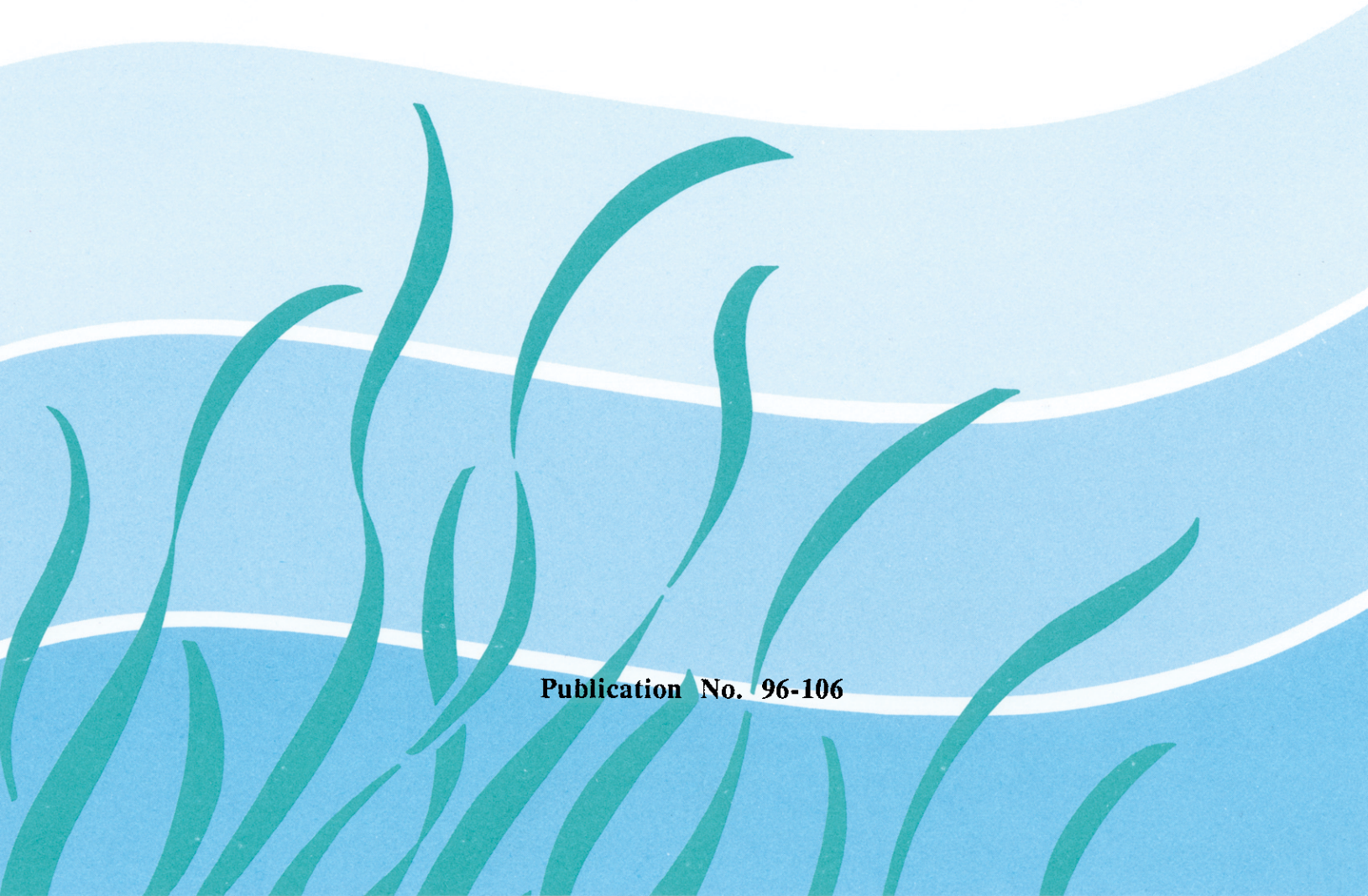
Padilla Bay
National Estuarine Research Reserve

Technical Report No. 5

SUSPENDED SEDIMENTS IN JOE LEARY SLOUGH, A NORTH PUGET SOUND COASTAL STREAM DRAINING AN AGRICULTURAL WATERSHED

Douglas A. Bulthuis

April 1996



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Padilla Bay National Estuarine Research Reserve
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ABSTRACT

Bulthuis, D.A. 1996. Suspended sediments in Joe Leary Slough, a North Puget Sound coastal stream draining an agricultural watershed. Washington State Department of Ecology, Padilla Bay National Estuarine Research Reserve Technical Report No. 5, Mount Vernon, Washington 46 pp.

The concentration of suspended sediments was measured weekly for one year at three locations in Joe Leary Slough and hourly for 26 hours on four occasions to indicate the seasonal and tidal variations. Water flow in Joe Leary Slough was influenced by the tide. The concentration of suspended sediment was highest during falling tides when outward flow was greatest. Suspended sediment concentration varied five to ten fold during the tidal cycle. Seasonally, the concentrations during winter were about four times as high as the dry season mean of about 20 mg l^{-1}. Peak concentrations during high rainfall and flooding were up to 200 mg l^{-1}. Joe Leary Slough contributes about 50-100 metric tonnes of sediment to Padilla Bay each year. The presence of cover crops on fields during winter decreased the flow of suspended sediments from the fields to the slough. The higher concentration of suspended sediments in Joe Leary Slough during winter reinforces the importance of winter cover crops in protecting water quality in fresh water sloughs and the bays to which they drain.

INTRODUCTION

Suspended sediments are one of the major constraints on biological productivity of estuaries. Reduced light from increased suspended sediments lowers productivity of seagrasses, phytoplankton and other estuarine plants. One important non-point source of sediments to small estuaries are agriculturally dominated watersheds drained by small streams or sloughs. Suspended sediments can vary widely among such streams depending partly on soil type and slope and on the type of agriculture and the farm management practices.

The objectives of this study were to determine the tidal and seasonal characteristics of the concentration of suspended sediments from Joe Leary Slough, a tidally influenced slough draining a predominately agricultural watershed, to Padilla Bay.

SITE DESCRIPTION

Joe Leary Slough has a watershed area of about 47 km^2 (18 $miles^2$) (Fig. 1). About 88% of the watershed is in agricultural land use and the remainder forest, urban and miscellaneous land use. (Entranco and Nelson 1989). The slough drains an area that had been primarily freshwater marsh a few feet above sea level before diking and draining about 100 years ago.

The mouth of Joe Leary Slough is dammed and has a series of ten tidal gates — pipes with hinged caps on the marine side that close when water height on the marine side is higher than on the freshwater side.

Sample sites for the weekly sample collection were located at the tidal gates, at the Farm to Market Road bridge over the slough and at the Allen West Road bridge over the slough (Fig. 2). The tidal gates site (L6) was located in mid-stream about 6 m from the tidal gates on the freshwater side. The Farm to Market Road bridge (L5) site has natural vegetation on both stream banks. Joe Leary Slough flows under Allen West Road (L4) in a circular pipe 3.4 m (11.2 ft.) in diameter. A second opening under Allen West Road, built for access of cattle under the road, functions as a culvert during times of very high flow.

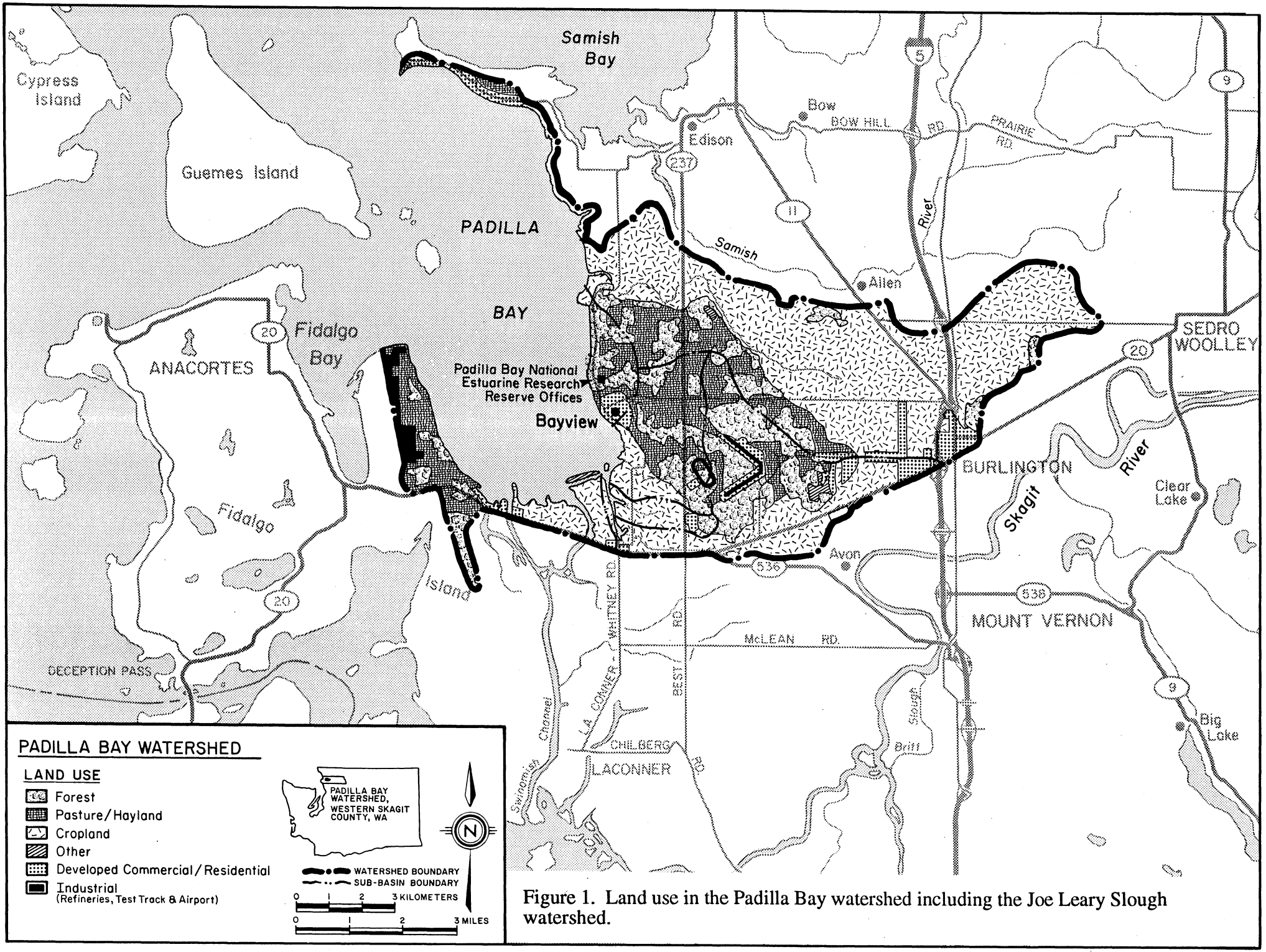

Figure 1. Land use in the Padilla Bay watershed including the Joe Leary Slough watershed.

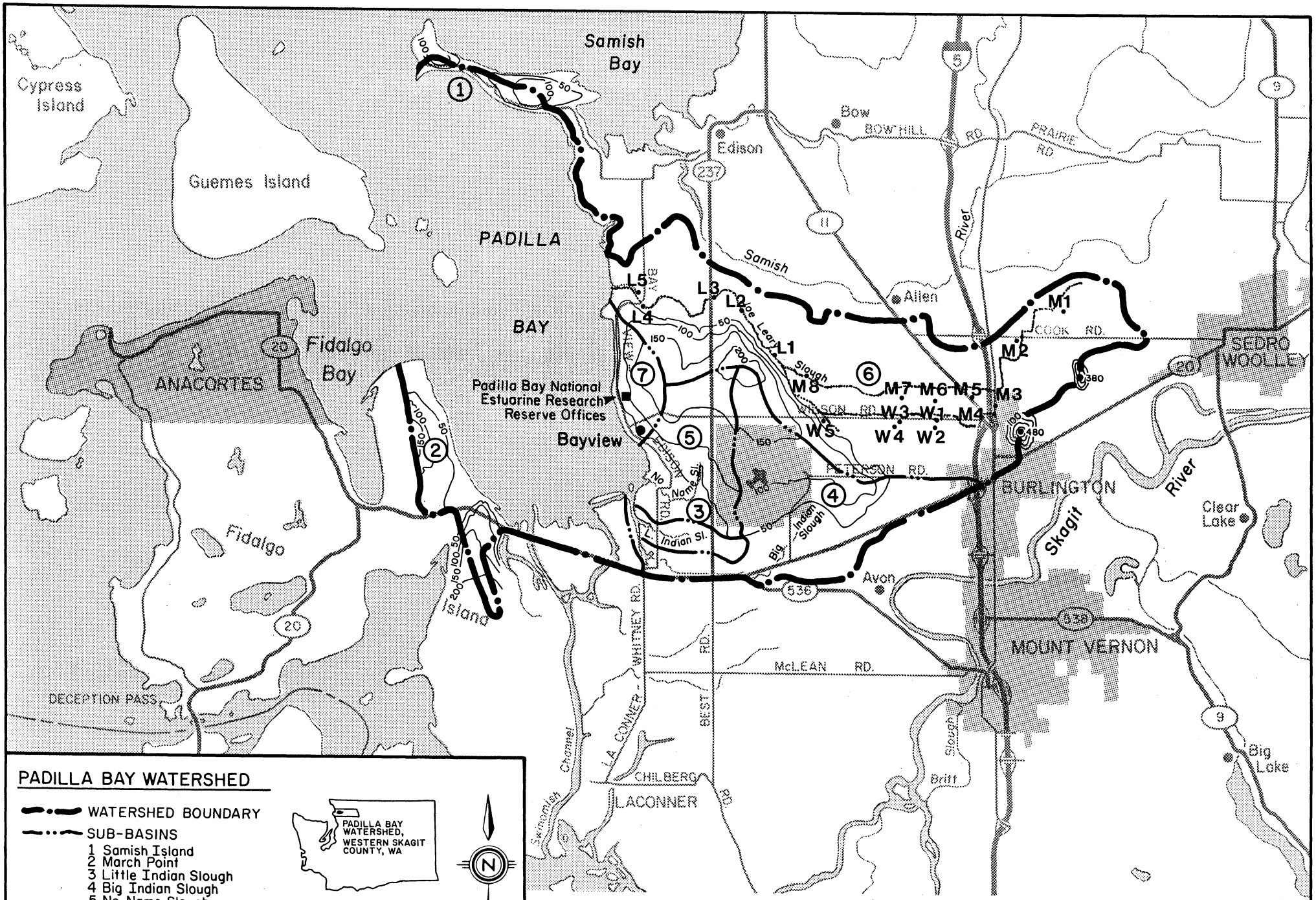

Figure 2. Location of sample sites on Joe Leary Slough for longitudinal survey and for weekly and tidal sampling. Site L5 is at the tide gates, site L3 is at the Farm to Market Road bridge and site L2 is at the Allen West Road bridge.

Sample sites for the longitudinal survey of Joe Leary Slough were placed at locations where a road bridge crossed Joe Leary Slough or where a tributary to the slough flowed through a pipe with a well defined channel in front of the pipe (Fig. 2). Sample sites were mid channel.

Sample sites for the comparison of fields with and without cover crop were placed where surface flow from the fields flowed into Joe Leary Slough or into one of the tributary ditches. Fields with a cover crop had at least one to two months of growth of a rye grass. Fields without a cover crop sometimes had some "volunteer" annuals visible, but an estimated 75% or greater of the ground surface was bare of vegetation.

METHODS

The concentration of suspended sediments was measured weekly during ebb tide for 12 months (Oct 90 to Sep 91) at three sites (L4, L5, L6; Fig. 2) on Joe Leary Slough; hourly for 26 hours four times during the year (autumn: Oct 11 and 12, 1990; winter: Feb 14 and 15, 1991; spring: May 16 and 17, 1991; summer: August 29 and 30, 1991) at the tidal gates (L6); twice (low flow: October 9, 1991; high flow: November 21, 1991) longitudinally from the headwater of Joe Leary Slough to the tidal gates at 18 sites; and on five rain events (April, 1991 and December, 1991) from fields with and without a cover crop. Weekly flow was estimated using velocity and cross sectional area measured at Allen West Road bridge on 19 occasions and correlated with water height measured weekly.

Sampling, preservation, and analytical methods were conducted according to the Puget Sound Protocols (Puget Sound Estuary Program 1986). Samples for analyses were collected at mid-depth using a LaMotte water sampler, kept cool and stored at $4^{o}C$ in cleaned, distilled water rinsed plastic sample containers until analysis within seven days. At the time of sample collection the temperature, salinity and conductivity of water in the slough were measured with a YSI model 33 field meter. Dissolved oxygen was measured with a YSI model 57 in the slough for the longitudinal survey.

Water samples for suspended sediments were filtered through preweighed Whatman GFC filters that had been pre-ashed and washed, dried for three hours at $105^{o}C$, weighed three times with one hour of drying between weighings, muffled at $550^{o}C$ for four hours and weighed again. Filters were kept in a desiccator when not in the oven or being

weighed. Blanks and laboratory replicates for quality control are reported in Appendix B. Replicate samples were taken each time during the 26 hour surveys, the longitudinal surveys and thecover crop surveys. Replicate field samples were taken for 25% of the weekly samples.

RESULTS

Longitudinal Survey

The concentration of suspended sediments differed by more than ten times from the headwaters of Joe Leary Slough to its mouth at the tidal gates with the highest concentrations near the headwaters (Tables 1 and 2, Appendix A). Concentrations of suspended sediments were somewhat lower during the time of high flow compared to low flow. Organic weight was higher in the headwaters than near the mouth. In the samples taken in November 1991, the percentages of the total suspended sediments that were organic were 50% or greater in the four sites east of Interstate 5. The dissolved oxygen content in the water varied among sites, but was greater than 75% saturated at most sites. Very little oxygen was present at station M8 in October and M1 in November. Very high conductivity was measured at the two stations closest to the mouth in October during a time of low flow.

Tidal Fluctuations

Concentration of suspended sediments increased when water flowed out of the tidal gates and decreased as saline water from Padilla Bay seeped into the slough (Fig. 3). The water height increased slowly when the tidal gates were closed, but decreased more quickly when the tidal gates were opened. This same pattern of inverse correlation between water salinity and concentration of suspended sediments was observed on all four tidal cycles that were measured (Figs. 3-6, Appendix C). The water flow (and concentration of suspended sediments) at Allen West Road also fluctuated with the tide (Fig. 7). Saltwater from Padilla Bay seeps through the tidal gates during high tide (Figs. 3-6, 8).

Flow

Flow in Joe Leary Slough was measured at Allen West Road bridge where flow was expected to be above tidal influence. However, during times of high flow, the water velocity at Allen West Road bridge decreased substantially when the tide gates were

closed (Fig. 7, Appendix C-3). When the velocity decreased, the concentration of suspended sediments decreased to less than one quarter the concentration during times of high current velocity (Fig. 7, Appendix C-3, Appendix F). As a consequence, the measurements of water height at Allen West Road bridge taken weekly could not be used to indicate flow. From all of the flow data, those measurements were selected that were taken during the time when the tide was falling and flow at Allen West Road bridge would not be expected to be restricted by closed tide gates. These selected data indicated a relatively linear relationship between discharge and water height at Allen West Road bridge (Appendix E).

Seasonal Differences

The concentrations of suspended sediments fluctuated widely from week to week, especially during winter and spring (Figs. 9 and 10). Much higher concentrations (greater than 150 mg L^{-1}) were recorded during the high rainfall months of winter and spring than during summer and early autumn when the concentration was consistently less than 20 mg L^{-1} (Figs. 9 and 10). Suspended sediments at Allen West Road and Farm to Market Road were similar to those measured at the tidal gates (Figs. 9 and 10, Appendix D).

The temperature of the water in the slough fluctuates as would be expected seasonally (Fig. 11). The percentage of suspended sediments that was organic was about 20% most of the year (Fig. 11, Appendix D). However, during periods of low flow (late summer, early autumn) the organic fraction was occasionally above 40% and up to 50% of the total suspended solids.

Cover Crop Study

The presence of cover crops on fields during winter significantly decreased the concentration of suspended sediments in the water (Figs. 12 and 13). The rate of flow of water from fields with and without cover crop was not measured precisely, but the apparent volume of water flowing off fields without a cover crop was consistently greater than that flowing off fields with a cover crop.

Table 1. Suspended sediments and water quality at 13 sites in Joe Leary Slough on 9 October 1991 at a time of low flow. Sample sites are shown in Fig. 2.

Station number	Temp. (C)	Conductivity (µohms)	Oxygen (O2 ppm)	SS mean mg/l	Organic weight mean	
					mg/l	percent
M4	9.	310		65.0	20.0	30
M5	11.	270		76.0	21.0	28
M6	11.	225		64.0	18.5	30
M7	9.	220		17.0	5.5	16
M8	9.	210	4.4	8.0	3.7	48
W3	9.	205	9.5	14.7	2.9	23
W4	10.5			23.4	4.9	20
W5	11.	202		16.0	4.8	38
L1	9.8	248		13.3	4.5	36
L2	9.	250		10.8	2.7	25
L3	9.	250		4.9	1.2	26
L4	12.	30000	7.4	4.7	1.0	22
L5	11.5	31000	6.2	18.3	10.0	40

Table 2. Suspended sediments and water quality at 18 sites in Joe Leary Slough on 21 November 1991 at a time of high flow following rainfall in the watershed. Sample sites are shown in Fig. 2.

Station number	Temp. (C)	Conductivity (µohms)	Oxygen (O2 ppm)	SS mean mg/l	Organic weight mean	
					mg/l	percent
M1	9.	265	3.6	31.5	20.0	63
M2	9.	350	8.2	32.5	19.0	59
M3	8.8	270	7.2	29.0	15.0	52
M4	9.5	275	8.8	25.3	12.7	50
M5	8.8	270		26.8	11.7	44
M6	8.7	270	6.9	26.5	11.5	44
M7	9.	270	7.6	17.2	6.9	33
M8	8.5	230	7.5	23.5	6.3	27
W1	9.	195	9.6	6.8	1.2	17
W2	8.	160	10.2	9.4	1.8	17
W3	8.5	205	9.6	14.5	3.0	21
W4	9.	300	10.8	14.3	3.5	25
W5	9.5	290	8.5	20.0	5.5	28
L1	8.5	252	7.6	15.8	4.5	30
L2	8.3	248		9.0	3.0	33
L3	8.3	240		7.2	2.2	30
L4	8.	700		6.2	1.8	29
L5	7.5	950	8.6	2.8	0.9	16

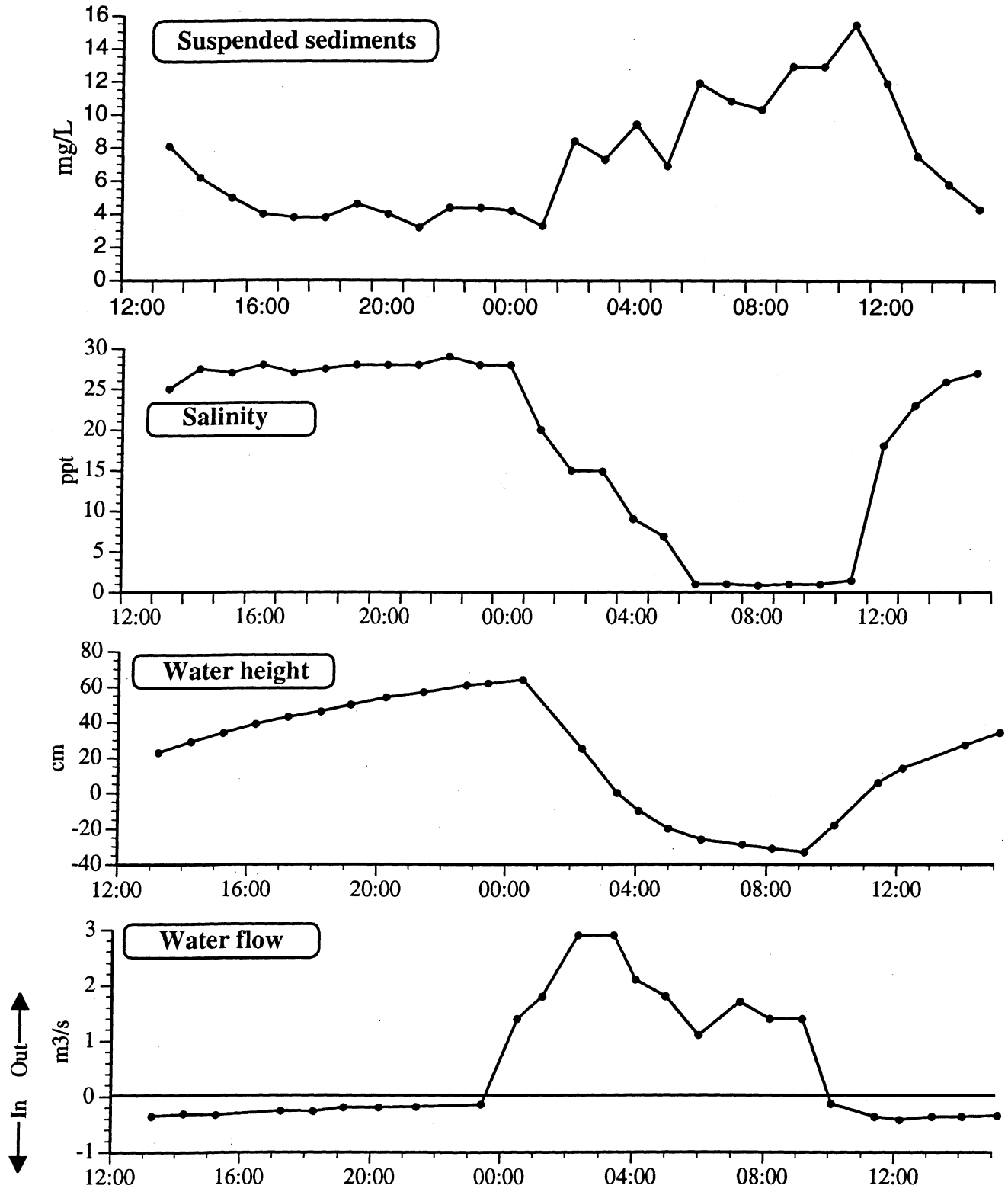

Figure 3. Suspended sediments and salinity (parts per thousand) at mid-water depth on the fresh water side of the tide gates in Joe Leary Slough at hourly intervals on October 11 & 12, 1990. Water height on the fresh water side of the tide gates relative to chart datum and flow "out" of the slough to Padilla Bay and "in" to the slough from Padilla Bay are shown for comparison.

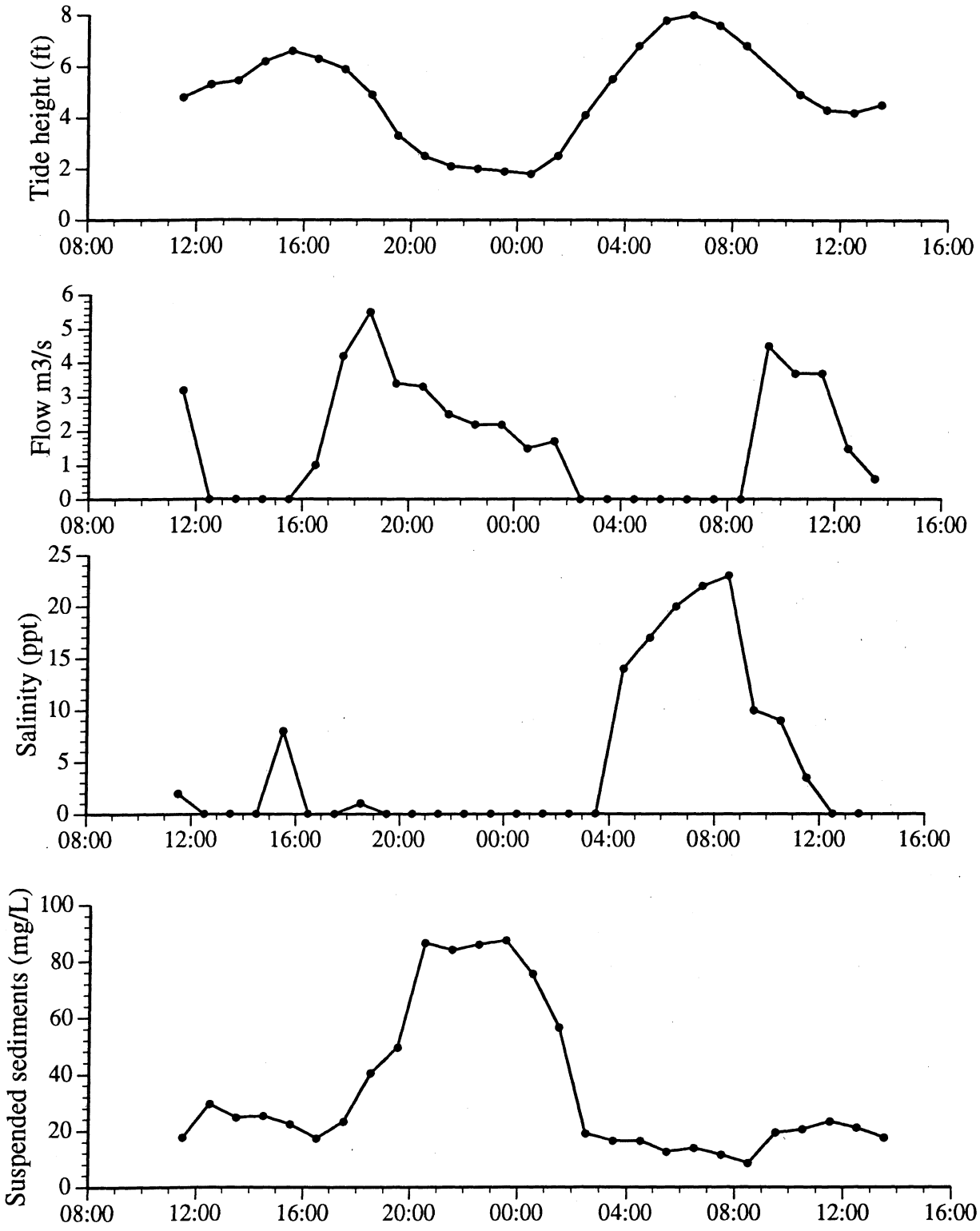

Figure 4. Suspended sediments, salinity (parts per thousand) and water flow on the freshwater side of the tide gates in Joe Leary Slough at hourly intervals on February 14 and 15, 1991. Tide height was measured on the marine side of the tidal gates.

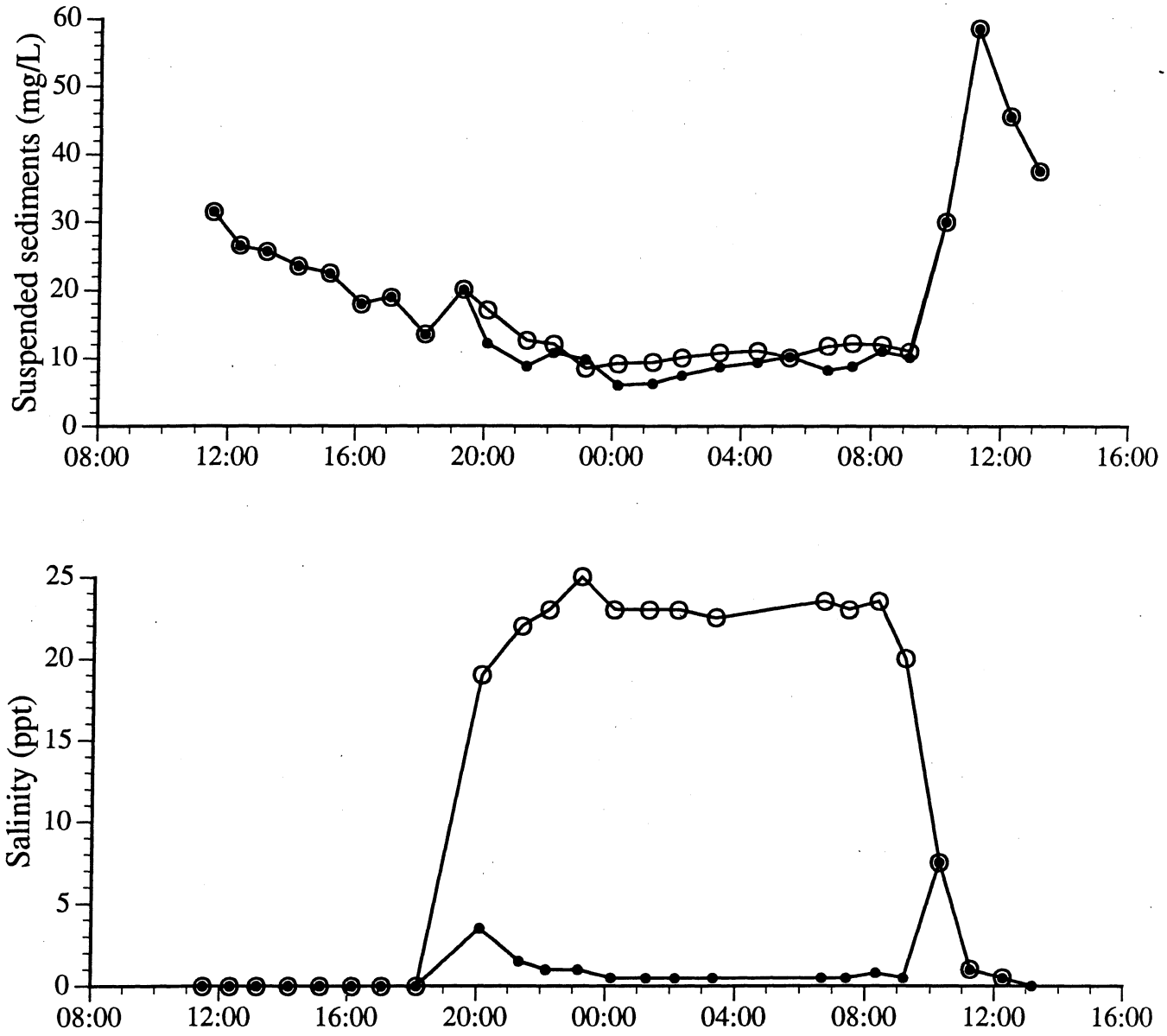

Figure 5. Suspended sediments and salinity (parts per thousand) in surface water (closed circles) and bottom water (open circles) on the fresh water side of the tide gates in Joe Leary Slough at hourly intervals on May 16 and 17, 1991.

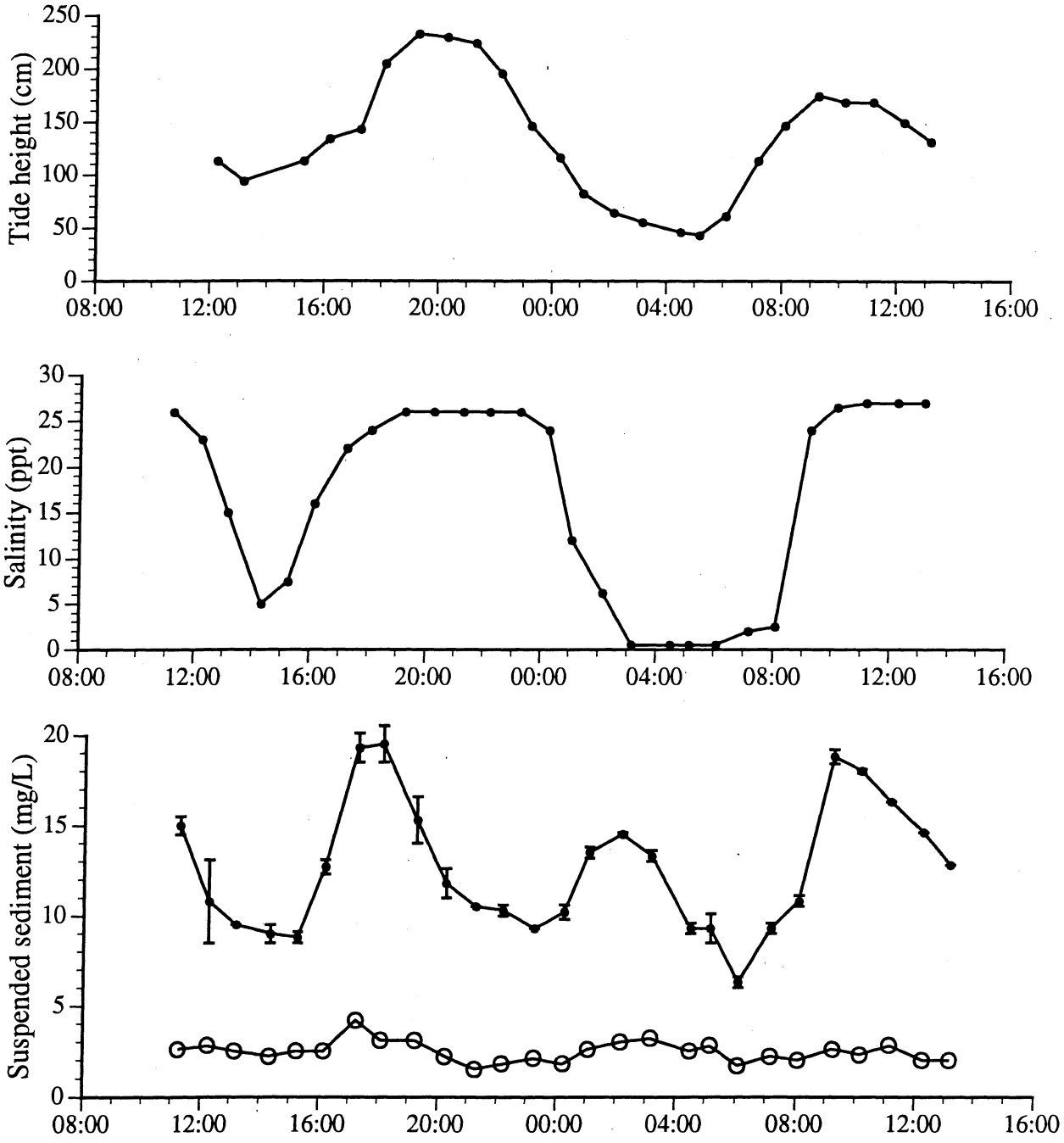

Figure 6. Tidal height, salinity (parts per thousand), total suspended sediments with standard error (n=2, closed circles) and organic weight of suspended sediment (open circles) on the fresh water side of the tide gates in Joe Leary Slough at hourly intervals on August 29 and 30, 1991.

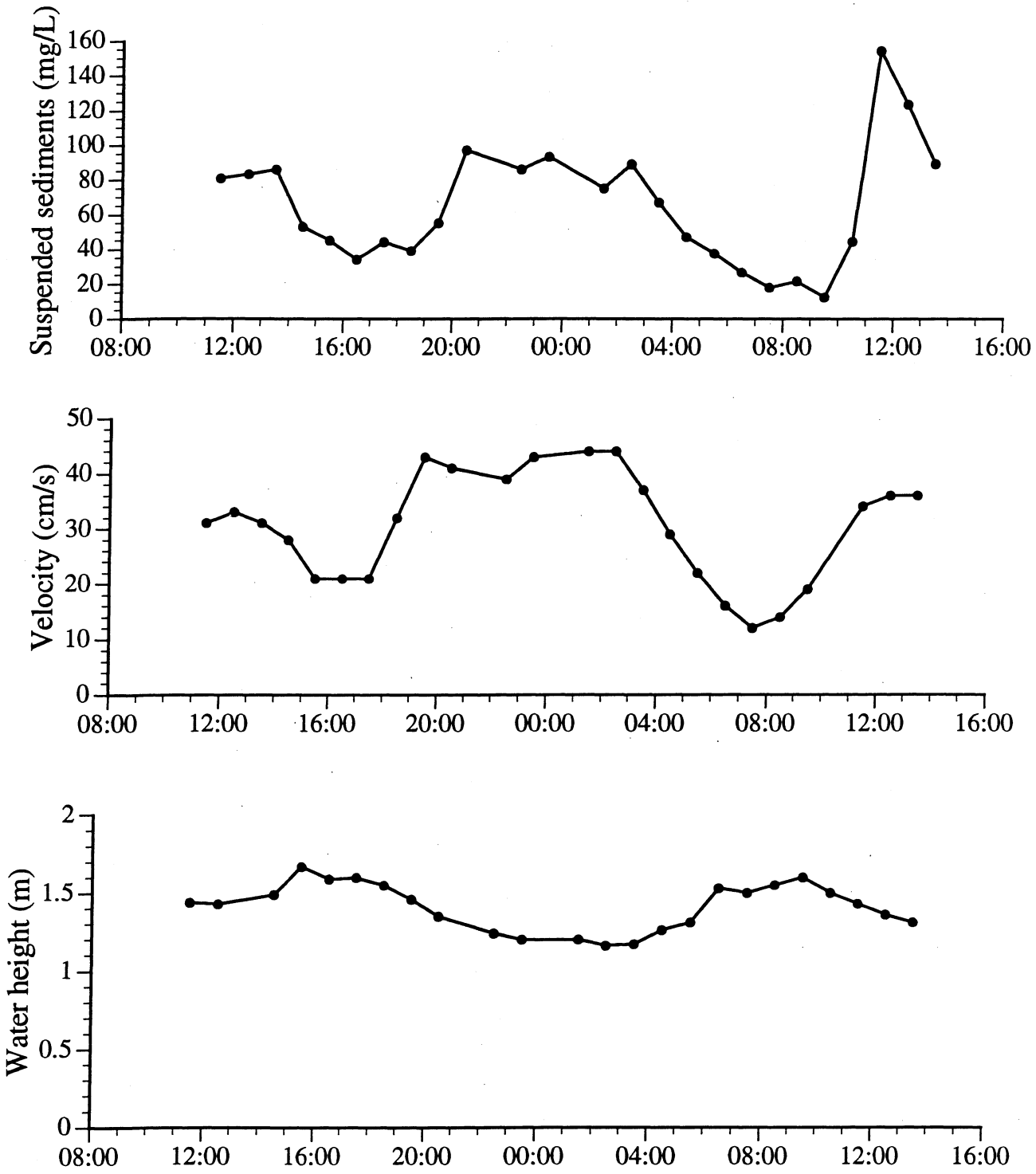

Figure 7. Suspended sediments, current velocity and water height in Joe Leary Slough at the Allen West Road bridge at hourly intervals on February 14 and 15, 1991.

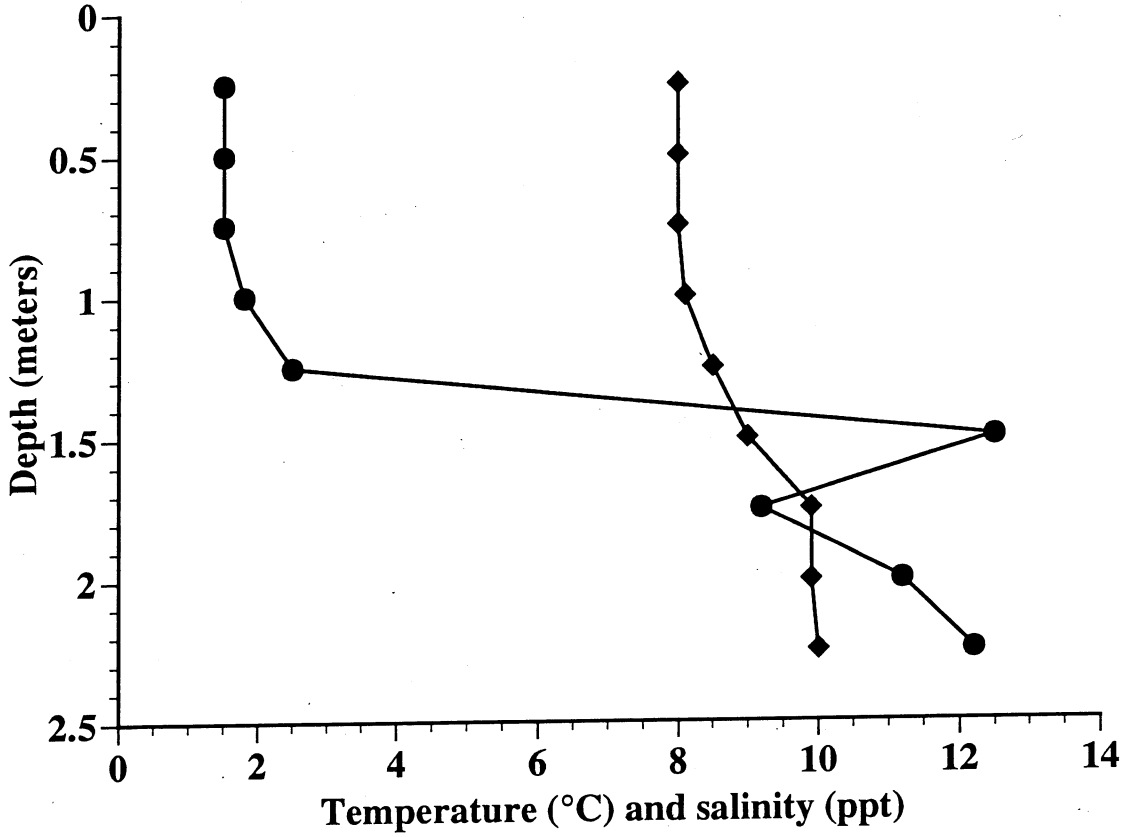

Figure 8. Salinity (circles) and temperature (diamonds) of Joe Leary Slough at the Bay View-Edison Road bridge on Saturday, April 6 at 8:45 am. The water had been ebbing for about an hour and was flowing out very strongly. Padilla Bay seawater was about 25 parts per thousand.

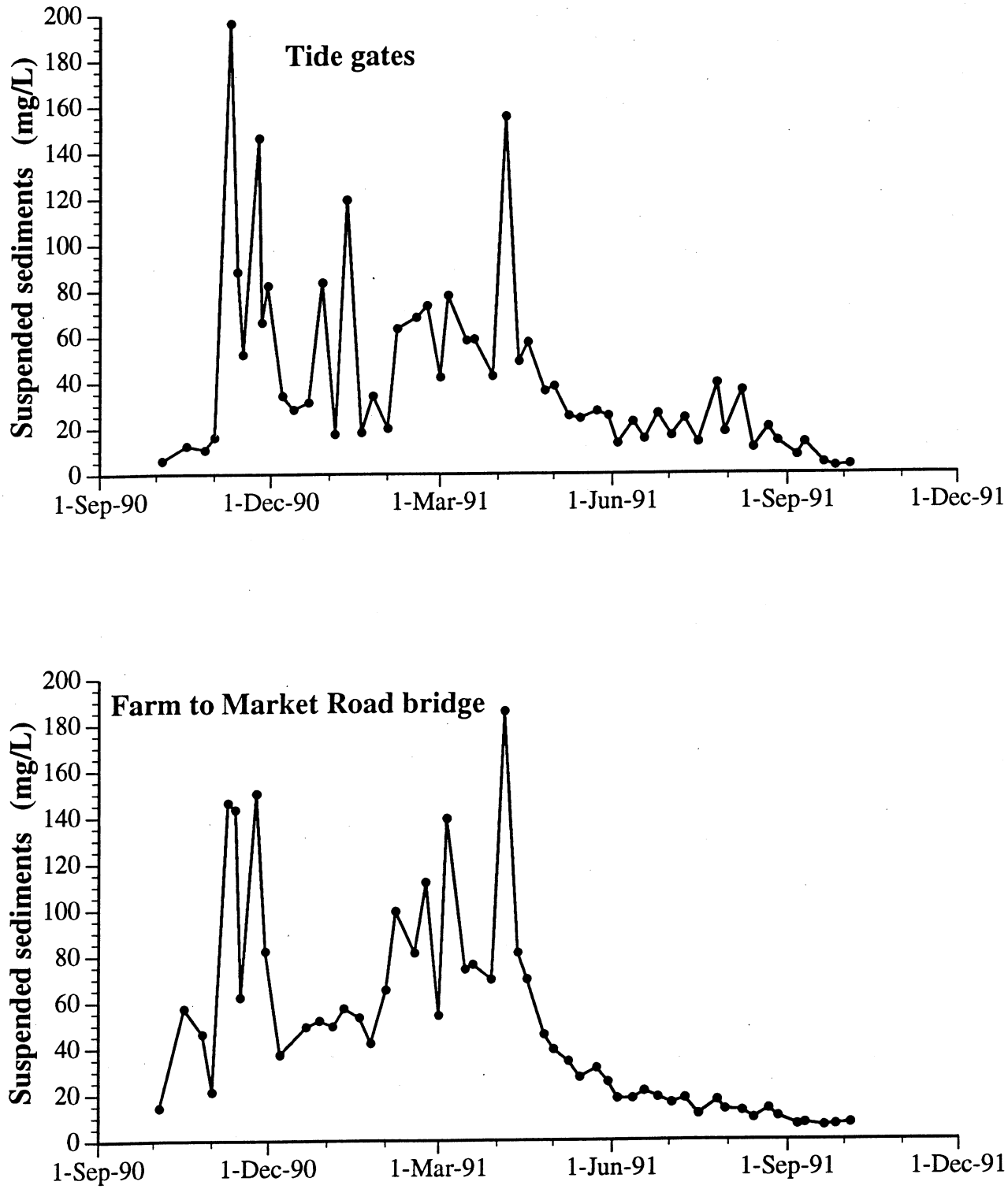

Figure 9. Suspended sediments at the tide gates and Farm to Market Road bridge on Joe Leary Slough from October, 1990 to September, 1991.

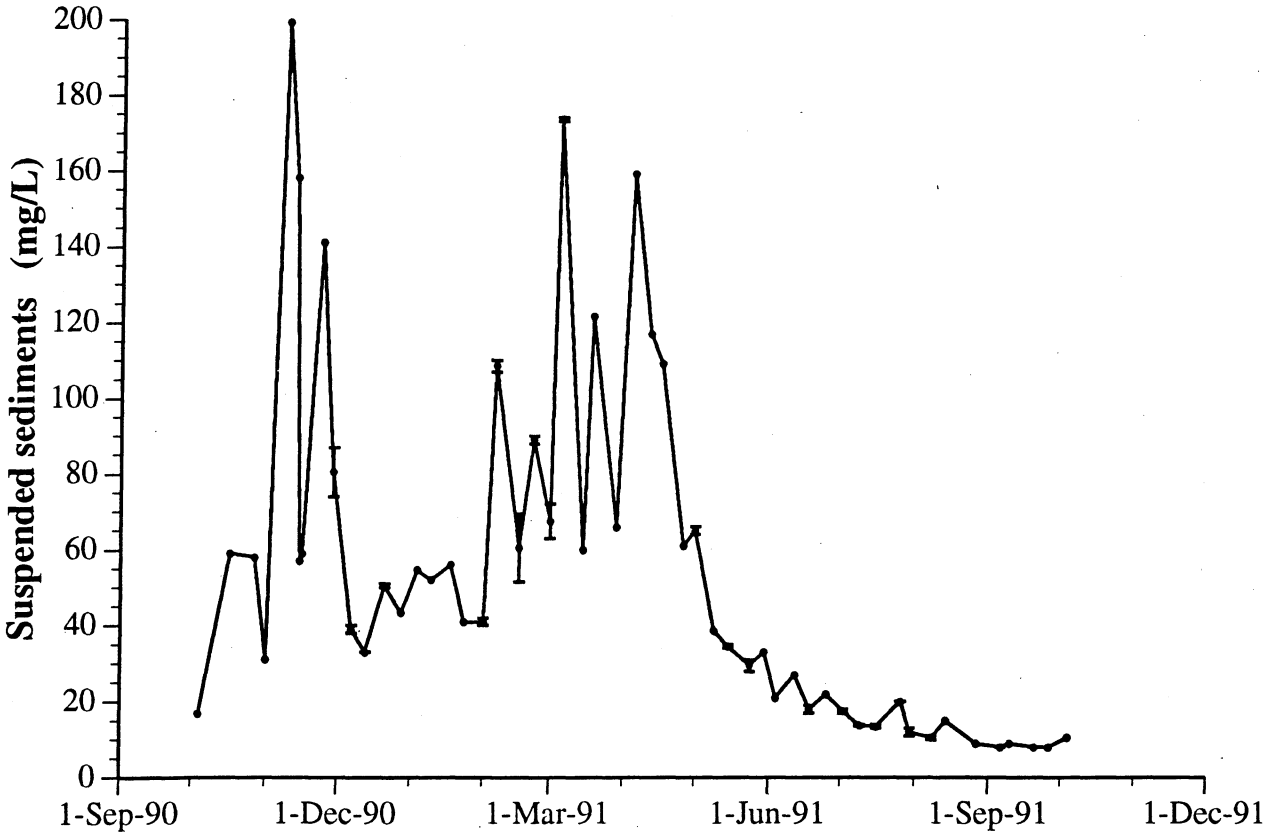

Figure 10. Suspended sediments (mean & s.e. of the mean, n=2) at the Allen West Road bridge from October, 1990 to September, 1991.

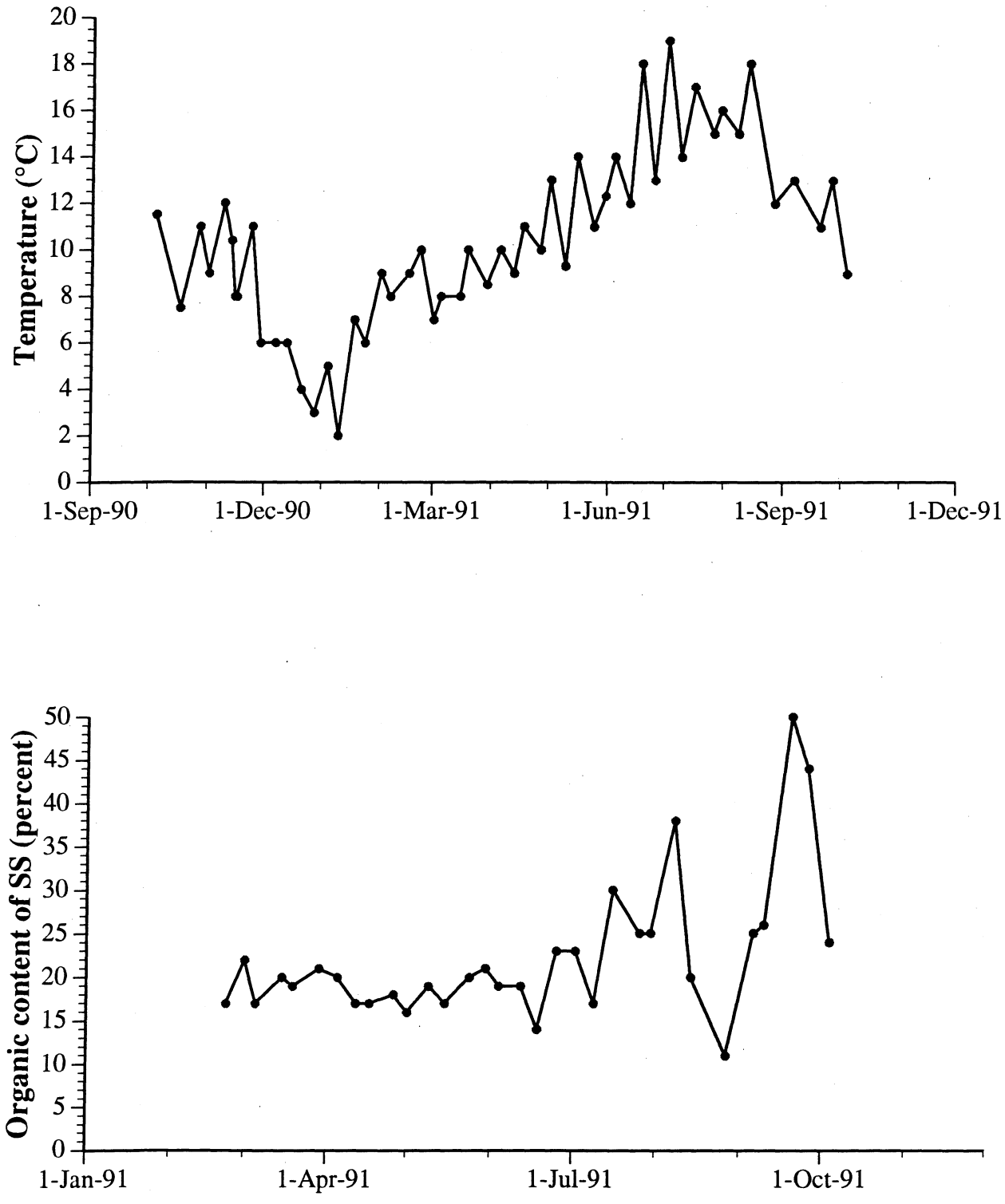

Figure 11. Temperature and organic content of suspended sediments in Joe Leary Slough at the Allen West Road bridge.

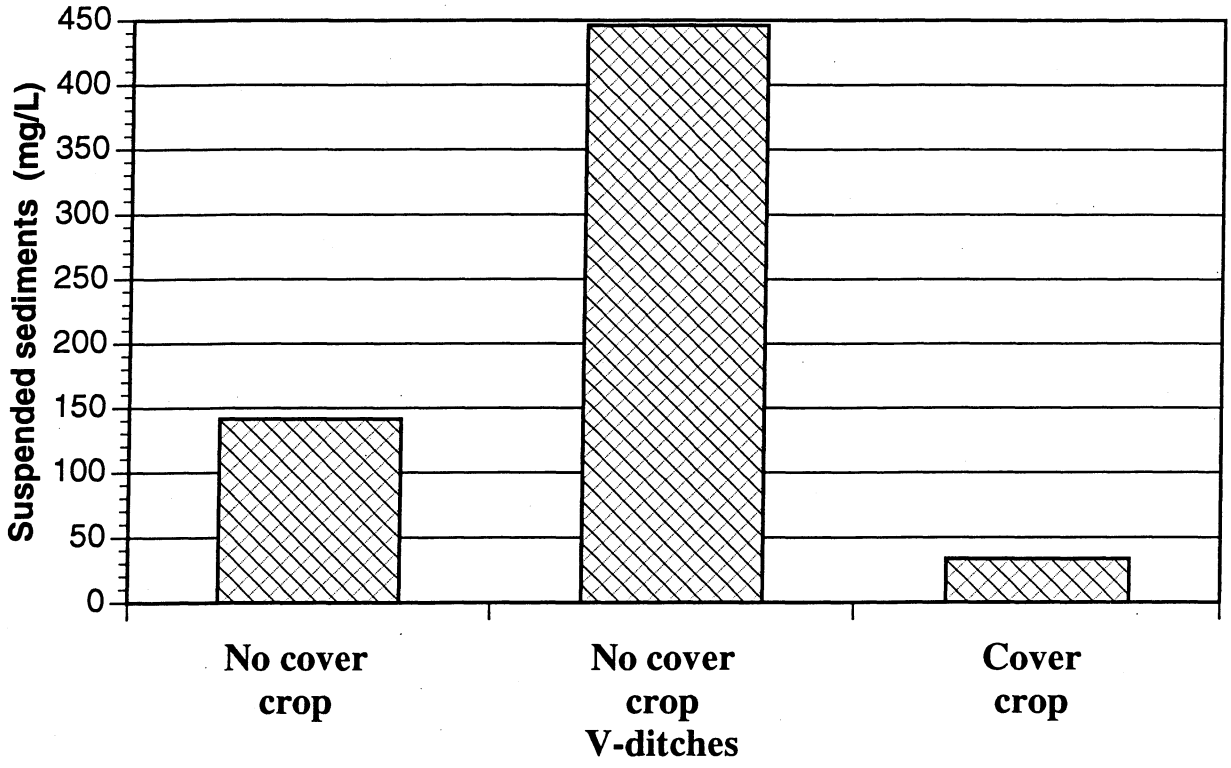

Figure 12. Concentration of suspended sediments in ditches draining fields during moderate rainstorms in December, 1991, in the watershed of Joe Leary Slough, Skagit County, Washington. Each column is the mean of 3 to 6 samples taken of surface water flowing from fields with the indicated type of cover.

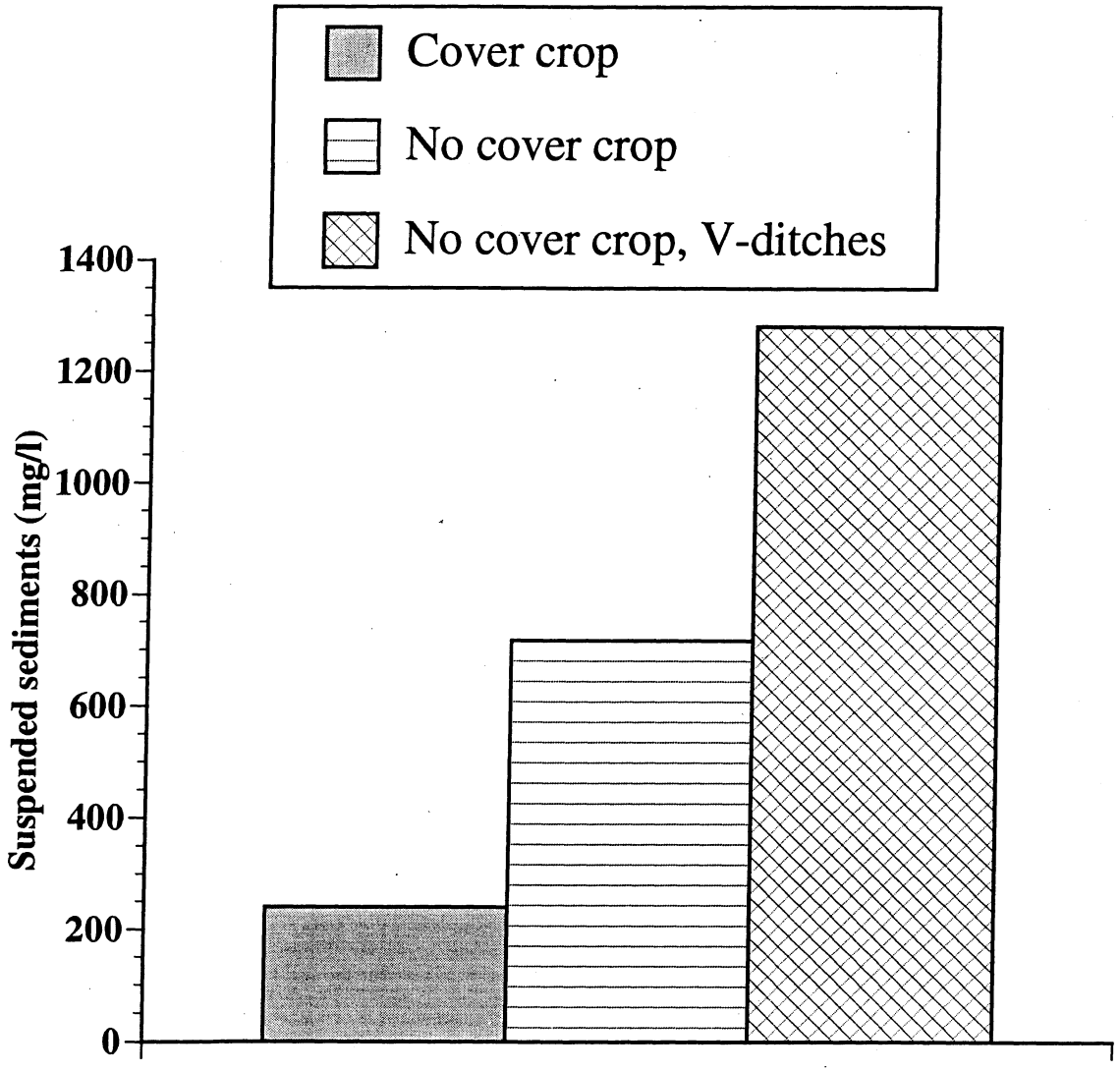

Figure 13. Concentration of suspended sediments in ditches draining fields during a moderate rainstorm on April 4, 1991, in the watershed of Joe Leary Slough, Skagit County. Each column is the mean of 3 to 6 samples taken from fields with the indicated type of cover or drainage type.

DISCUSSION

This study has documented the tidal and seasonal variations in concentration of suspended sediments in Joe Leary Slough. In spite of the "tidal gates", tidal fluctuations are an important factor controlling concentration of suspended sediments in the slough. Saltwater intrusion occurs with each tidal cycle, but tidal fluctuations in water height and flow occur far above the area of salinity intrusion, at least as far upstream as the Allen West Road crossing. Thus, Joe Leary Slough functions as a small estuary with a tidal freshwater portion and a portion with intermittent seawater intrusion. The seawater usually has less suspended sediment than the overlying freshwater. The decreased suspended sediments during high tide may be caused both by dilution with seawater and by decreased stream velocity in the slough. During low tide, stream velocity is higher in the lower reaches of Joe Leary Slough and the concentration of suspended sediments is higher. However, during August the 26 hour study did not follow this same pattern of suspended sediment fluctuations as in the previous 26 hour studies. Instead, the concentration of suspended sediments peaked as salt water seeped back into the slough (Fig. 6) and then decreased while the salinity remained the same and peaked a second time as freshwater flowed out of the slough. The reason for the peak in suspended sediments when the salt water first enters the slough is not clear, but may have been caused by currents reversing through the tidal pipes or by salinity — sediment interactions as salt water contacted sediments in the basin around the tide gates. The peaks in suspended solids that occurred during maximum outflow are probably caused by the higher velocity that keeps the sediments in suspension and may resuspend sediments that settled to the bottom during the previous high tide (low velocity flow). The need for regular dredging of the slough indicates that there is net deposition of suspended sediments in the lower part of Joe Leary Slough, so not all of the sediments that settle during high tide (low velocity) are resuspended during low tide (high velocity).

In addition to the tidal variations, the seasonal fluctuations in concentration of suspended sediment are large. The tidal and seasonal differences are illustrated in a comparison of the 26 hour studies in October (dry season) and February (wet season). In October the concentration of suspended sediments fluctuated between a low of 3 mg l^{-1} during no flow conditions to 15 mg l^{-1} during high flow conditions (Fig. 3). In February, the concentration of suspended sediments fluctuated between 8 and 88 mg l^{-1}. Most of the suspended sediments that flow from Joe Leary Slough to Padilla Bay do so during

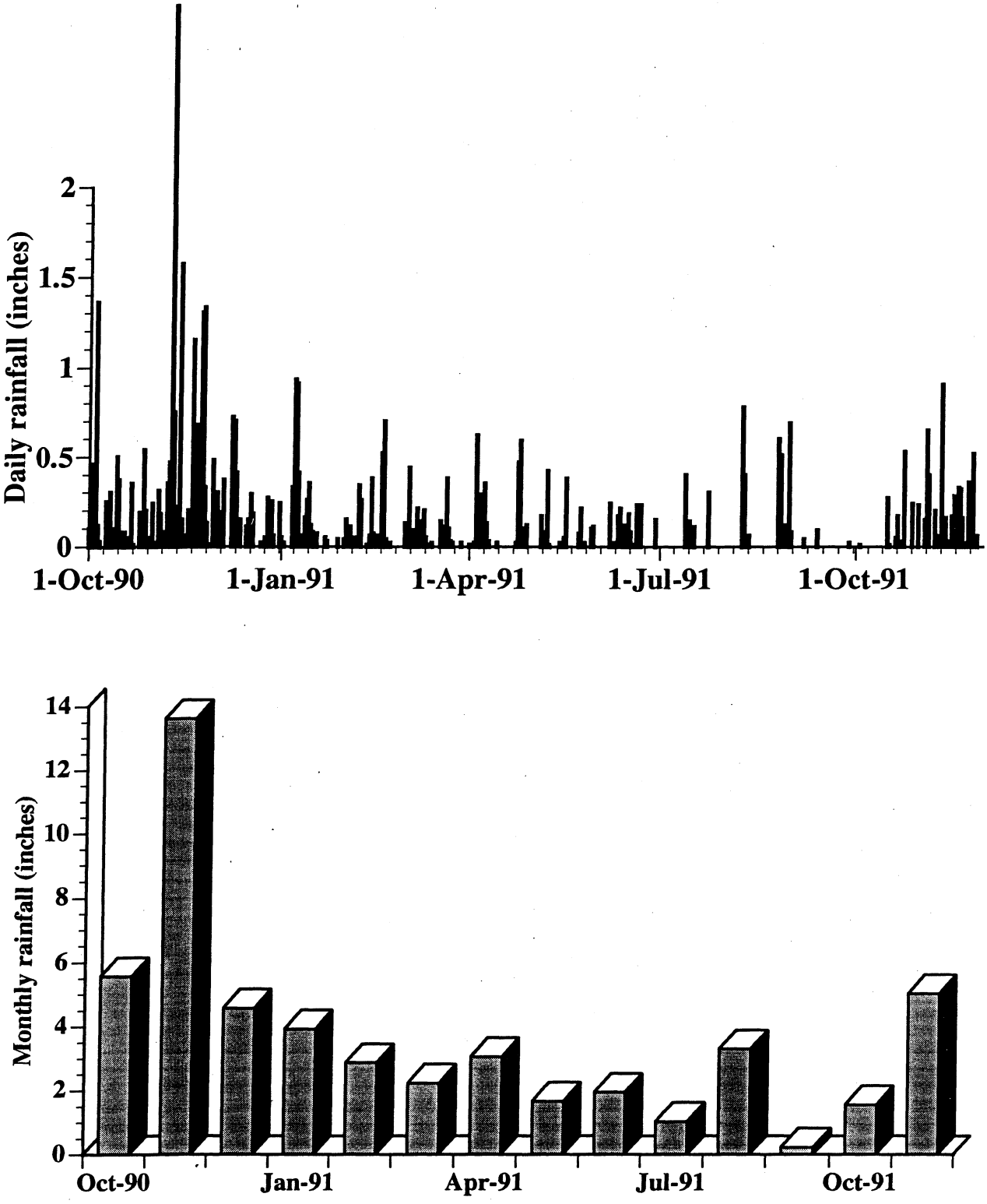

Figure 14. Daily and monthly rainfall totals (inches) as measured at the Washington State University Agricultural Experiment Station—Mount Vernon from October 1990 to November 1991.

winter and during times of high flow that are associated with high rainfall (cf. Figs. 9 and 14). These same characteristics—high concentration of suspended sediments coinciding with high flow are often observed in streams and sloughs from many different types of watersheds (Ursic and Dendy 1965, Campbell and Doeg 1989), so that storm event sampling is recommended to insure the best possible estimates of suspended sediment or pollutant flux (Paustian and Beschta 1979, Campbell and Doeg 1989, Horner *et al.*, 1986).

The variations in suspended sediments that were measured both seasonally and with each tidal cycle are due mainly to changes in the inorganic suspended sediments rather than the organic portion (Figs. 6 and 11). This is consistent with the hypothesis that the source of most of the suspended sediment in Joe Leary Slough is from the adjoining fields and not from organic production within the slough.

The limited sampling of water flowing from fields with and without a cover crop indicated several trends. The presence of cover crops substantially reduced the concentration of suspended sediment. On the other hand, the construction of V ditches to drain fields of excess water, also increases substantially the flow of sediments to the slough. Two other observations that were made during the course of the study were 1) that surface runoff from the fields in the Joe Leary Slough watershed rarely occurred except during the highest rainfalls; and 2) that when surface runoff did occur, there was far more flow off of fields that lacked a cover crop than from adjacent fields with a cover crop. The observations on suspended sediments from different fields were based on very limited sampling. The clear trends seen in this study should be tested with more extensive sampling and combined with quantitative measurements of the volume of flow off of different field types and measurements of the size of the drainage area.

The concentration of suspended sediments in Joe Leary Slough was always much higher than that in Padilla Bay, often about 10 times higher (unpublished data). The effect of this high concentration of suspended sediments on Padilla Bay needs to be evaluated by reference to the volume of flow of Joe Leary Slough and any indication of plumes off the mouth of the slough. Flow measurements were attempted in the present study, but tidal influence extends above Allen West Road on the slough, rendering conventional methods of measuring flow invalid. Entranco Engineers and Nelson (1989) estimated an annual discharge of about 14,000 acre-feet (17×10^6 m^3) from Joe Leary Slough. At

an annual average suspended sediment concentration of 40 mg l^{-1}, this would amount to about 68 metric tonnes of sediment discharged to Padilla Bay each year.

In summary, the present study indicated that flow in Joe Leary Slough responded to tidal fluctuations, that the concentration of suspended sediments varied five to ten fold in each tidal cycle and was highest during falling tides when current velocity was also highest, and that wet season (winter) concentrations were 60 - 100 mg l^{-1} and about four times as high as dry season (late summer) concentrations around 20 mg l^{-1}. Peak concentrations during high rainfall and storm events were up to 200 mg l^{-1}. Joe Leary Slough contributes on the order of 50 to 100 metric tonnes of suspended sediment to Padilla Bay each year. The presence of cover crops on fields during winter decreased the flow of suspended sediments to the slough and the use of v-ditches to drain fields increased the concentration of suspended sediments to the slough.

ACKNOWLEDGMENTS

Sincere thanks are due to all of the staff at Padilla Bay National Estuarine Research Reserve who helped throughout this study and particularly during the 26 hour studies; to Robin Cottrell who sampled, conducted almost all of the analyses of the samples as well as all of the initial data handling; to Sharon Riggs who developed the analytical methods and assisted in many aspects of the study; to Mark Olson and the WCC crew who sampled during good weather and not so good weather; to Debra Fiscus who assisted with the flow measurements; to Kraig Olason, Skagit Conservation District who helped develop this study; to Vicki Mesman, Skagit Conservation District, who assisted throughout the study; to the farmers in the watershed who gave permission for samples to be collected from their fields; and to Linda Smith for typing the manuscript. This study was financially aided through a grant to Skagit Conservation District from the Washington State Department of Ecology, Centennial Clean Water Fund and through a grant to the Washington State Department of Ecology with funds obtained from NOAA/Office of Ocean and Coastal Resource Management/Sanctuaries and Reserves Division, and appropriated for Section 315 of the Coastal Zone Management Act of 1972, as amended. The views expressed herein are those of the authors and do not necessarily reflect the views of NOAA or Washington Department of Ecology or any of their subagencies.

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APPENDICES

Appendix A-1. Suspended sediments and water quality from longitudinal survey of Joe Leary Slough during times of low flow (9 October 1991) and high flow (21 November 1991).

Date	Field station number	Station number	Temp. (C)	Conductivity (uohms)	Oxygen (O2 ppm)	SS mean mg/l	Organic weight mean		Field type and comments
							mg/l	percent	
9-Oct-91	J19	M1							no flow, oily sheen, no sample
9-Oct-91	J18	M2							no flow, oily sheen, no sample
9-Oct-91	J16773	M4	9.	310		65.0	20.0	30	N. side Old 99,(ditch); pasture,J17 (slough) inaccessable
9-Oct-91	J15771	M5	11.	270		76.0	21.0	28	Chuckanut bridge; plowed N.,winter wheat S.
9-Oct-91	J14769	M6	11.	225		64.0	18.5	30	Pulver and Maiben Rds.;mod. flow, plowed W., wheat S., unharvested potatoes N.
9-Oct-91	J13761	M7	9.	220		17.0	5.5	16	Maiben/Avon Allen intersection;plowed both sides, moderate flow
9-Oct-91	J06759	M8	9.	210	4.4	8.0	3.7	48	newly plowed south, berries north; moderate flow
9-Oct-91	J12	W1							no flow, stagnant water, not sampled
9-Oct-91	J10763	W3	9.	205	9.5	14.7	2.9	23	Avon Allen & Wilson Rd. int., (slough);corn & wheat N., plowed S.
9-Oct-91	J09765	W4	10.5			23.4	4.9	20	same location as J10 but in ditch flowing into slough; higher volume in ditch than slougl
9-Oct-91	J08775	W5	11.	202		16.0	4.8	38	foot of Bay View ridge; slow flow,plowed to N., pasture to S.
9-Oct-91	J05757	L1	9.8	248		13.3	4.5	36	berry fields and pasture
9-Oct-91	J04755	L2	9.	250		10.8	2.7	25	Allen West site; pasture
9-Oct-91	J03753	L3	9.	250		4.9	1.2	26	Farm to Market bridge;pasture north, volunteers south
9-Oct-91	J02751	L4	12.	30000	7.4	4.7	1.0	22	Bayview Rd. bridge; mowedwild grass & brambles
9-Oct-91	J01749	L5	11.5	31000	6.2	18.3	10.0	40	Tide gates; sunny, dry day
21-Nov-91	J19886	M1	9.	265	3.6	31.5	20.0	63	manure spreading in progress up slough;sheen on slough, slow flow; plowed & mowed f
21-Nov-91	J18884	M2	9.	350	8.2	32.5	19.0	59	Cook Rd. bridge, smells like manure,plowed N., cover crops S.; slow flow
21-Nov-91	J17882	M3	8.8	270	7.2	29.0	15.0	52	same location as J16 (slough);pasture
21-Nov-91	J16880	M4	9.5	275	8.8	25.3	12.7	50	E. of Old 99 (ditch);
21-Nov-91	J15878	M5	8.8	270		26.8	11.7	44	Chuckanut bridge;cover crops and some stubble
21-Nov-91	J14876	M6	8.7	270	6.9	26.5	11.5	44	Pulver and Maiben rds. spuds/plowed W., cover crop/spuds E.
21-Nov-91	J13888	M7	9.	270	7.6	17.2	6.9	33	Maiben &Avon Allen intersection; cover crops and volunteers, swift flow
21-Nov-91	J06866	M8	8.5	230	7.5	23.5	6.3	27	berries N., fresh plowed S.,fast current
21-Nov-91	J12872	W1	9.	195	9.6	6.8	1.2	17	mod. current from buried pipe;(slough)
21-Nov-91	J11874	W2	8.	160	10.2	9.4	1.8	17	same location as J12,(ditch);3 corners cover crop, SE potato stubble
21-Nov-91	J10870	W3	8.5	205	9.6	14.5	3.0	21	Avon Allen intersection,(slough);fast current spilling over rocks
21-Nov-91	J09868	W4	9.	300	10.8	14.3	3.5	25	mod. flow; wheat N., plowed S.
21-Nov-91	J08890	W5	9.5	290	8.5	20.0	5.5	28	foot of Bay View Ridge; plowed N., pasture S.
21-Nov-91	J05864	L1	8.5	252	7.6	15.8	4.5	30	pasture W., berries across road to E., fast current
21-Nov-91	J04862	L2	8.3	248		9.0	3.0	33	Allen West; pasture,slow flow,2 m from top of culvert to water
21-Nov-91	J03860	L3	8.3	240		7.2	2.2	30	Farm to Market; mostly pasture, volunteer spinach S.
21-Nov-91	J02858	L4	8.	700		6.2	1.8	29	Bayview Rd.; slow flow
21-Nov-91	J01856	L5	7.5	950	8.6	2.8	0.9	16	tide gates; partly cloudy,high water

Appendix B. Replicate laboratory analyses (splits 1 and 2) of suspended sediments in Joe Leary Slough, the standard deviation of the replicates and the coefficient of variation.

Sample date	Sample #	Split 1 (mg/L)	Split 2 (mg/L)	Difference	Standard deviation	Coefficient of variation
12-Oct-90	STG035	8.3	7.7	0.6	0.42	5.3
27-Oct-90	SWG066	10.	10.2	- 0.2	0.14	1.4
1-Nov-90	SWM070	20.	20.	0.	0.	0.0
16-Nov-90	SWM081	63.	62.	1.	0.71	1.1
24-Nov-90	SWA084	170.	170.	0.	0.	0.0
29-Nov-90	SWM092	88.	77.3	10.7	7.57	9.2
7-Dec-90	SWG097	33.5	35.	- 1.5	1.06	3.1
13-Dec-90	SWM100	32.	32.	0.	0.	0.0
21-Dec-90	SWG105	31.3	31.3	0.	0.	0.0
28-Dec-90	SWM107	52.7	50.7	2.	1.41	2.7
4-Jan-91	SWG113	15.3	16.7	- 1.4	0.99	6.2
18-Jan-91	SWM120	52.	52.	0.	0.	0.0
24-Jan-91	SWG125	34.	35.	- 1.	0.71	2.0
1-Feb-91	SWG129	19.	20.	- 1.	0.71	3.6
6-Feb-91	SWM133	96.	102.	- 6.	4.24	4.3
14-Feb-91	STA137	81.	81.	0.	0.	0.0
14-Feb-91	STA140	80.7	86.	- 5.3	3.75	4.5
14-Feb-91	STG147	21.	22.	- 1.	0.71	3.3
14-Feb-91	STG165	89.	91.	- 2.	1.41	1.6
22-Feb-91	SWM230	110.	113.	- 3.	2.12	1.9
1-Mar-91	SWM235	48.	60.	-12.	8.49	15.7
5-Mar-91	SWG240	77.	78.	- 1.	0.71	0.9
15-Mar-91	SWG244	58.	58.	0.	0.	0.0
19-Mar-91	SWA245	123.	120.	3.	2.12	1.7
29-Mar-91	SWG252	44.	41.	3.	2.12	5.0
5-Apr-91	SWM254	186.	185.	1.	0.71	0.4
12-Apr-91	SWG308	50.	49.	1.	0.71	1.4
17-Apr-91	SWA310	107.	111.	- 4.	2.83	2.6
26-Apr-91	SWA314	62.	60.	2.	1.41	2.3
1-May-91	SWA318	63.	65.	- 2.	1.41	2.2
9-May-91	SWA322	38.	39.	- 1.	0.71	1.8
15-May-91	SWM328	27.	27.	0.	0.	0.0
16-May-91	STG349	12.	11.6	0.4	0.28	2.4
17-May-91	STG365	6.5	6.5	0.	0.	0.0
17-May-91	STG403	10.7	10.2	0.5	0.35	3.4
24-May-91	SWM414	30.	31.	- 1.	0.71	2.3
30-May-91	SWG419	25.	26.	- 1.	0.71	2.8

Appendix B. Continued.

Sample date	Sample #	Split 1 (mg/L)	Split 2 (mg/L)	Difference	Standard deviation	Coefficient of variation
4-Jun-91	SWA423	21.	27.	- 6.	4.24	17.7
12-Jun-91	SWG449	22.	23.	- 1.	0.71	3.1
18-Jun-91	SWA452	17.	21.	- 4.	2.83	14.9
26-Jun-91	SWG469	26.	23.	3.	2.12	8.7
2-Jul-91	SWG470	16.	17.	- 1.	0.71	4.3
9-Jul-91	SWA474	14.	13.	1.	0.71	5.2
16-Jul-91	SWG478	14.	13.	1.	0.71	5.2
26-Jul-91	SWG509	38.	40.	- 2.	1.41	3.6
30-Jul-91	SWM589	13.	13.	0.	0.	0.0
8-Aug-91	SWM594	12.	13.	- 1.	0.71	5.7
14-Aug-91	SWM597	10.	9.	1.	0.71	7.4
22-Aug-91	SWM637	13.	14.	- 1.	0.71	5.2
27-Aug-91	SWA639	9.	9.	0.	0.	0.0
30-Aug-91	STG671	13.4	14.2	- 0.8	0.57	4.1
30-Aug-91	STG689	18.2	18.	0.2	0.14	0.8
6-Sep-91	SWG700	8.	7.5	0.5	0.35	4.6
10-Sep-91	SWA704	9.	9.	0.	0.	0.0
20-Sep-91	SWM739	6.	6.	0.	0.	0.0
26-Sep-91	SWM742	6.5	6.5	0.	0.	0.0
4-Oct-91	SWG747	3.5	3.5	0.	0.	0.0

Appendix C-1. Field data and suspended sediments for Joe Leary Slough during tidal fluctuations on 11 and 12 October 1990. Sample location was the freshwater side of the tidal gates. Current direction OUT of Joe Leary Slough to Padilla Bay or IN to Joe Leary Slough from Padilla Bay.

Date	Time	Temp	Salinity	Water height		Current			Flow	Suspended sediments
				Fresh	Marine	pipe no.	direction	Water velocity		
		°C	‰	cm	cm			ft/sec	m3/sec	mg/L
11-Oct-90	1311	9.5	25	95						8.6
11-Oct-90	1315									7.6
11-Oct-90	1329					1	IN	1.06	0.38	
11-Oct-90	1336					2to10	none			
11-Oct-90	1340					1	IN	0.89	0.32	
11-Oct-90	1413	8.8	27.5	101	209					4.9
11-Oct-90	1415			102						7.4
11-Oct-90	1435			95		1	IN	0.89	0.32	
11-Oct-90	1437			95		1	IN	0.84	0.3	
11-Oct-90	1510	9	27	106						4.9
11-Oct-90	1515	9	27	107						5.0
11-Oct-90	1525			108		1	IN	0.84	0.3	
11-Oct-90	1535			108	183	1	IN	0.95	0.34	
11-Oct-90	1610	9	28	111						4.0
11-Oct-90	1615									3.9
11-Oct-90	1620			112		1	IN			
11-Oct-90	1710	9	27	115						3.9
11-Oct-90	1720	9	27.5	115						3.6
11-Oct-90	1715					1	IN	0.68	0.24	
11-Oct-90	1717				155	1	IN	0.73	0.26	
11-Oct-90	1810	9	27.5	118						3.3
11-Oct-90	1815									4.2
11-Oct-90	1820			118		1	IN	0.73	0.26	
11-Oct-90	1905	9	28	122						4.4
11-Oct-90	1910									4.8
11-Oct-90	1921			122		1	IN	0.52	0.19	
11-Oct-90	2015	9	28	126						3.7
11-Oct-90	2020									4.3
11-Oct-90	2025			126		1	IN	0.41	0.15	
11-Oct-90	2030			129		1	IN	0.68	0.24	
11-Oct-90	2120	9	28	129						3.3
11-Oct-90	2125									3.1
11-Oct-90	2155					1	IN	0.46	0.16	
11-Oct-90	2200			134		1	IN	0.57	0.2	
11-Oct-90	2240			133						3.9
11-Oct-90	2245	9.2	29							4.9
11-Oct-90	2325			134						4.6
11-Oct-90	2328	9.2	28							4.1
11-Oct-90	2340			135		1	IN	0.41	0.15	
11-Oct-90	2342			135		1	IN	0.35	0.12	

Appendix C-1. (continued)

Date	Time	Temp	Salinity	Water height		Current			Flow	Suspended sediments
				Fresh	Marine	pipe no.	direction	Water velocity		
		°C	‰	cm	cm			ft/sec	m3/sec	mg/L
12-Oct-90	30	9	28	136						4.6
12-Oct-90	35									3.7
12-Oct-90	101			129		1	OUT	0.46	0.16	
12-Oct-90	103			129		1	OUT	0.35	0.12	
12-Oct-90	110	8.8	20							3.2
12-Oct-90	110		6.5							
12-Oct-90	110		20							
12-Oct-90	110		27							
12-Oct-90	115			124						3.3
12-Oct-90	128			118		1	OUT	0.62	0.22	
12-Oct-90	130			118		2	OUT	0.41	0.15	
12-Oct-90	219	9	15	97						8.5
12-Oct-90	223									8.3
12-Oct-90	233			89		1	OUT	0.57	0.2	
12-Oct-90	237			88		4	OUT	1.27	0.45	
12-Oct-90	242					10	OUT	0.62	0.22	
12-Oct-90	322	9	14.9	72						8.0
12-Oct-90	330									6.6
12-Oct-90	331			70		4	OUT	1.38	0.48	
12-Oct-90	335			67		1	OUT	0.39	0.13	
12-Oct-90	339					10	OUT	0.73	0.25	
12-Oct-90	402	(9)11	9	62						10.8
12-Oct-90	402									8.0
12-Oct-90	412					1	OUT	0.46	0.15	
12-Oct-90	415			59		4	OUT	0.84	0.27	
12-Oct-90	419					10	OUT	0.62	0.2	
12-Oct-90	458	9	6.8	52						6.2
12-Oct-90	458									7.5
12-Oct-90	509			51		1	OUT	0.35	0.11	
12-Oct-90	513					4	OUT	0.89	0.27	
12-Oct-90	517					10	OUT	0.57	0.17	
12-Oct-90	558	(9)11	1	46						12.2
12-Oct-90	606									11.5
12-Oct-90	614			45		1	OUT	0.26	0.07	
12-Oct-90	616					4	OUT	0.46	0.13	
12-Oct-90	619					10	OUT	0.46	0.13	
12-Oct-90	710	9	1	43						11.6
12-Oct-90	716									10.0
12-Oct-90	715			42		1	OUT	0.35	0.1	
12-Oct-90	720					4	OUT	1.	0.28	
12-Oct-90	728					10	OUT	0.46	0.13	
12-Oct-90	805	9	0.8	41						10.3
12-Oct-90	812									10.3
12-Oct-90	819			41		1	OUT	0.3	0.08	
12-Oct-90	821					4	OUT	0.89	0.24	
12-Oct-90	823					10	OUT	0.41	0.11	
12-Oct-90	905	9	1	39						11.8
12-Oct-90	910									14.0
12-Oct-90	913			39		1	OUT	0.3	0.08	
12-Oct-90	914					4	OUT	0.84	0.22	
12-Oct-90	916					10	OUT	0.41	0.11	

Appendix C-1. (continued)

Date	Time	Temp	Salinity	Water height		Current			Flow	Suspended sediments
				Fresh	Marine	pipe no.	direction	Water velocity		
		°C	‰	cm	cm			ft/sec	m3/sec	mg/L
12-Oct-90	1002	9.1	1	54						12.0
12-Oct-90	1007									13.8
12-Oct-90	1015			62		1	IN	0.62	0.21	
12-Oct-90	1016					4	IN	0.15	0.05	
12-Oct-90	1018					10				
12-Oct-90	1121			78		1	IN	0.95	0.34	
12-Oct-90	1122					1	IN	1.06	0.38	
12-Oct-90	1124	9.5	1.5	78						15.3
12-Oct-90	1125									15.5
12-Oct-90	1208	9.9	18.1	86						11.6
12-Oct-90	1213									12.1
12-Oct-90	1222			88		1	IN	1.16	0.41	
12-Oct-90	1305	10	23	113						7.3
12-Oct-90	1312									7.7
12-Oct-90	1318			96		1	IN	1.	0.36	
12-Oct-90	1405	10	26	99						5.5
12-Oct-90	1408									6.0
12-Oct-90	1406			99		1	IN	1.	0.36	
12-Oct-90	1508			106		1	IN	0.95	0.34	
12-Oct-90	1510	10	27	106						4.3
12-Oct-90	1512									4.2

Appendix C-2. Field data and suspended sediments data for Joe Leary Slough during tidal fluctuations study on 14 and 15 February 1991. Sample location was the freshwater side of the tidal gates. Mean & s.e. of the mean (n=2) of suspended sediments. No s.e. reported when only one sample was taken. Temperature in degrees Celsius. Salinity in parts per thousand. Water height on both the marine and the freshwater side of the tidal gate is listed. Flow data from pipe number 1.

Date-Time	Sample depth	Temp-erature	Salinity	Suspended sediments			Water height		Flow rate
				total		organic	fresh	marine	
				mean	s.e.				
	cm	°C	ppt	mg/L		percent	cm	cm	m3/sec
14-11:05	90	10	2	17.8	0.4	25	144	146	0.32
14-12:30	90	10	0	29.5	9.5	24	156	162	0.
14-13:25	90	10	0	24.8	2.3	21	163	166	0.
14-14:25	95	10	0	25.3	1.3	25	173	189	0.
14-15:15	105	10	8	22.3	0.8	30	179	201	0.
14-16:20	105	10	0	20.0		35	185	192	0.10
14-16:20	50	10	0	19.0		32			
14-16:20	100	10	0	14.7		27			
14-16:20	150	9	26	20.0		40			
14-17:30	100	9.5	0	23.3	1.3	25	181	180	0.42
14-17:30	150	9.5	15	24.0		27			
14-18:35	100	10	1	40.5	7.5	23	148	149	0.55
14-19:30	75	10	0	49.5	2.5	26	106	101	0.34
14-20:35	55	10	0	86.5	3.5	19	79	76	0.33
14-21:30	47	10	0	84.0	0.0	19	68	64	0.25
14-22:25	44	10	0	88.5		19	61	61	0.22
14-23:40	43	10	0	87.5	13.5	19	58	58	0.22
15-00:50	40	10	0	75.5	0.5	20	56	55	0.15
15-02:00	42	10	0	56.5	3.5	19	57	76	0.17
15-02:45	62	10	0	19.0	0.5	24	97	125	0.
15-03:35	75	10	0	16.5	2.0	20	126	168	0.
15-04:30	85	10	14	16.5		18	143	207	0.
15-04:30	25		4	15.0		20			
15-05:25	90	10	17	12.5	0.5	22	155	238	0.
15-05:25	25	10	3	14.0		25			
15-06:20	100	10	20	13.9	3.4	25	169	244	0.
15-06:20	25	10	3	18.0		31			
15-07:20	100	10	22	11.4	3.9	29	176	232	0.
15-07:20	25	10	2	15.5		29			
15-08:10	105	10	23	8.5	1.0	30	182	207	0.
15-08:10	25	10	1	17.8		30			
15-09:10	102	10	10	19.3	0.8	30	179	207	0.45
15-09:10	50	10	1	17.5		30			
15-10:15	100	10	9	20.5	1.5	27	155	149	0.37
15-11:15	80	10	4	23.3	1.3	24	135	131	0.37
15-12:15	77	10	0	21.0	0.5	25	125	128	0.15
15-13:15	80	10	0	17.5	0.0	23	134	137	0.06

Appendix C-3. Field data and suspended sediments for Joe Leary Slough during tidal fluctuations on 14 and 15 February 1991. Sample location was at the Allen West Road bridge. Water depth was recorded at the deepest section under the bridge.

Date	Time	Temp. °C	Salinity ppt	Water depth m	Water velocity cm/sec	Suspended sediments mg/L
14-Feb-91	1150	10.	0	1.44	31	81.0
14-Feb-91	1247	10.	0	1.43	33	83.4
14-Feb-91	1347	10.	0		31	86.0
14-Feb-91	1450	10.	0	1.49	28	53.0
14-Feb-91	1540	10.	0	1.67	21	45.0
14-Feb-91	1640	10.	0	1.59	21	34.0
14-Feb-91	1750	10.	0	1.6	21	44.0
14-Feb-91	1850			1.55	32	39.0
14-Feb-91	2001	10.	0	1.46	43	55.0
14-Feb-91	2105	11.	0	1.35	41	97.0
14-Feb-91	2255	10.5	0	1.24	39	86.0
14-Feb-91	2359	10.	0	1.2	43	93.0
15-Feb-91	130	10.	0	1.2	44	75.0
15-Feb-91	224	10.	0	1.16	44	89.0
15-Feb-91	312	10.	0	1.16	42	123.5
15-Feb-91	350	9.5	0	1.17	37	67.0
15-Feb-91	445	9.		1.26	29	47.0
15-Feb-91	545	10.	0	1.31	22	37.5
15-Feb-91	645	9.5	0	1.53	16	26.5
15-Feb-91	740	10.	0	1.5	12	18.0
15-Feb-91	825			1.55	14	21.5
15-Feb-91	925			1.6	19	12.3
15-Feb-91	1033			1.5		44.5
15-Feb-91	1130	9.5	0	1.43	34	153.8
15-Feb-91	1225	10.	0	1.36	36	123.0
15-Feb-91	1334	10.	0	1.31	36	89.0

Appendix C-4. Field data and suspended sediments data for Joe Leary Slough during tidal fluctuations study on 16 and 17 May 1991. Location was the freshwater side of the tidal gates. Temperature in degrees Celsius. Salinity in parts per thousand. Water height was measured on both the marine and the freshwater side of the tidal gate. Current data from pipe numbers 1and 4.

Date	Time	Sample depth	Temp-erature	Salinity	Suspended sediments total	Suspended sediments organic	Water fresh	height marine	Mean flow rate
		cm	°C	ppt	mg/L	percent	cm	cm	cm/sec
16-May-91	1129	35	15.	0.	31.5	19	51	52	16
16-May-91	1225		16.	0.	26.5	15	44	43	24
16-May-91	1310	32	17.	0.	25.7	18	40	40	20
16-May-91	1413	35	17.	0.	23.5	19	38	37	16
16-May-91	1512	30	17.5	0.	22.5	20	36	34	15
16-May-91	1613	30	17.5	0.	18.	19	34	27	18
16-May-91	1704	30	17.5	0.	19.	20	33	30	18
16-May-91	1807	40	17.	0.	13.5	22	61	110	
16-May-91	1930	50	17.	11.	22.3	19	77	198	
16-May-91	2010	25	17.	3.5	12.2	23	86	235	
16-May-91	2015	100	18.	19.	17.1	18			
16-May-91	2120	25	16.5	1.5	8.8	25	95	244	
16-May-91	2125	100	17.5	22.	12.6	18			
16-May-91	2210	25	16.	1.	10.9	21	102	241	
16-May-91	2220	100	17.	23.	12.1	21			
16-May-91	2315	25	15.	1.	9.9	19	106	229	
16-May-91	2315	100	17.	23.	8.5	20			
17-May-91	15	25	15.	0.5	6.	29	111	204	
17-May-91	15	100	16.5	23.	9.2	26			
17-May-91	120	25	15.	0.5	6.3	29	116	195	
17-May-91	120	100	16.5	23.	9.4	25			
17-May-91	215	25	15.	0.5	7.5	21	120	186	
17-May-91	215	100	16.5	23.	10.2	25			
17-May-91	322	25	15.	0.5	8.7	22	125	189	
17-May-91	322	100	15.5	22.5	10.8	21			
17-May-91	430	25			9.4	22			
17-May-91	430	100			11.1	22			
17-May-91	530	25			10.2	23			
17-May-91	530	100			10.1	23			
17-May-91	641	25	14.	0.5	8.2	18	136	213	
17-May-91	641	100	15.5	23.5	11.8	19			
17-May-91	726	25	13.5	0.5	8.8	18	137	195	
17-May-91	726	100	15.5	23.	12.2	19			
17-May-91	820	25	14.	0.8	11.	18	140	171	
17-May-91	820	100	16.5	23.5	12.	20			
17-May-91	911	25	13.5	0.5	10.1	17	142	140	
17-May-91	911	100	16.	20.	11.1	19			
17-May-91	1014	25	14.	7.5	30.1	20	101	104	
17-May-91	1135	45	12.5	1.	58.5	18	61	67	31
17-May-91	1217	40	12.5	0.5	45.5	21	53	55	27
17-May-91	1310	35	12.5	0.	37.5	23	45	46	26

Appendix C-5. Field data and suspended sediments for Joe Leary Slough during tidal fluctuations study on 29 and 30 August 1991. Sample location was the freshwater side of the tidal gates. Water height was measured on both the marine and freshwater side of the tidal gates. Equipment failure after 4:30 am prevented further collection of flow data.

Date	Time	Sample depth	Tempera - ture	Salinity	Conductivity	Water height		Suspended sediments			Water flow		
								total		organic			
						fresh	marine	mean	s.e.		direction	pipe	flow
		cm	°C	ppt		cm	cm	mg/L	mg/L	percent		no.	m3/sec
29-Aug-91	1115	75	14.2	26.	32500	128		15.0	0.5	17			
29-Aug-91	1215	67	15.5	23.	29000	108	113	10.8	2.3	26			
29-Aug-91	1310	60	16.	15.	20000	90	94	9.5	0.0	26	out	1	0.095
											out	10	0.147
29-Aug-91	1420	60	15.	5.	7000			9.0	0.5	24		1	0.0
												10	0.0
29-Aug-91	1515	70	16.	7.5	11000	98	113	8.8	0.3	29	out	1	0.083
29-Aug-91	1515	25	15.	4.							out	10	0.0
29-Aug-91	1515	50	15.	6.									
29-Aug-91	1515	70	16.	7.5									
29-Aug-91	1515	100	16.	9.5									
29-Aug-91	1610	75	16.	16.	22000	108	134	12.7	0.4	20	in?	1	0.183
29-Aug-91	1615	25									in?	5	0.016
29-Aug-91	1615	25	16.	11.								10	0.0
29-Aug-91	1615	50	16.	14.									
29-Aug-91	1615	100	16.	17.									
29-Aug-91	1715	75	16.5	22.	29000	118	143	19.3	0.8	22	in	1	0.232
												5	0.0
												10	0.0
29-Aug-91	1805	75	17.	24.	32000	125	204	19.5	1.0	16	in	1	0.283
												5	0.0
												10	0.0
29-Aug-91	1915	80	18.	26.	34500	136	232	15.3	1.3	20		1	0.0
29-Aug-91	2015	80	18.	26.	35200	141	229	11.8	0.8	19			
29-Aug-91	2115	85	18.5	26.	36000	149	223	10.5	0.0	14			

Date	Time	Sample depth	Tempera - ture	Salinity	Conductivity	Water height		Suspended sediments			Water flow		
								total		organic			
						fresh	marine	mean	s.e.		direction	pipe	flow
		cm	°C	ppt		cm	cm	mg/L	mg/L	percent		no.	m3/sec
29-Aug-91	2210	85	18.	26.	35300	152	195	10.3	0.3	18			
29-Aug-91	2315	85	18.	26.	35200	145	146	9.3	0.0	23	out	1	0.283
30-Aug-91	15	65	18.	24.	32000	111	116	10.2	0.4	18			
30-Aug-91	105	80	17.2	12.	17300	81	82	13.5	0.3	19	out	1	0.191
											out	5	0.081
											out	10	0.311
30-Aug-91	210	40	17.	6.2	9000	62	64	14.5	0.1	21			
30-Aug-91	310	35	17.	0.5	1300	53	55	13.3	0.3	24	out	1	0.131
											out	5	0.102
											out	10	0.236
30-Aug-91	430	35	16.	0.5	1050	46	46	9.3	0.3	27	out	1	0.059
											out	5	0.0
											out	10	0.173
30-Aug-91	510	35	16.	0.5	1100	45	43	9.3	0.8	30			
30-Aug-91	605	40	15.5	0.5	1150	48	61	6.3	0.3	27			
30-Aug-91	710	50	16.	2.	3350	85	113	9.3	0.3	24			
30-Aug-91	805	60	16.1	2.5	4100	98	146	10.8	0.3	19			
30-Aug-91	915	70	17.	24.	32500	111	174	18.8	0.4	14			
30-Aug-91	1010	70	16.5	26.5	35000	119	168	18.0	0.1	13			
30-Aug-91	1110	75	17.	27.	35000	125	168	16.3	0.0	17			
30-Aug-91	1215	75	16.	27.	35000	130	149	14.6	0.0	14			
30-Aug-91	1310	75	16.	27.	35000	129	131	12.8	0.0	16			

Appendix D-1. Field data and suspended sediments from Joe Leary Slough at the Tide Gates from October 1990 through September 1991. Mean and standard error (s.e.) of the mean given for total suspended sediments when two samples were taken at the indicated time.

Date	Time	Temperature	Salinity	Conductivity	Suspended sediment		
					Total		Organic
		°C	ppt	µohms	mg/L	s.e.	percent
4-Oct-90	1159	12			5.7		
17-Oct-90	1205	8	2		12.2		
27-Oct-90	1620	10	27		10.5	0.5	
1-Nov-90	925	9	20		16.		
9-Nov-90	1625	11	0		195.5	2.5	
13-Nov-90	1545	10	0		88.		
16-Nov-90	1142	8	0		52.	6.	
16-Nov-90	1145	8	0		46.		
24-Nov-90	1505	11	0		146.		
26-Nov-90	1330	6	0		66.		
29-Nov-90	1640	6	0		82.		
7-Dec-90	1625	6	0		34.		
13-Dec-90	1635	5	0		28.		
21-Dec-90	1425	3	0		31.		
28-Dec-90	1615	2	0		83.3	2.	
4-Jan-91	1525	4	0		17.4	1.4	
10-Jan-91	1610	2	0		119.		
18-Jan-91	1625	7	0		18.		
24-Jan-91	1615	6	0		33.8	0.8	
1-Feb-91	1305	8	4		19.8	0.3	
6-Feb-91	1615	8	0		63.		
16-Feb-91	1202	9	0		68.		
22-Feb-91	1650	8	0		73.		16
1-Mar-91	1135	7	0		42.		19
5-Mar-91	1430	8	0		77.5		18
15-Mar-91	1045	8	0	250	58.		18
19-Mar-91	1340	10	0	300	58.5	0.5	19
29-Mar-91		10	0	295	42.5		22
5-Apr-91	1545	10	0	650	155.	2.	18
12-Apr-91	1105	10	0	270	48.8	0.8	19
17-Apr-91	1430	13	0	650	57.		18
26-Apr-91	1046	11	0	255	36.		22

Appendix D-1. continued

Date	Time	Temper-ature	Salinity	Conduc-tivity	Suspended sediment		
					Total		Organic
		°C	ppt	µohms	mg/L	s.e.	percent
1-May-91	1340	16	0	350	38.		18
9-May-91	1030	10	0	310	24.	1.	19
15-May-91	1334	15	0	420	24.		25
24-May-91	945	11	0	320	27.		21
30-May-91	1330	14	0	7000	25.		18
4-Jun-91	1610	16	0	440	13.		19
12-Jun-91	1120	14	0	310	22.5		17
18-Jun-91	1554	18	0	50	15.		20
25-Jun-91	1120	14	0	1500	26.		25
2-Jul-91	1510	20	0	1000	16.5		13
9-Jul-91	935	18	2	3500	24.		17
16-Jul-91	1520	19	0	60	13.5		15
26-Jul-91	1130	18	1	2700	39.		19
30-Jul-91	1400	18	0	800	18.		28
8-Aug-91	1018	18	2	2400	36.		33
14-Aug-91	1519	20	1	1180	11.		18
22-Aug-91	1010	22	4	7000	20.	5.	26
27-Aug-91	1317	15	0	1200	14.	0.	14
6-Sep-91	1045	14	2	1600	7.8		26
10-Sep-91	1330		0	1100	12.8	6.3	15
20-Sep-91	945	14	1	1500	4.5		44
26-Sep-91	1315	18	25	32700	2.8	0.3	42
4-Oct-91	900	10	1	905	3.5	0.	21

Appendix D-2. Field data and suspended sediments from Joe Leary Slough at the Farm to Market Road bridge from October 1990 through September 1991. Mean and standard error (s.e.) of the mean given for total suspended sediments when two samples were taken at the indicated time.

Date	Time	Temperature	Salinity	Conductivity	Suspended sediment		
					Total		Organic
		°C	ppt	µohms	mg/L	s.e.	percent
4-Oct-90	1220	12			14		
17-Oct-90	1140	8	0		57		
27-Oct-90	1605	11	0		46		
1-Nov-90	953	9	0		21	1.0	
9-Nov-90	1605	11	0		146		
13-Nov-90	1530	10	0		143		
16-Nov-90	1126	8	0		62		
24-Nov-90	1435	11	0		150	9.5	
29-Nov-90	1625	6	0		82		
7-Dec-90	1615	6	0		37		
21-Dec-90	1410	3	0		49		
28-Dec-90	1600	4	0		52		
4-Jan-91	1515	4	0		49		
10-Jan-91	1555	2	0		57	0.3	
18-Jan-91	1600	7	0		53	1.0	
24-Jan-91	1600	6	0		42		
1-Feb-91	1250	9	0		65		
6-Feb-91	1600	8	0		99		
16-Feb-91	1151	9	0		81		
22-Feb-91	1645	9	0		112		16
1-Mar-91	1115	7	0		54		21
5-Mar-91	1417	8	0		139		18
15-Mar-91	1030	7	0		74	5.0	19
19-Mar-91	1330	10	0	200	76		22
29-Mar-91	940	9	0	211	70	0.5	21
5-Apr-91	1515	10	0	182	186		18
12-Apr-91	1045	9	0	200	81		19
17-Apr-91	1355	11	0	202	70	2.5	15
26-Apr-91	1105	10	0	212	46	2.5	18

Appendix D-2 continued

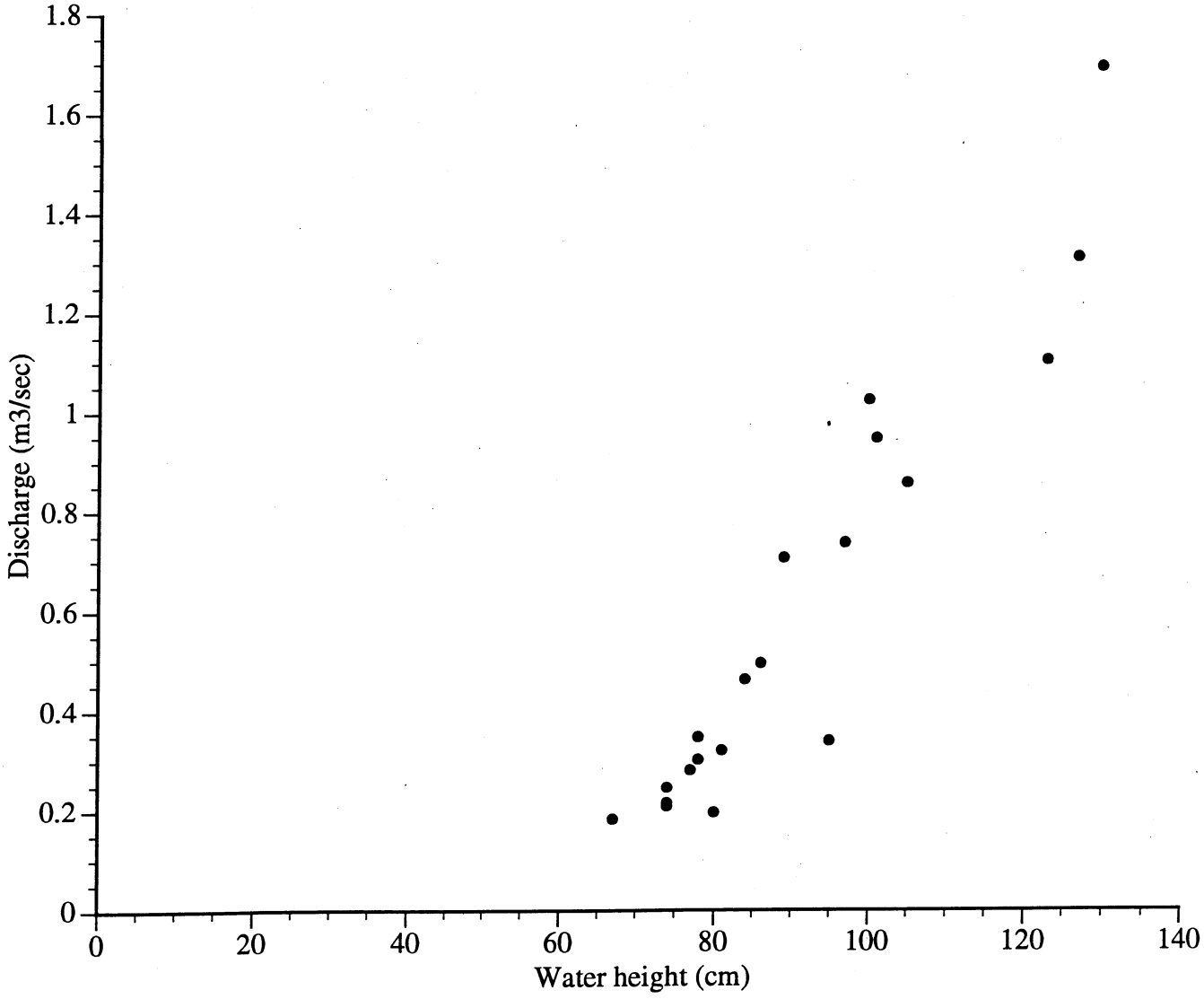
Date	Time	Temper-ature	Salinity	Conduc-tivity	Suspended sediment		
					Total		Organic
		°C	ppt	µohms	mg/L	s.e.	percent
1-May-91	1355	14	0	240	39		21
9-May-91	1016	9	0		34		21
15-May-91	1350	14	0	250	27		19
24-May-91	952	11	0	240	31		18
30-May-91	1405	12	0	260	25	0.0	22
4-Jun-91	1620	15		278	19	1.0	21
12-Jun-91	1150	13	0	205	18	0.0	20
18-Jun-91					21		10
25-Jun-91	1137	13	0	225	19	3.5	25
2-Jul-91	1525	18	0	280	16		19
9-Jul-91	945	11	0	350	18		22
16-Jul-91	1532	23	0	30	11		27
26-Jul-91	1145	15	0	270	17		24
30-Jul-91	1415	16	0	290	13		27
8-Aug-91	1051	15	0	285	13		40
14-Aug-91	1539	17	0	295	9	0.3	24
22-Aug-91	1030	15	0	350	13	0.3	13
27-Aug-91	1340	13	0	250	10		20
6-Sep-91	1100	13	0	250	7		31
10-Sep-91	1340		0	300	7		29
20-Sep-91	1000	11	0	250	6		58
26-Sep-91	1325	12	0	260	7		51
4-Oct-91	917	9	0	240	7		21

Appendix D-3. Field data and suspended sediments from Joe Leary Slough at the Allen West Road bridge from October 1990 through September 1991. Mean and standard error (s.e.) of the mean given for total suspended sediments when two samples were taken at the indicated time.

Date	Time	Temperature	Salinity	Conductivity	Suspended sediment			Water height
					Total		Organic	
		°C	ppt	µohms	mg/L	s.e.	percent	cm
4-Oct-90	1235	11.5			16.9			
17-Oct-90	1130	7.5	0.2		59.			
27-Oct-90	1600	11	0		58.			
1-Nov-90	1013	9	0		31.			
9-Nov-90	1550	12	0		199.			
13-Nov-90	1445	10.4	0		158.			76
15-Nov-90	1112	8	0		57.			
16-Nov-90	1115	8	0		59.			
24-Nov-90	1430	11	0		141.			60
16-Nov-90	1115	8	0		59.			
29-Nov-90	1610	6	0		80.5	6.5		78
7-Dec-90	1600	6	0		39.	1.0		164
13-Dec-90	1610	6	0		33.	0.0		137
21-Dec-90	1400	4	0		50.5	0.5		
28-Dec-90	1545	3	0		43.3			
4-Jan-91	1510	5	0		54.7			
10-Jan-91	1545	2	0		52.1			
18-Jan-91	1555	7	0		56.			
24-Jan-91	1550	6	0		41.			
1-Feb-91	1240	9	0		41.	1.0		
6-Feb-91	1550	8	0		108.5	1.5		
16-Feb-91	1140	9	0		60.5	9.0		
22-Feb-91	1600	10	0		89.	1.0	17	
1-Mar-91	1100	7	0		67.5	4.5	22	
5-Mar-91	1405	8	0		173.5	0.5	17	
15-Mar-91	1020	8	0	200	60.		20	
19-Mar-91	1325	10	0	200	121.5		19	
29-Mar-91	933	8.5	0	211	66.		21	
5-Apr-91	1505	10	0	182	159.		20	
12-Apr-91	1034	9	0	200	117.		17	
17-Apr-91	1345	11	0	210	109.		17	
26-Apr-91	1112	10	0	220	61.		18	

Appendix D-3. continued

Date	Time	Temperature	Salinity	Conductivity	Suspended sediment			Water height
					Total		Organic	
		°C	ppt	µohms	mg/L	s.e.	percent	cm
1-May-91	1405	13	0	250	65.	1.0	16	
9-May-91	942	9.3	0	210	38.5		19	
15-May-91	1355	14	0	255	34.5	0.5	17	
24-May-91	1005	11	0	250	29.5	1.5	20	
30-May-91	1410	12.3	0	270	33.		21	
4-Jun-91	1632	14	0	290	21.		19	
12-Jun-91	1158	12	0	210	27.		19	
18-Jun-91	1607	18	0	300	18.	1.0	14	
25-Jun-91	1146	13	0	240	22.		23	
2-Jul-91	1550	19	0	285	17.5	0.5	23	
9-Jul-91	955	14	0	220	13.8	0.3	17	
16-Jul-91	1545	17	0	20	13.5	0.5	30	
26-Jul-91	1155	15	0	240	20.	0.0	25	
30-Jul-91	1428	16	0	290	12.	1.0	25	
8-Aug-91	1100	15	0	295	10.5	0.5	38	
14-Aug-91	1554	18	0	305	15.		20	
27-Aug-91	1345	12		260	9.		11	
6-Sep-91	1110	13	0	250	8.	0.0	25	
10-Sep-91	1350		0	310	9.		26	
20-Sep-91	1015	11	0	240	8.	0.0	50	
26-Sep-91	1349	13	0	265	8.		44	
4-Oct-91	927	9	0	240	10.5		24	



Appendix E. Total flow of Joe Leary Slough at Allen West Road bridge vs water height on 19 occasions during the period October, 1990 to September, 1991. The only data points that were included were those measurements made when the tide was falling and water was flowing out of the tide gates.

Appendix F. Suspended sediments and field data from Joe Leary Slough at the Allen West Road bridge during five days in March 1992.

Date	Time	Salinity	Temp.	Water depth	Suspended sediments		
					total		organic
					mean	s.e.	
		‰	°C	cm	mg/L		mean %
3-Mar-92	1545	0	9	129	22	±0.5	20%
4-Mar-92	1000	0	9		24	±1.0	20%
4-Mar-92	1558	0	10	129	32	±0.5	20%
5-Mar-92	1001	0	10		26	±0.5	20%
5-Mar-92	1602	0	10.5	127	57	±1.0	18%
6-Mar-92	1001	0	9.5		25	±1.8	19%
6-Mar-92	1603	0	11	126	81	±2.5	19%
9-Mar-92	1012	0	9		23	±0.3	20%
9-Mar-92	1605	0	10	100	80	±3.5	19%