative of large selenium load discharge into the wetland channels.

In the San Joaquin River, weekly selenium samples were collected at stations upstream of the GBP discharge (station G), downstream of the discharge and above the Merced River (station H), and downstream of the Merced River (station N) (Figure 8). Selenium concentrations at station G were low, averaging 0.9 ug/l. Concentrations were higher at station H, averaging 4.0 ug/l and reaching a maximum of 7.8 ug/l on October 9.

Specific conductance

Specific conductance is measured at 15 min intervals at stations B, D, F, and N, and in weekly grab samples at stations A, B, C, D, F, G, H, J, K, L, M, and N. These data are presented in Figures 9 and 10.

Toxicity Testing

The purpose of the GBP toxicity testing program is to evaluate the potential adverse effects to test organisms of the GBP discharge and of waters in Mud Slough below the discharge. Monthly toxicity tests are conducted in the laboratory using water

collected from stations B, C, D, and F. Test results from these stations are compared to results obtained using water from the Delta-Mendota Canal. Monthly toxicity tests include: the 7-day chronic fathead minnow (*Pimephales promelas*) larvae survival and growth test; the 7-day chronic water flea (*Daphnia magna*) survival and reproduction test; and the 4-day chronic algal (*Selenastrum capricornutum*) growth test. A 7-day *in situ* survival test using 4-day-old fathead minnow larvae is conducted at stations B, D, F, and a reference site (Windmill) on a quarterly basis. Toxicity test results are summarized below; complete datasets are presented in the GBP Monthly Data Reports and GBP Quarterly Data Reports.

In the fathead minnow tests, many samples exhibited significantly reduced survival or growth. There was a statistically significant 50% reduction in survival of fathead minnows in Mud Slough at station C upstream of the GBP discharge in December. A similar statistically significant reduction in survival (58%) was also observed at station D downstream of the discharge in December. Statistically significant reductions in survival were also observed at station C in November and at station F in October. Only one of these reductions in survival occurred at a station under the influence of the GBP discharge.

Statistically significant reductions in fathead minnow growth were observed in most of the samples collected during the quarter. In October samples from all four stations B, C, D, and F caused reduced growth. In November samples from three stations (B, D, and F) caused reduced growth. In December only the station C sample caused reduced growth. Stations C and F, which are not under the influence of the GBP discharge, had as many incidences of reduced growth as stations B and D, which are under the influence of the discharge.

In the *Daphnia* tests, only one field sample caused a reduction in either survival or reproduction. Survival in the laboratory control for the *Daphnia* survival test, which has occasionally been low in past sampling, was zero in November. In the *Daphnia* reproduction test, one sample (from station F in December) was significantly reduced relative to the Delta-Mendota control.

In the *Selenastrum* tests inhibition of growth was observed in one sample (from station B in October). *Selenastrum* growth in the Delta-Mendota control in December was relatively low.

IV. SEDIMENT MONITORING

Sediment Quality Monitoring

Sediment quality is measured in the San Luis Drain and in Mud and Salt Sloughs. The purpose of monitoring sediment chemistry in the San Luis Drain is to assess whether selenium concentrations in drain sediments are approaching the California Department of Health Services hazardous waste criterion (100 ug/g wet weight) and to provide

information on the fate and transport of selenium within the Drain. Stations in Mud and Salt Sloughs are monitored to determine whether changes in sediment chemistry in these locations occur as a result of the GBP and to provide data that can be used in conjunction with biological data to assess accumulation or depletion of selenium in the aquatic food web.

Selenium concentrations in San Luis Drain sediments have been quite variable (Table 2). At station A concentrations measured at different depths were relatively consistent on each sampling date, but concentrations in June were much lower (about one order of magnitude) than concentrations measured in November 1996 and September 1997. At station B a large amount of variation was observed among composites collected in June 1997. The whole core concentration of 0.1 ug/g measured in June was an extreme outlier, more than two orders of magnitude lower than other samples collected on the same date. This data point was confirmed by reanalysis. The large variability in the sediment selenium data has been identified as a QA issue of concern in the Grassland Bypass monitoring program. Heterogeneity of selenium concentrations over small spatial scales in sediment will necessitate the collection of larger numbers of samples before statistically significant changes in Drain sediments can be detected. Selenium concentrations in San Luis Drain sediments (stations A and B) were much higher than concentrations at the slough stations (C, D, E, F, and I).

Sediment Quantity Monitoring

A survey to estimate the quantity of sediment in the San Luis Drain is conducted annually. Results will be summarized and reported when they are available.

V. BIOLOGICAL MONITORING

Organisms are collected throughout the GBP area on a quarterly basis (USBR 1996). Tissue sampling in the GBPCMP is being performed to assess the potential for adverse impacts to fish and wildlife and to assess public health risks. Food web organisms (aquatic plants, invertebrates, and fish) are being analyzed for selenium residues to assess impacts to fish and wildlife. Muscle fillets from gamefish are being analyzed for selenium to assess human health risks. Results of these efforts are discussed in the GBP Annual Report.

REFERENCES

Entrix, Inc. 1997. Final Draft Quality Assurance Plan for the Compliance Monitoring Program for the Use and Operation of the Grassland Bypass Project. Prepared for the U.S. Bureau of Reclamation, Mid-Pacific Region, Sacramento, CA.

Grassland Area Farmers. 1997. Grassland Bypass Channel operations during two major storm events in January 1997. Report to the Central Valley Regional Water Quality Control Board, Rancho Cordova, CA.

USBR. 1995. Finding of No Significant Impact and Supplemental Environmental Assessment, Grassland Bypass Channel Project, Interim Use of a Portion of the San Luis Drain for Conveyance of Drainage Water through the Grassland Water District and Adjacent Grassland Areas. U.S. Bureau of Reclamation, Mid-Pacific Region, Sacramento, CA.

USBR. 1996. Compliance Monitoring Program for Use and Operation of the Grassland Bypass Project. U.S. Bureau of Reclamation, Mid-Pacific Region, Sacramento, CA.

Table 1. Comparison of monthly selenium load discharge from the terminus of the San Luis Drain (station B) with the monthly load values in the Interim Use Permit (USBR 1995).

	Selenium load discharge (lbs)	Monthly load value (lbs)	Amount over monthly load value (%)
Oct 1997	248	348	na
Nov 1997	207	348	na
Dec 1997	178	389	na

na: not applicable (load discharge was less than load value)

Table 2. Summary of sediment monitoring results from March 1996 to September 1997. Dry weight concentrations. USBR=U.S. Bureau of Reclamation.

Station Code	PARAMETER	Selenium			Organic Carbon		
Station Name	DEPTH	0-3 cm	3-8 cm	Whole Core	(0-3 cm)	(3-8 cm)	Whole Core
	SOURCE	USBR	USBR	USBR	USBR	USBR	USBR
	UNITS	ppm	ppm	ppm	%	%	%
Station A:	Mar-13-1996	2.0	16.0	10.0			
Inflow to San Luis Drain	Jun-27-1996	8.0	20.0	29.0	4.3	5.0	3.0
	Sep-04-1996	3.4	24.0	7.7	4.4	2.7	4.1
	Nov-12-1996	22.0	62.0	55.0	2.9	3.1	3.7
	Mar-12-1997	NT	NT	NT			
	Jun-10-1997	2.9	4.2	5.4			
	Sep-11-1997	38.0	56.0	50.0			
Station B:	Mar-12-1996	NT	NT	NT			
Discharge from	Jun-27-1996	19.0	12.0	30.0	2.7	2.8	2.2
San Luis Drain	Sep-04-1996	11.0	18.0	20.0	3.9	3.8	2.1
	Nov-12-1996	24.0	41.0	40.0	2.0	1.9	3.5
	Mar-13-1997	26.0	48.0	42.0	2.9	3.1	3.7
	Jun-10-1997	14.0	27.0	0.1			
	Sep-11-1997	21.0	61.0	48.0			
Station C:	Mar-12-1996	NT	NT	NT			
Mud Slough North	May-20-1996	0.2	0.2	0.1			
upstream of	Jun-27-1996	0.1	<0.1	0.1	0.5	0.4	0.1
drainage discharges	Sep-04-1996	0.3	0.1	<0.1	0.4	0.5	0.5
	Nov-12-1996	0.2	0.2	0.3	0.3	0.3	1.0
	Mar-12-1997	0.2	<0.1	0.1	0.4	0.3	0.7
	Jun-09-1997	0.1	0.2	<0.1			
	Sep-11-1997	0.2	0.1	0.4			
Station D:	Mar-12-1996	NT	NT	NT			
Mud Slough North	Apr-03-1996	<0.1	0.1	<0.1			
downstream of	Jun-27-1996	0.4	0.4	0.2	0.3	0.4	0.2
drainage discharges	Sep-04-1996	0.2	0.2	0.2	0.2	0.2	0.2
	Nov-13-1996	0.1	0.3	0.2	0.1	0.1	0.1
	Mar-12-1997	0.5	0.3	0.8	0.3	0.2	0.3
	Jun-09-1997	0.1	<0.1	0.2			
	Sep-11-1997	0.5	0.3	0.3			
Station E:	Mar-12-1996	NT	NT	NT			
Mud Slough at Highway 140	May-20-1996	0.1	0.1	0.1			
	Jun-27-1996	0.1	0.1	<0.1	1.1	0.5	0.4
	Sep-04-1996	NT	NT	NT			
	Nov-13-1996	0.7	0.7	0.7	0.4	0.3	0.3
	Mar-13-1997	0.8	1.0	1.0	0.1	0.2	0.1
	Jun-09-1997	1.5	1.6	1.5			
	Sep-11-1997	1.6	1.3	1.9			
Station F:	Mar-12-1996	NT	NT	NT			
Salt Slough at Highway 165	Jun-27-1996	0.6	0.5	0.2	0.7	0.6	0.2
	Sep-05-1996	0.4	0.8	0.4	0.4	0.8	0.3
	Nov-13-1996	0.2	0.4	0.3	0.1	0.2	0.1
	Mar-13-1997	0.9	0.4	0.6	0.6	0.4	0.3
	Jun-09-1997	0.1	0.1	0.4			
	Sep-12-1997	0.6	0.7	0.7			
Station I:	Jun-13-1996	0.4	0.4	0.3	1.6	1.3	1.2
Mud Slough:	Mar-13-1997	1.5	0.8	0.4	1.8	0.8	0.6
Seasonal backwater tributary							

Figure 1. Map of the Grassland Bypass Project.

Figure 2. Schematic diagram showing locations of GBP monitoring stations relative to major hydrologic features of the study area.

Figure 3. Daily mean flows (cfs) at GBPCMP stations. Flow at station A is recorded as a daily mean. Flows at stations B, D, F, and N are recorded at 15 min intervals. Note different scales of vertical axes and break in vertical axis for station N.

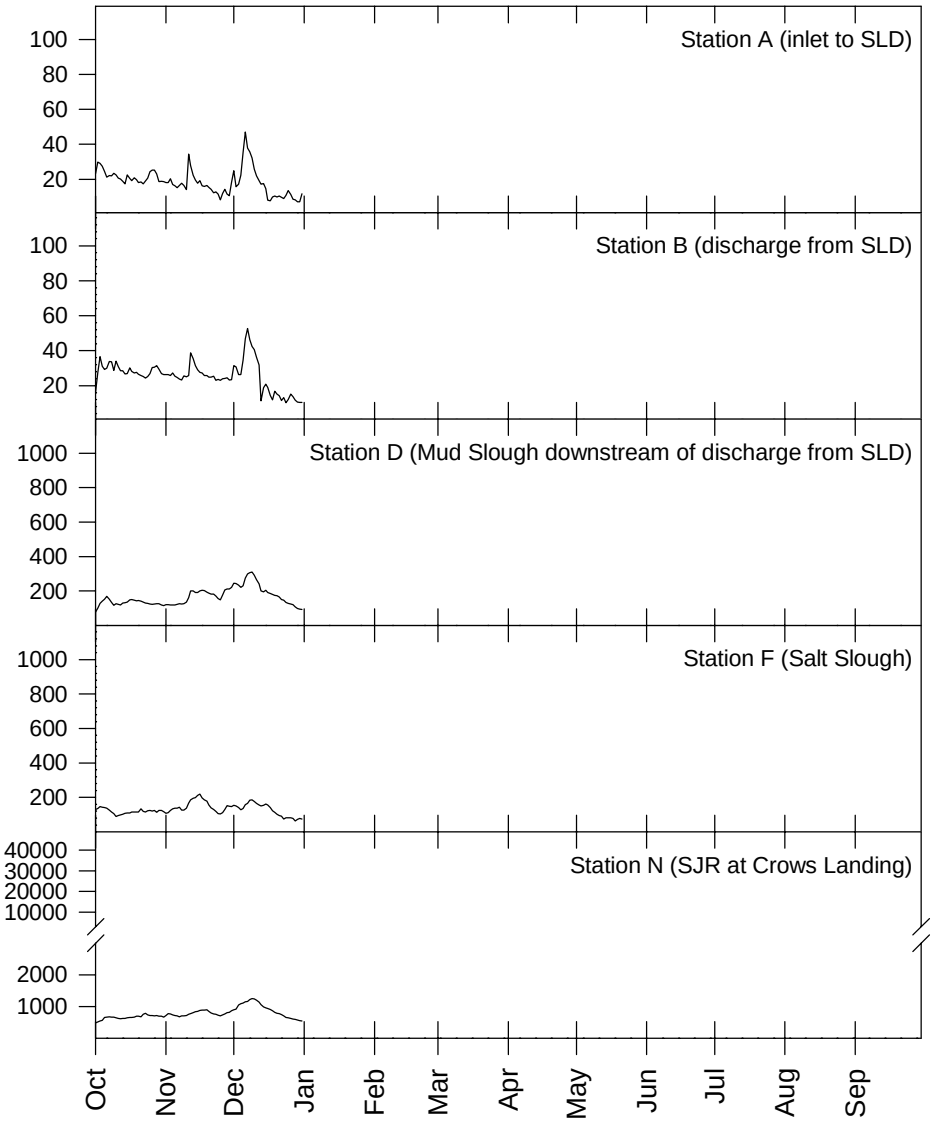

Figure 4. Selenium concentrations and selenium load discharge at station B (discharge from SLD): a) comparison of monthly load discharge and load values; b) comparison of cumulative load discharge and load values; c) daily average flows; d) daily average selenium concentrations; and e) calculated daily average load discharge.

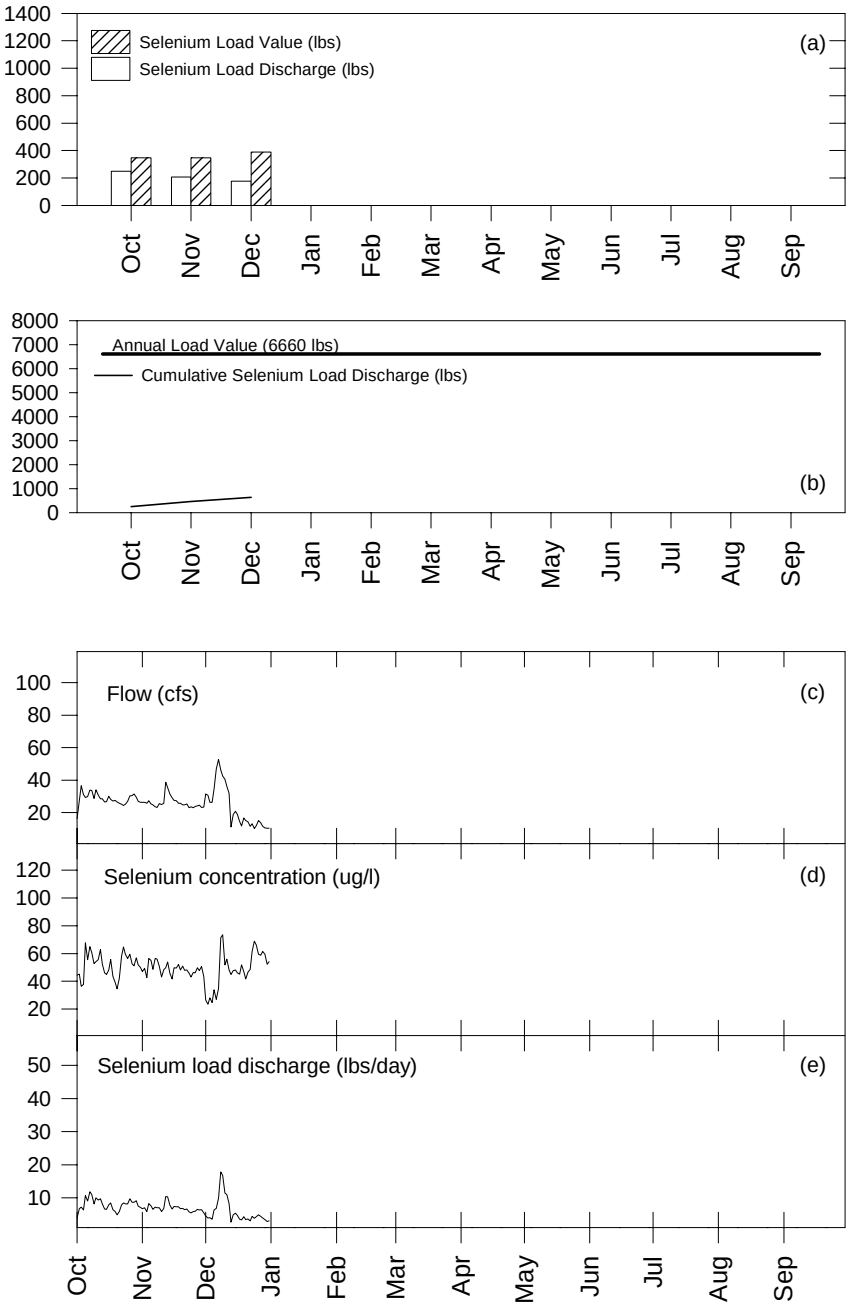

Figure 5. Daily average flows and selenium concentrations at station N (San Joaquin River at Crow's Landing). Flows at station N for January and February were estimated (see text). Note break in vertical axis for flow plot.

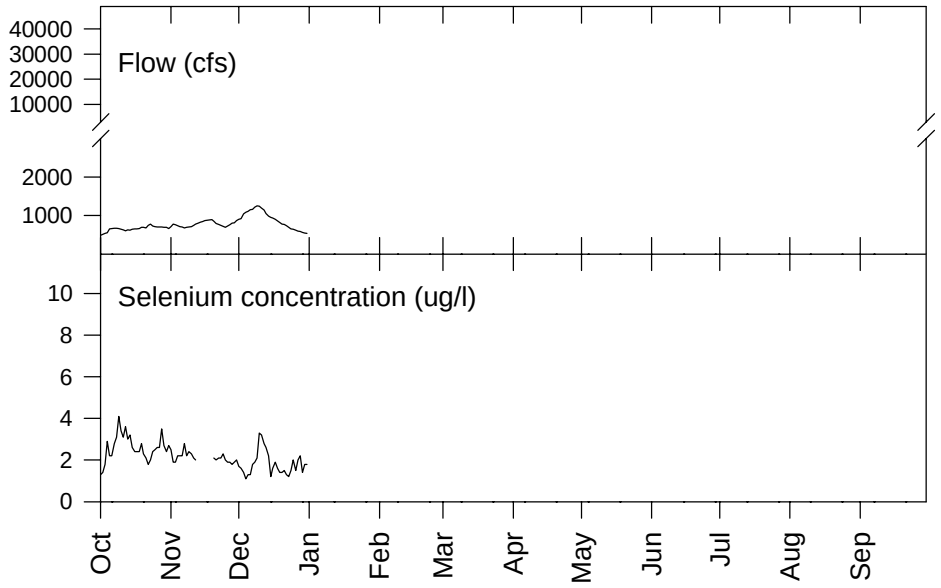

Figure 6. Selenium concentrations (ug/l) at station A (near the inlet to the San Luis Drain), station B (discharge from the San Luis Drain), station C (Mud Slough upstream of the GBP discharge), and station D (downstream of the GBP discharge). Data from weekly grab samples.

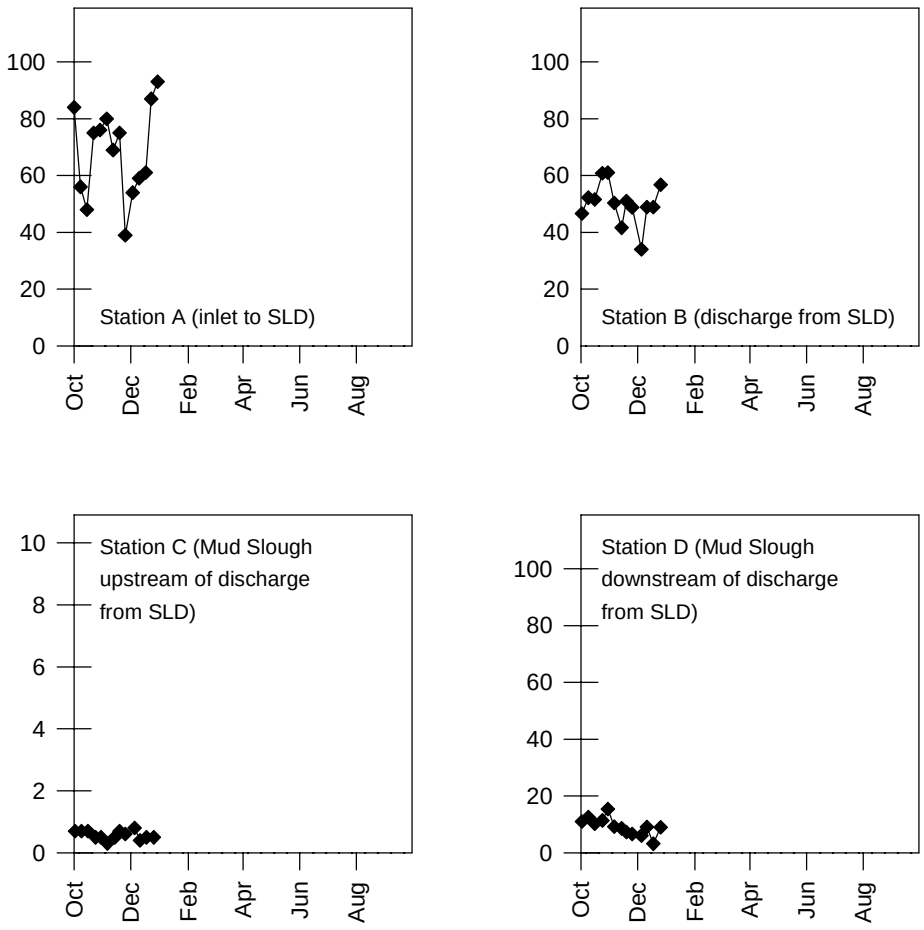

Figure 7. Selenium concentrations (ug/l) at station F (Salt Slough) and in the wetland water supply channels at station J, station K, station L, and station M. Data from weekly grab samples.

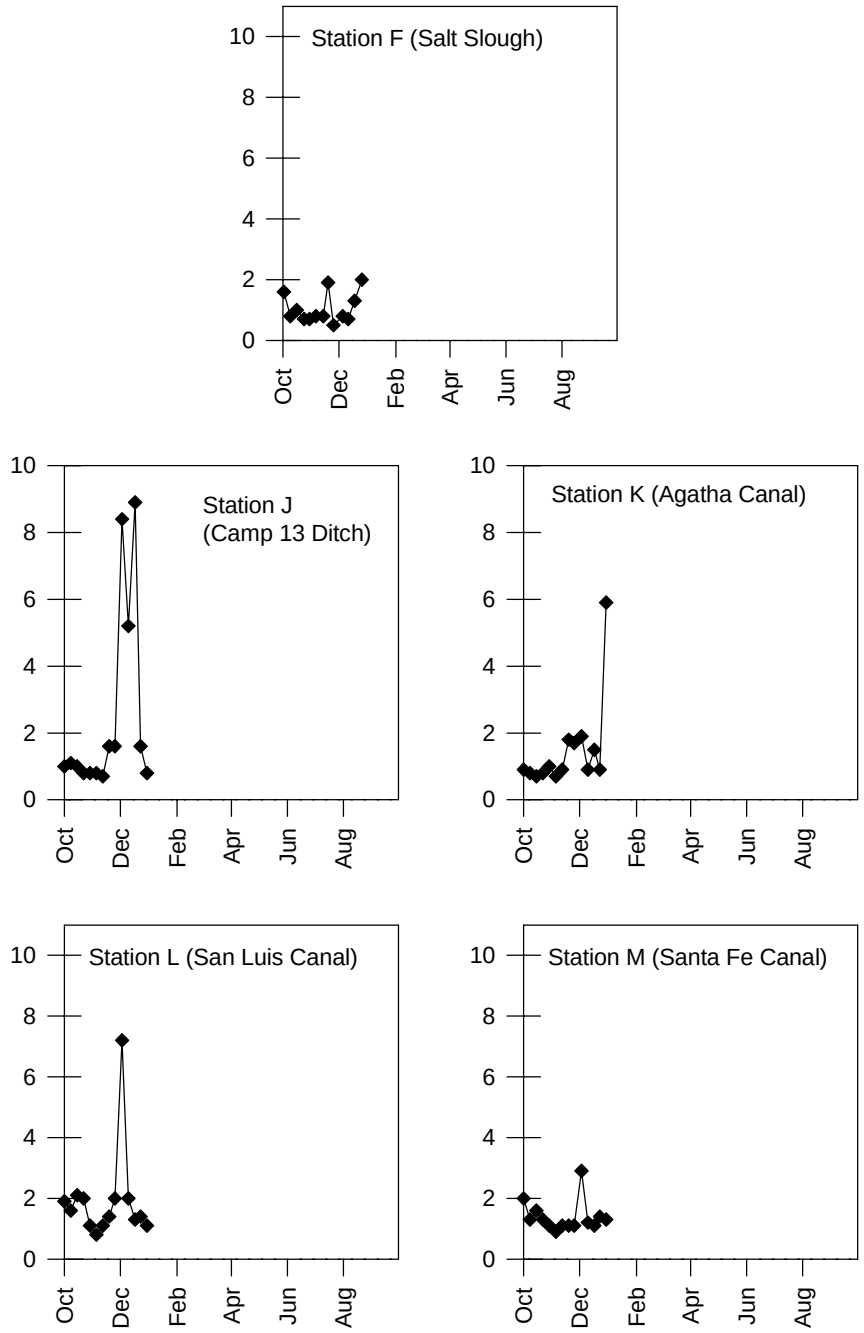

Figure 8. Selenium concentrations (ug/l) at San Joaquin River stations G (San Joaquin River upstream of Mud Slough confluence), H (San Joaquin River downstream of Mud Slough confluence), and N (at Crow's Landing, downstream of Merced River confluence). Data from weekly grab samples.

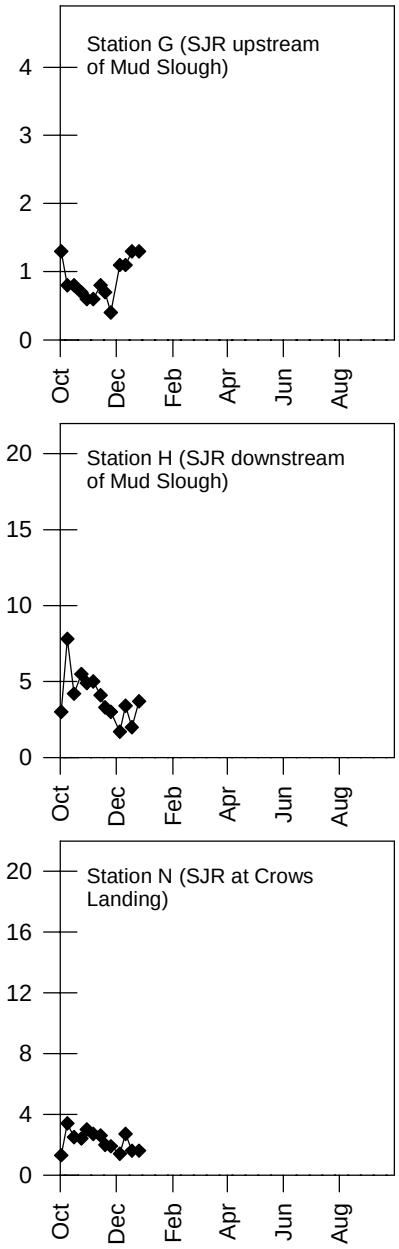

Figure 9. Daily average specific conductance (µS/cm) derived from measurements at 15 min intervals at stations B (discharge from the SLD), D (Mud Slough downstream of the GBP discharge), F (Salt Slough), and N (San Joaquin River at Crow's Landing).

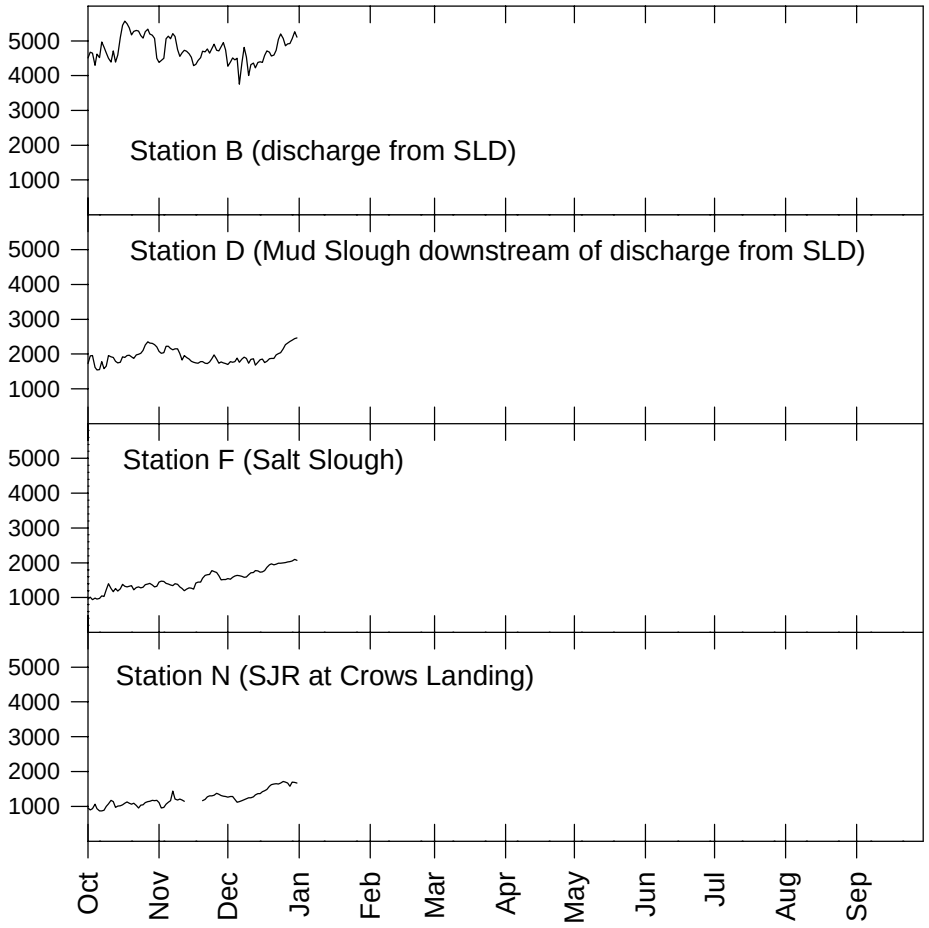

Figure 10. Specific conductance (µS/cm) in weekly grab samples. Letters indicate stations.