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October 9, 1998

William L. Longley, Ph.D.
Texas Water Development Board
P.O. Box 13231, Capital Station
1700 N. Congress Ave., Rm. 462
Austin, TX 78711-3231

RE: Submission of Draft Final Report for Project No. 98-483-233: "Effect of Freshwater Inflow on Macrobenthos Productivity and Nitrogen Losses in Texas Estuaries"

Dear Dr. Longley,

This letter is to inform you that I have received your comments and the official TWDB comments on the draft final report. I have incorporated all comments and transmit here nine copies and one unbound copy of the referenced report.

Thank you for your continued support. If I can be of any further assistance, please contact me by telephone (512-749-6779), Fax (512-749-6777) or e-mail (paul@utmsi.utexas.edu).

Sincerely,

Paul A. Montagna, Ph.D.
Research Scientist and Associate Professor

EFFECT OF FRESHWATER INFLOW ON MACROBENTHOS PRODUCTIVITY AND NITROGEN LOSSES IN TEXAS ESTUARIES

Paul A. Montagna, Principal Investigator
TWDB Contract No. 98-483-233
Technical Report Number TR/98-03

October 1998

FINAL REPORT

EFFECT OF FRESHWATER INFLOW ON MACROBENTHOS PRODUCTIVITY AND NITROGEN LOSSES IN TEXAS ESTUARIES

by

Paul A. Montagna, Principal Investigator

from

University of Texas at Austin
Marine Science Institute
750 Channelview Drive
Port Aransas, Texas 78373

to

Texas Water Development Board
P.O. Box 13231, Capital Station
1700 N. Congress Ave., Rm. 462
Austin, TX 78711-3231

Interagency Cooperative Contract
TWDB Contract No. 98-483-233

The University of Texas Marine Science Institute
Technical Report Number TR/98-03
October 1998

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PREFACE

The current contract period is a continuation of a long-term study with the goal to determine the importance of freshwater inflow in maintaining productivity in Texas estuaries. Previous work has been performed with support, or partial support, by the Texas Water Development Board, Water Research Planning Fund, authorized under the Texas Water Code sections 15.402 and 16.058(e). This support was administered by the Board under interagency cooperative contract numbers: (1986-87) 0757, 8-483-607, 9-483-705, 90-483-706, 91-483-787, 92-483-300, 93-483-352, 94-483-003, 95-483-068, 96-483-132, 97-483-199, and most recently 98-483-233.

This is an iterative report, much like the Texas Parks and Wildlife, Data Management Series. Data is added to the time series, and the whole time series is reported so that year-to-year comparisons can be made. The report has several sections. First, all contributions that acknowledged the Texas Water Development Board for support during the current project (98-483-233) are reported. These contributions represent the products of the research project. Second, is a compilation of biological and hydrographical data obtained over the course of the study. Third, is a compilation of the sediment data on nitrogen losses that has been collected during the contract period.

LIST OF CONTRIBUTIONS

Scientific Publications

Mannino, A., and P.A. Montagna. 1997. Small scale spatial variation of macrobenthic community structure. *Estuaries* 20:159-173.

Technical Reports

Montagna, P.A. 1997. Effect of freshwater inflow on macrobenthos productivity and nitrogen losses in Texas estuaries. Final report to Texas Water Development Board, Contract No. 97-483-199, University of Texas Marine Science Institute Technical Report Number TR/97-02, Port Aransas, Texas. 157 pp.

*Oral Presenetations (*Invited seminars)*

*Montagna, P.A. "Water Quality & Freshwater Inflow: Biological and Ecological Effects," Bay Summit: Presentation of the Coastal Bend Bays Plan, Corpus Christi Bay National Estuary Program, April 27, 1998, Corpus Christi, Texas.

*Montagna, P.A. "Natural and Anthropogenic Disturbances to Bay Bottoms," Corpus Christi Bay National Estuary Program, Texas A&M University-Corpus Christi, January 22, 1998, Corpus Christi, Texas.

*Montagna, P.A. and R.D. Kalke. "Effect of Freshwater Inflow on Infaunal Benthos of Texas Bays," Instream & Environmental Flows Symposium, North American Lake Management Society, 17th Annual International Meeting, December 2, 1997, Houston, Texas.

Montagna, P.A. S, Jarvis, D. Stockwell, T. Whitledge and M. Irlbeck. "Effect of marsh restoration on meiofauna." Tenth International Meiofauna Conference, Plymouth, U.K., July 27 -31, 1998.

ACKNOWLEDGMENTS

I must acknowledge the significant contributions of Mr. Rick Kalke. Rick began the first sampling study of Lavaca Bay in 1984. He is an outstanding field person and taxonomist. The work reported on in this study could not have been performed without him. Carroll Simanek also provided significant help in data management. We obviously are collecting and processing a large amount of data. Input, proof-reading and maintenance of this large data set is a daunting task that Carroll handles very well. Dr. Steve Jarvis and Mr. Robert Burgess aided in field collections. This work has also benefitted by discussions with colleagues at the Texas Water Development Board (TWDB), e.g., Gary Powell, William Longley, and David Brock who have provided much help and guidance.

The Texas estuarine research reported here has been supplemented by many other projects. The Lower Colorado River Authority recently supplemented the long-term study in Matagorda Bay by adding funding to sample additional stations in the Eastern arm of Matagorda Bay to study the effects of the diversion of the Colorado River through 1997. Several studies of the Laguna Madre were made possible by a program funded by the Texas Advanced Technology Program and Advanced Research Program. Long-term studies on the Nueces Estuary have been recently funded by the Texas Sea Grant Program and the Corpus Christi Bay National Estuary Program (CCBNEP). Both of these project utilized stations originally established by the TWDB projects in 1988. The primary focus of the Sea Grant program was to determine the role of climatic variability in controlling productivity in estuaries. In the CCBNEP study, TWDB stations were used as reference stations for assessing anthropogenic effects due to storm drain outfalls. The U.S. Bureau of Reclamation has funded studies on the effect of freshwater diversion to Rincon Bayou to restore the Nueces Delta Marsh. In these studies, we have built on past information and used the TWDB long-term data set in Nueces Bay as a baseline for comparisons.

INTRODUCTION

The primary goal of the current research program is to define quantitative relationships between marine resource populations and freshwater inflows to the State's bays and estuaries. However, we know that there is year-to-year variability in the population densities and successional events of estuarine communities. This year-to-year variability is apparently driven by long-term, and global-scale climatic events, e.g., El Niño, which affects rates of freshwater inflow. Therefore, this report documents long-term changes in populations and communities that are influenced by freshwater inflow. The best indicator of productivity is the change in biomass of the community.

A secondary goal of the current research is to quantify loss of nitrogen in Texas estuaries. Nitrogen is the key element limiting productivity. A simple budget would account for nitrogen entering the bay via freshwater inflow, how it is captured and transformed into biomass, and finally how it is lost from the ecosystem. One aspect of nitrogen loss is very poorly understood: How much nitrogen is buried in sediments and lost from the system? We report here nitrogen content changes with respect to sediment depth. Presumably nitrogen is labile in the upper, biologically active, layers of sediment, and refractory at depth. Therefore, it is important to determine the sediment depth at which nitrogen content is at a low and constant value.

This study is a continuation of freshwater inflow studies that began in 1984. The goals have evolved over the years to reflect the synthesis of new information and the management needs of the Texas Water Development Board (TWDB). The original studies (1984-1986) were designed to determine the effect of inflow on Lavaca Bay. One station used during that study is still being sampled. San Antonio Bay was studied in 1987, and the Nueces Estuary (Nueces and Corpus Christi Bays) were studied in 1988. Long-term studies of the Lavaca-Colorado and Guadalupe Estuaries began in 1990. Our initial conclusions based on one to four years of data were that inflow does increase benthic productivity (Kalke and Montagna, 1991; Montagna and Kalke, 1992; 1995). However, later analysis of the data set over a 5-year period demonstrated that the largest effect may not be on productivity, but may be on community structure (Montagna and Li, 1996). This implies that reduced inflows may not only reduce productivity but may also change the composition of species in an estuary. The complete long-term record now extends over eight years. The completion of this research will take 12 to 20 years, because the trends are driven by long-term climatic events controlled by global climate patterns, e.g., El Niño.

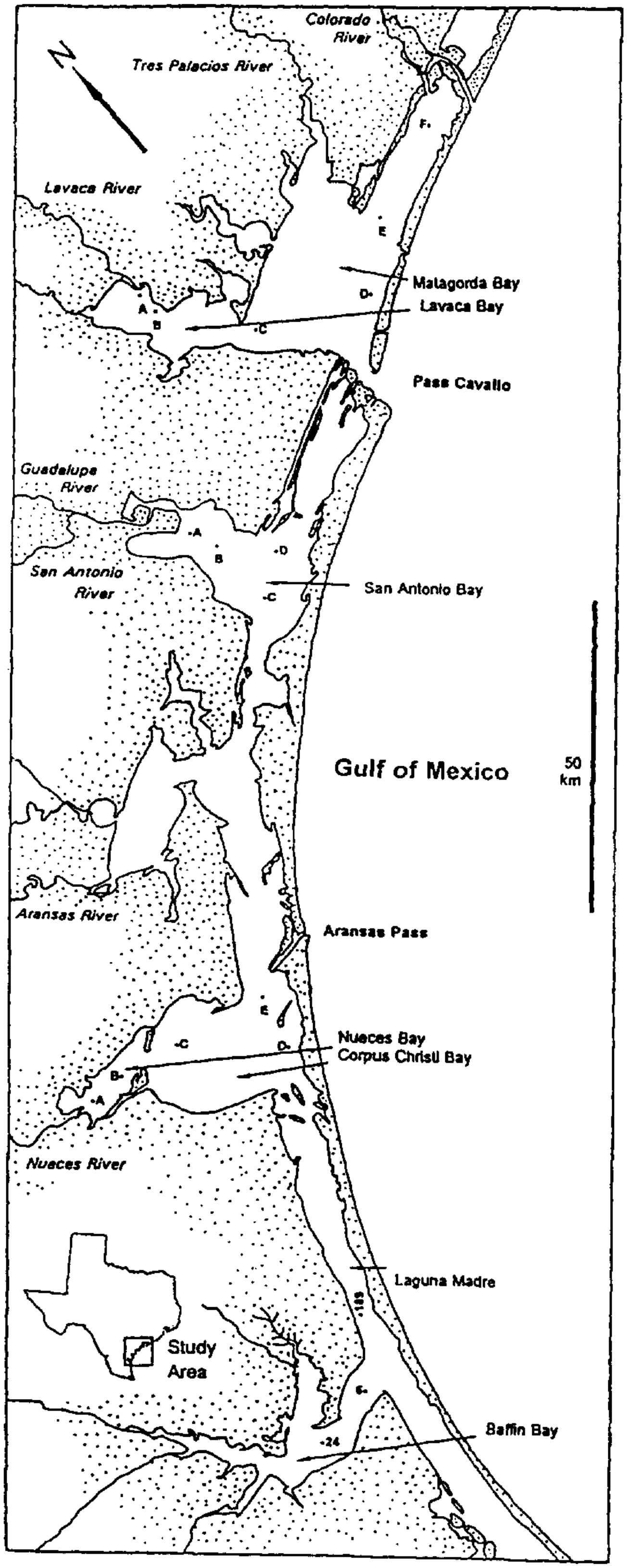
METHODS

Study Design and Area

There are seven major estuarine systems along the Texas coast. Each system receives drainage from one to three major rivers. The northeastern most estuaries receive more freshwater inflow than the southwestern estuaries. Two estuarine systems were studied in detail (Figure 1). Both systems have similar freshwater inflow characteristics, but the Lavaca-Colorado Estuary has direct exchange of marine water with the Gulf of Mexico via Pass Cavallo, whereas the Guadalupe Estuary does not. To assess ecosystem-wide variability stations in the freshwater influenced and marine influenced zones were chosen. Two stations, which replicate each of the two treatment effects (freshwater and marine) influence, were sampled. Generally these stations were along the major axis of the estuarine system leading from river mouth to the foot of the estuary near the barrier island. This design avoids pseudoreplication, where only one station has the characteristic of the main effect, and it is not possible to distinguish between station differences and treatment differences.

The Lavaca River empties into Lavaca Bay, which is connected to Matagorda Bay. Matagorda Bay also has freshwater input from the Colorado and Tres Palacios River. Over a 47-year period (1941-1987) the Lavaca-Colorado Estuary received an average of 3.800×10^9 m^3 y^{-1} with a standard deviation of 2.080 m^3 y^{-1} ($3.080 \pm 1.686 \times10^6$ ac-ft y^{-1}) of freshwater input, and the freshwater balance (input-output) was 3.392×10^9 m^3 y^{-1} with a standard deviation of 2.345×10^9 m^3 y^{-1} ($2.750 \pm 1.901 \times10^6$ ac-ft y^{-1}) (TDWR, 1980a; TWDB unpublished data). Four Stations were occupied along the axis of the system. Two stations were in Lavaca Bay (A and B), and two stations were in Matagorda Bay (C and D) (Figure 3). Depths of stations A, B, C, and D were 1.3 m, 2.0 m, 3.1 m, and 4.2 m, respectively. Five field trips were performed. Station A in Lavaca Bay was the same station 85 sampled in 1984-1986 (Jones et al., 1986).

The San Antonio River joins the Guadalupe River that flows into San Antonio Bay. Over a 46-year period the Guadalupe Estuary received an average of 2.896×10^9 m^3 y^{-1} with a standard deviation of 1.597 m^3 y^{-1} ($2.347 \pm 1.295 \times10^6$ ac-ft y^{-1}) of freshwater input, and the freshwater balance (input-output) was 2.624×10^9 m^3 y^{-1} with a standard deviation of 1.722×10^9 m^3 y^{-1} ($2.127 \pm 1.396 \times10^6$ ac-ft y^{-1}) (TDWR, 1980b; TWDB unpublished data). This system was studied from January through July 1987. Four stations were occupied: freshwater influenced stations at the head of the bay (station A) and at mid-bay (station B), and two marine influenced stations near the Intracoastal Waterway, one at the southwestern foot of the bay (station C) and one at the



southeastern foot of the bay (station D) (Fig. 1). Stations were sampled five times in the first year. All stations were in shallow water. Depths of stations A, B, C, and D were 1.3 m, 1.9 m, 2.0 m, and 1.6 m, respectively.

Hydrographic Measurements

Salinity, conductivity, temperature, pH, dissolved oxygen, and redox potential were measured at the surface and bottom at each station during each sampling trip. Measurements were made by lowering a probe made by Hydrolab Instruments. Salinities levels are automatically corrected to 25°C. The manufacturer states that the accuracy of salinity measurements are 0.1 ppt. When the Hydrolab instrument was not working, water samples were collected from just beneath the surface and from the bottom in jars, and refractometer readings were made at the surface.

Figure 1. The Texas Coastal Bend lagoonal estuaries with major rivers, tidal inlets, and station locations.

Geological Measurements

Sediment grain size analysis was also performed. Sediment core samples were taken by diver and sectioned at depth intervals 0-3 cm and 3-10 cm. Analysis followed standard geologic procedures (Folk, 1964; E. W. Behrens, personal communication). Percent contribution by weight was measured for four components: rubble (e.g. shell hash), sand, silt, and clay. A 20 cm^3 sediment sample was mixed with 50 ml of hydrogen peroxide and 75 ml of deionized water to digest organic material in the sample. The sample was wet sieved through a 62 μm mesh stainless steel screen using a vacuum pump and a Millipore Hydrosol SST filter holder to separate rubble and sand from silt and clay. After drying, the rubble and sand were separated on a 125 μm screen. The silt and clay fractions were measured using pipette analysis.

Biological Measurements

Sediment was sampled with core tubes held by divers. The macrofauna were sampled with a tube 6.7 cm in diameter, and sectioned at depth intervals of 0-3 cm and 3-10 cm. Three replicates were taken within a 2 m radius. Samples were preserved with 5% buffered formalin, sieved on 0.5 mm mesh screens, sorted, identified to the lowest taxonomic level possible, and counted.

Each macrofauna sample was also used to measure biomass. Individuals were combined into higher taxa categories, i.e., Crustacea, Mollusca, Polychaeta, Ophiuroidea, and all other taxa were placed together in one remaining sample. Samples were dried for 24 h at 55 °C, and weighed. Before drying, mollusks were placed in 1 N HCl for 1 min to 8 h to dissolve the carbonate shells, and washed with fresh water.

Sediment Nitrogen Measurements

All Texas estuaries have been studied. The Sabine-Neches and Trinity-San Jacinto Estuaries were sampled in 1993. The Lavaca-Colorado and Guadalupe Estuaries were sampled in 1990, and resampled in 1992. The Nueces Estuary and Baffin Bay were sampled in 1991. Our approach is to take sediments cores and measure nitrogen changes with respect to sediment depth. Cores are taken to a depth of 1 m. One-cm sediment sections are taken at the depth intervals listed. The sediment is dried, ground up, and homogenized. Carbon and nitrogen content, as a percent dry weight of sediment, is measured using a CHN analyzer.

Station Locations

Estuary	Station	Latitude (N)	Longitude (W)
Lavaca-Colorado	A	28.40.439	96.34.950
	B	28.38.192	96.34.985
	C	28.32.482	96.28.082
	D	28.28.661	96.17.230
	E	28.33.162	96.12.558
	F	28.35.767	96.02.456
Guadalupe	A	28.23.611	96.46.344
	B	28.20.866	96.44.744
	C	28.14.920	96.45.619
	D	28.18.126	96.41.061
Lower Laguna Madre	1	26.07.583	97.15.000
	2	26.10.832	97.13.435
	3	26.18.583	97.17.833
	4	26.26.667	97.21.583
	5	26.36.416	97.25.333
	6	26.41.416	97.26.916

RESULTS

Hydrographic Data

Hydrographic measurements. Abbreviations: STA=Station, Z=Depth, SAL(R)=Salinity by refractometer, SAL(M)=Salinity by meter, COND=Conductivity, TEMP=Temperature, DO=dissolved oxygen, and ORP=oxidation redox potential. Missing values show with a period.

Lavaca-Colorado Estuary

Date	STA	z	SAL(R)	SAL(M)	COND	TEMP	pH	DO	ORP
09JUL97	A	0.00	0	0.9	2.65	30.59	8.55	6.71	0.216
09JUL97	A	1.20	0	1.0	2.81	30.61	8.48	6.78	0.219
09JUL97	B	0.00	5	5.5	10.28	30.73	8.20	7.64	0.205
09JUL97	B	1.80	5	5.5	10.28	30.66	8.59	7.13	0.211
09JUL97	C	0.00	12	13.4	22.60	30.55	8.41	6.72	0.208
09JUL97	C	2.60	12	13.5	22.70	30.01	8.47	5.60	0.215
09JUL97	D	0.00	7	8.6	14.63	28.86	8.25	6.70	0.226
09JUL97	D	4.10	7	34.0	50.40	24.27	7.65	1.29	0.257
09JUL97	E	0.00	0	1.1	2.88	29.76	8.59	7.74	0.207
09JUL97	E	3.50	0	30.2	48.60	25.75	7.61	0.12	0.219
09JUL97	F	0.00	0	0.0	0.79	29.42	8.69	6.97	0.212
09JUL97	F	1.40	0	0.0	1.03	28.51	8.44	6.65	0.221
17OCT97	A	0.00	0	0.0	0.23	20.86	7.70	7.99	0.270
17OCT97	A	1.40	0	0.0	0.23	20.90	7.86	7.97	0.285
17OCT97	B	0.00	0	0.0	0.38	20.82	8.26	8.31	0.264
17OCT97	B	2.00	0	0.0	0.38	20.85	8.29	8.23	0.274
17OCT97	C	0.00	2	3.3	6.64	19.73	8.94	9.62	0.234
17OCT97	C	2.70	2	9.0	15.50	21.26	9.01	8.26	0.238
17OCT97	D	0.00	10	11.7	20.00	20.25	9.48	10.24	0.223
17OCT97	D	4.00	10	24.8	39.20	23.30	8.87	6.21	0.232
17OCT97	E	0.00	6	7.5	13.60	20.28	10.6	9.77	0.223
17OCT97	E	3.30	6	17.3	29.00	21.67	9.68	5.63	0.235
17OCT97	F	0.00	0	0.3	1.50	21.40	10.4	8.64	0.224
17OCT97	F	1.10	0	10.0	17.60	21.50	10.2	5.08	0.245
09JAN98	F	0.00	16	18.1	29.40	15.22	.	10.90	0.243
09JAN98	E	0.00	22	24.5	38.70	14.70	.	9.57	0.249
09JAN98	F	0.60	16	20.0	32.10	14.56	.	10.85	0.245
09JAN98	E	0.00	22	24.5	38.70	14.70	.	9.57	0.249
09JAN98	E	2.70	22	25.5	40.00	14.36	.	8.59	0.251
09JAN98	D	0.00	24	26.5	41.40	14.63	.	9.55	0.254
09JAN98	D	3.40	24	31.5	48.30	15.20	.	8.46	0.259
09JAN98	C	0.00	20	23.0	36.50	13.99	.	9.80	0.270
09JAN98	C	2.10	20	26.6	42.10	14.86	.	9.05	0.271
09JAN98	B	0.00	6	9.6	16.60	13.68	11.0	10.28	0.292
09JAN98	B	1.30	6	17.8	30.30	14.92	10.1	8.33	0.297

09JAN98	A	0.00	0	0.0	0.55	13.69	10.6	11.21	0.295
09JAN98	A	0.80	0	3.0	8.97	14.31	10.2	10.58	0.317
01APR98	A	0.00	5	7.3	13.18	20.91	6.90	9.34	0.066
01APR98	A	1.30	5	12.0	20.60	22.22	6.45	5.52	0.081
01APR98	B	0.00	8	10.2	17.80	21.12	6.75	8.50	0.087
01APR98	B	1.90	8	16.0	26.30	21.97	6.55	6.16	0.094
01APR98	C	0.00	18	20.0	32.20	22.03	6.98	8.14	0.088
01APR98	C	2.80	18	21.9	35.00	22.17	6.76	6.67	0.093
01APR98	D	0.00	22	23.4	37.00	22.14	6.87	7.74	0.095
01APR98	D	4.10	22	24.8	39.00	21.32	6.81	6.65	0.096
01APR98	E	0.00	18	19.5	31.50	22.30	7.01	8.83	0.095
01APR98	E	3.40	18	23.8	37.60	21.83	6.71	5.51	0.103
01APR98	F	0.00	13	14.1	23.60	22.42	7.05	8.73	0.099
01APR98	F	1.40	13	18.4	30.10	22.68	6.93	6.77	0.104
06JUL98	F	0.00	25	27.4	42.60	30.01	8.32	6.97	0.189
06JUL98	F	1.30	25	27.5	42.70	29.57	8.45	5.90	0.191
06JUL98	E	0.00	27	29.0	44.80	29.85	8.36	7.95	0.181
06JUL98	E	3.40	27	29.0	44.80	29.66	8.60	7.32	0.189
06JUL98	A	0.00	18	20.8	33.40	29.16	8.60	6.91	0.189
06JUL98	A	1.30	18	20.9	33.50	29.17	8.60	6.91	0.191
06JUL98	B	1.90	20	23.3	37.30	29.24	8.70	6.98	0.195
06JUL98	C	0.00	25	27.8	43.20	29.57	8.58	7.57	0.187
06JUL98	C	3.00	25	28.0	43.20	29.67	8.56	6.72	1.910
06JUL98	D	0.00	28	29.8	45.90	29.69	8.69	7.68	0.187
06JUL98	D	4.10	28	30.9	47.40	29.64	8.58	6.70	0.193

Guadalupe Estuary

Date	STA	z	SAL(R)	SAL(M)	COND	TEMP	pH	DO	ORP
08JUL97	A	0.00	0	0.0	0.57	31.12	8.57	6.63	0.210
08JUL97	A	1.00	0	0.0	0.57	31.11	8.44	6.62	0.214
08JUL97	B	0.19	0	0.0	23.00	31.02	8.92	7.00	0.580
08JUL97	B	1.50	0	0.0	0.58	30.92	8.85	6.93	0.194
08JUL97	C	0.00	3	4.1	8.01	30.95	8.69	6.92	0.196
08JUL97	C	1.60	3	4.1	8.03	30.81	8.62	6.76	0.199
08JUL97	D	0.00	0	0.1	1.14	30.80	8.93	7.48	0.193
08JUL97	D	1.20	0	0.1	1.20	30.54	8.86	7.13	0.196
16OCT97	D	0.00	8	9.7	16.60	19.67	8.10	9.21	0.161
16OCT97	D	1.90	8	20.2	32.50	21.44	8.74	5.52	0.188
16OCT97	C	0.00	10	12.0	20.60	19.49	9.40	9.91	0.190
16OCT97	C	2.20	10	17.8	29.30	20.74	9.30	7.84	0.197
16OCT97	B	0.00	0	2.1	4.68	19.64	9.75	9.11	0.192
16OCT97	B	2.00	0	9.2	16.00	20.61	9.98	7.74	0.195
16OCT97	A	0.00	0	0.0	0.89	20.15	10.9	7.43	0.202
16OCT97	A	1.40	0	0.0	0.98	20.14	10.5	7.34	0.210
12JAN98	A	0.00	0	0.3	1.60	20.11	.	10.66	0.211
12JAN98	A	0.80	0	1.7	4.29	19.63	.	12.63	0.213
12JAN98	B	0.00	6	6.7	12.23	19.38	.	23.25	0.201
12JAN98	B	1.30	6	10.8	18.70	18.07	.	9.37	0.222

12JAN98	C	0.00	13	14.3	24.00	18.69	.	10.04	0.221
12JAN98	C	1.40	13	16.1	26.60	18.45	.	9.65	0.230
12JAN98	D	0.00	12	12.5	21.00	19.67	.	13.77	0.199
12JAN98	D	1.00	12	18.1	29.40	18.32	.	8.91	0.222
02APR98	A	0.00	0	0.7	2.26	21.65	7.06	7.86	0.111
02APR98	B	0.00	4	4.9	9.41	21.78	7.15	8.09	0.111
02APR98	B	1.80	4	4.9	9.41	21.74	7.14	7.98	0.112
02APR98	C	0.00	6	7.8	13.97	21.52	7.12	8.41	0.108
02APR98	C	1.90	6	8.3	14.98	21.62	7.09	7.77	0.109
02APR98	D	0.00	8	9.4	16.40	21.60	6.54	8.35	0.090
02APR98	D	1.40	8	9.6	16.60	21.61	6.92	8.07	0.101
07JUL98	D	0.00	13	14.6	24.30	29.29	.	7.74	2.700
07JUL98	D	1.40	13	14.7	24.50	29.24	.	7.39	.
07JUL98	C	0.00	22	24.7	38.80	29.53	.	7.49	.
07JUL98	C	1.80	22	25.5	40.10	29.44	.	7.10	.
07JUL98	A	0.00	3	5.0	9.35	29.78	.	8.92	.
07JUL98	A	1.10	3	12.7	21.70	29.41	.	7.54	.
07JUL98	B	0.00	12	13.3	22.50	29.66	.	7.85	.
07JUL98	B	1.60	12	13.8	23.30	29.41	.	6.24	.

Nutrient Concentrations

Nutrient measurements take during sampling. Water depth is in m. Nutrient concentrations are in umol/l.

Lavaca-Colorado Estuary

Date	Station	Depth	PO_4	SIO_4	NO_2	NO_3	NH_4
09JUL97	A	0	0.247	140	0.153	0.000	0.824
09JUL97	A	1.2	0.273	193	0.171	0.000	1.055
09JUL97	B	0	0.194	63	0.116	0.000	1.082
09JUL97	B	1.8	0.185	77	0.125	0.000	1.052
09JUL97	C	0	0.203	156	0.179	0.000	1.447
09JUL97	C	2.6	0.106	53	0.125	0.000	1.127
09JUL97	D	0	0.071	72	0.105	0.000	1.073
09JUL97	D	4.1	0.344	46	0.790	0.382	7.148
09JUL97	E	0	0.079	99	0.493	9.866	1.519
09JUL97	E	3.5	0.362	37	1.321	1.017	12.383
09JUL97	F	0	0.071	134	0.259	21.08	2.607
09JUL97	F	1.4	0.106	124	0.358	14.87	12.171
17OCT97	A	0	2.342	190	1.651	3.854	3.100
17OCT97	A	1.4	1.773	190	1.699	3.585	3.386
17OCT97	B	0	2.448	191	1.561	3.503	2.904
17OCT97	B	2	2.011	191	1.734	3.646	3.028
17OCT97	C	0	1.376	174	1.267	2.463	2.586
17OCT97	C	2.7	1.402	162	1.591	2.276	3.885
17OCT97	D	0	1.416	125	1.889	3.547	4.232
17OCT97	D	4	0.807	51	2.738	3.729	3.365
17OCT97	E	0	2.910	141	9.110	7.221	8.286
17OCT97	E	3.3	2.780	111	2.453	5.184	11.446
17OCT97	F	0	2.315	159	3.214	14.04	12.198
17OCT97	F	1.1	1.826	137	2.328	6.479	26.876
09JAN98	F	0	1.221	25	0.721	3.140	1.494
09JAN98	F	0.6	1.206	22	0.427	0.034	1.758
09JAN98	E	0	0.497	11	0.214	0.000	1.186
09JAN98	E	2.7	0.660	11	0.223	0.000	1.142
09JAN98	D	0	0.519	10	0.250	0.000	1.099
09JAN98	D	3.4	0.666	11	0.487	0.000	1.758
09JAN98	C	0	0.614	27	0.275	0.000	1.099
09JAN98	C	2.1	0.421	20	0.175	0.000	0.659
09JAN98	B	0	1.033	24	0.180	1.965	1.977
09JAN98	B	1.3	1.148	27	0.559	0.000	1.758
09JAN98	A	0	2.264	62	0.476	10.36	1.867
09JAN98	A	0.8	1.365	22	0.192	0.348	1.318
01APR98	A	0	0.272	85	1.666	8.807	1.746
01APR98	A	1.3	1.033	72	1.475	0.000	7.156
01APR98	B	0	0.380	84	0.640	1.528	1.875
01APR98	B	1.9	0.467	82	0.960	0.000	3.834

01APR98	C	0	0.283	23	0.113	0.000	2.004
01APR98	C	2.8	0.761	35	1.090	0.000	3.503
01APR98	D	0	0.250	26	0.110	0.000	1.815
01APR98	D	4.1	0.435	23	0.241	0.000	2.234
01APR98	E	0	0.435	26	0.139	0.000	1.803
01APR98	E	3.4	0.761	33	0.471	0.000	3.265
01APR98	F	0	0.870	54	0.280	3.255	2.144
01APR98	F	1.4	1.087	180	0.323	0.000	2.209

Guadalupe Estuary

Date	Station	Depth	PO_4	SIO_4	NO_2	NO_3	NH_4
08JUL97	A	0	0.079	188	0.627	23.08	3.488
08JUL97	A	1	0.088	189	0.609	24.25	2.785
08JUL97	B	0	0.088	162	0.167	0.448	0.059
08JUL97	B	1.5	0.115	163	0.222	0.788	1.559
08JUL97	C	0	0.079	113	0.095	0.000	1.097
08JUL97	C	1.6	0.088	106	0.140	0.000	1.496
08JUL97	D	0	0.150	241	0.113	0.000	1.309
08JUL97	D	1.2	0.071	134	0.095	0.000	0.468
16OCT97	D	0	1.760	146	1.059	4.480	1.380
16OCT97	D	1.9	1.733	119	0.758	1.380	4.570
16OCT97	C	0	2.051	140	0.350	1.610	0.595
16OCT97	C	2.2	1.879	132	0.368	1.240	0.850
16OCT97	B	0	2.818	188	1.055	13.25	2.886
16OCT97	B	2	2.699	187	1.038	12.91	3.040
16OCT97	A	0	2.250	197	2.152	21.28	5.906
16OCT97	A	1.4	3.771	195	2.028	20.69	5.513
12JAN98	A	0	11.90	152	0.885	0.000	2.602
12JAN98	A	0.8	7.850	142	0.906	0.000	2.272
12JAN98	B	0	2.190	98	0.533	0.000	1.606
12JAN98	B	1.3	1.878	105	0.416	0.104	1.143
12JAN98	C	0	1.635	100	0.298	0.000	0.854
12JAN98	C	1.4	1.978	97	0.341	0.000	1.126
12JAN98	D	0	2.211	96	0.288	0.000	1.910
12JAN98	D	1	1.562	77	0.309	0.000	1.166
02APR98	D	0	0.272	58	0.121	0.225	1.884
02APR98	D	1.4	0.326	69	0.097	0.378	1.984
02APR98	C	0	0.489	72	0.307	0.000	2.332
02APR98	C	1.9	0.522	76	0.260	0.140	2.396
02APR98	B	0	0.652	92	0.492	0.148	2.266
02APR98	B	1.8	0.652	71	0.590	0.179	2.384
02APR98	A	0	0.630	202	0.644	0.000	5.068
02APR98	A	1.1	2.283	118	0.742	0.000	5.504

Biomass Data

Biomass is measured for taxonomic groupings. Number (n) of individuals and biomass (mg) for each vertical section within a replicate core.

Lavaca-Colorado Estuary

Date	Station	Replicate	Section	Taxa	n	mg
09JUL97	A	1	3	Polychaeta	12	0.65
09JUL97	A	1	10	Polychaeta	1	0.05
09JUL97	A	2	3	Mollusca	2	0.36
09JUL97	A	2	3	Rhynchocoela	1	0.17
09JUL97	A	2	3	Polychaeta	17	0.77
09JUL97	A	2	10	Mollusca	1	6.63
09JUL97	A	2	10	Polychaeta	4	0.2
09JUL97	A	3	3	Chironomid larvae	1	0.01
09JUL97	A	3	3	Mollusca	1	0.01
09JUL97	A	3	3	Polychaeta	6	0.18
09JUL97	A	3	10	Mollusca	1	8.34
09JUL97	B	1	3	Mollusca	1	0.4
09JUL97	B	1	3	Polychaeta	7	0.78
09JUL97	B	1	10	Polychaeta	4	1.43
09JUL97	B	2	3	Mollusca	1	0.25
09JUL97	B	2	3	Polychaeta	4	0.69
09JUL97	B	2	10	Rhynchocoela	1	2.27
09JUL97	B	2	10	Polychaeta	4	0.5
09JUL97	B	3	3	Rhynchocoela	1	0.02
09JUL97	B	3	3	Polychaeta	15	0.62
09JUL97	B	3	10	Polychaeta	7	1.11
09JUL97	C	1	3	Mollusca	1	0.24
09JUL97	C	1	3	Polychaeta	6	0.23
09JUL97	C	1	10	Rhynchocoela	2	0.28
09JUL97	C	1	10	Polychaeta	8	2.2
09JUL97	C	2	3	Polychaeta	6	0.2
09JUL97	C	2	10	Polychaeta	4	0.94
09JUL97	C	3	3	Mollusca	1	0.02
09JUL97	C	3	3	Polychaeta	8	0.46
09JUL97	C	3	10	Rhynchocoela	1	0.29
09JUL97	C	3	10	Polychaeta	11	3.51
09JUL97	D	1	3	Crustacea	1	0.02
09JUL97	D	1	3	Rhynchocoela	1	0.02
09JUL97	D	1	3	Polychaeta	3	0.37
09JUL97	D	1	10	Mollusca	6	16.54
09JUL97	D	1	10	Rhynchocoela	3	2.93
09JUL97	D	1	10	Ophiuroidea	1	7.95
09JUL97	D	1	10	Polychaeta	5	1.26
09JUL97	D	2	3	Rhynchocoela	1	0.49
09JUL97	D	2	3	Other	1	0.29

09JUL97	D	2	3	Polychaeta	17	1.11
09JUL97	D	2	10	Mollusca	12	3.65
09JUL97	D	2	10	Rhynchocoela	2	0.59
09JUL97	D	2	10	Ophiuroidea	2	16.44
09JUL97	D	2	10	Polychaeta	19	19.8
09JUL97	D	3	3	Mollusca	1	0.08
09JUL97	D	3	3	Polychaeta	7	0.34
09JUL97	D	3	10	Mollusca	4	0.73
09JUL97	D	3	10	Rhynchocoela	6	19.01
09JUL97	D	3	10	Ophiuroidea	1	6.64
09JUL97	D	3	10	Polychaeta	18	0.74
09JUL97	E	1	3	Polychaeta	4	0.03
09JUL97	E	1	10	Polychaeta	4	0.17
09JUL97	E	2	3	Polychaeta	6	0.03
09JUL97	E	2	10	Polychaeta	1	0.06
09JUL97	E	3	3	Polychaeta	3	0.06
09JUL97	E	3	10	Polychaeta	7	4.29
09JUL97	F	1	3	Polychaeta	9	0.73
09JUL97	F	1	10	Polychaeta	2	1.44
09JUL97	F	2	3	Polychaeta	3	0.37
09JUL97	F	2	10	Polychaeta	6	1.15
09JUL97	F	3	3	Rhynchocoela	1	0.39
09JUL97	F	3	3	Polychaeta	2	0.55
09JUL97	F	3	10	Polychaeta	5	1
17OCT97	A	1	3	Polychaeta	14	1.09
17OCT97	A	1	10	Polychaeta	2	0.16
17OCT97	A	2	3	Rhynchocoela	1	0.12
17OCT97	A	2	3	Polychaeta	19	0.81
17OCT97	A	2	10	Polychaeta	4	0.2
17OCT97	A	3	3	Chironomid larvae	1	0.12
17OCT97	A	3	3	Other	1	0.22
17OCT97	A	3	3	Polychaeta	5	0.46
17OCT97	A	3	10	Polychaeta	6	1.32
17OCT97	B	1	3	Chironomid larvae	1	0.02
17OCT97	B	1	3	Polychaeta	3	0.51
17OCT97	B	1	10	Polychaeta	9	1.8
17OCT97	B	2	3	Polychaeta	5	0.67
17OCT97	B	2	10	Polychaeta	6	2.21
17OCT97	B	3	3	Polychaeta	3	0.4
17OCT97	B	3	10	Polychaeta	8	1.27
17OCT97	C	1	3	Crustacea	2	0.04
17OCT97	C	1	3	Ophiuroidea	1	0.06
17OCT97	C	1	3	Polychaeta	8	0.19
17OCT97	C	1	10	Rhynchocoela	2	0.16
17OCT97	C	1	10	Polychaeta	21	4.59
17OCT97	C	2	3	Mollusca	1	0.02
17OCT97	C	2	3	Polychaeta	4	0.27
17OCT97	C	2	10	Polychaeta	7	0.37
17OCT97	C	3	3	Polychaeta	4	0.09
17OCT97	C	3	10	Polychaeta	7	1.29
17OCT97	D	1	3	Rhynchocoela	3	2.49

17OCT97	D	1	3	Polychaeta	17	0.47
17OCT97	D	1	10	Mollusca	1	0.02
17OCT97	D	1	10	Rhynchocoela	2	1.82
17OCT97	D	1	10	Ophiuroidea	1	0.6
17OCT97	D	1	10	Polychaeta	2	1.5
17OCT97	D	2	3	Mollusca	1	1.51
17OCT97	D	2	3	Polychaeta	14	0.62
17OCT97	D	2	10	Mollusca	4	5.66
17OCT97	D	2	10	Rhynchocoela	1	0.12
17OCT97	D	2	10	Ophiuroidea	1	4.5
17OCT97	D	2	10	Polychaeta	21	8.15
17OCT97	D	3	3	Mollusca	1	0.73
17OCT97	D	3	3	Rhynchocoela	2	0.14
17OCT97	D	3	3	Polychaeta	25	0.68
17OCT97	D	3	10	Mollusca	5	0.148
17OCT97	D	3	10	Rhynchocoela	1	0.848
17OCT97	D	3	10	Ophiuroidea	1	0.83
17OCT97	D	3	10	Polychaeta	9	79.68
17OCT97	E	1	3	Polychaeta	13	1.26
17OCT97	E	1	10	Rhynchocoela	1	0.7
17OCT97	E	1	10	Polychaeta	8	4.04
17OCT97	E	2	3	Polychaeta	21	1.12
17OCT97	E	2	10	Rhynchocoela	1	0.09
17OCT97	E	2	10	Polychaeta	5	2.19
17OCT97	E	3	3	Hemicordata	1	1.02
17OCT97	E	3	3	Other	3	0.14
17OCT97	E	3	3	Polychaeta	19	0.65
17OCT97	E	3	10	Crustacea	1	0.49
17OCT97	E	3	10	Rhynchocoela	1	0.84
17OCT97	E	3	10	Polychaeta	18	3.6
17OCT97	F	1	3	Polychaeta	18	1.42
17OCT97	F	1	10	Rhynchocoela	1	0.3
17OCT97	F	1	10	Polychaeta	7	2.46
17OCT97	F	2	3	Polychaeta	17	3.29
17OCT97	F	2	10	Polychaeta	1	0.08
17OCT97	F	3	3	Polychaeta	14	3.47
17OCT97	F	3	10	Polychaeta	2	1.16
09JAN98	A	1	3	Crustacea	2	0.14
09JAN98	A	1	3	Mollusca	7	0.26
09JAN98	A	1	3	Polychaeta	33	3.13
09JAN98	A	1	10	Polychaeta	2	0.24
09JAN98	A	2	3	Mollusca	1	0.01
09JAN98	A	2	3	Rhynchocoela	1	0.03
09JAN98	A	2	3	Polychaeta	10	1.29
09JAN98	A	2	10	Rhynchocoela	1	0.68
09JAN98	A	2	10	Polychaeta	1	0.3
09JAN98	A	3	3	Mollusca	6	1.56
09JAN98	A	3	3	Polychaeta	16	1.23
09JAN98	A	3	10	Polychaeta	0	0
09JAN98	B	1	3	Crustacea	1	0.01
09JAN98	B	1	3	Mollusca	5	0.33

09JAN98	B	1	3	Polychaeta	14	2.66
09JAN98	B	1	10	Polychaeta	1	0.03
09JAN98	B	2	3	Mollusca	4	2.82
09JAN98	B	2	3	Rhynchocoela	1	0.29
09JAN98	B	2	3	Polychaeta	22	1.46
09JAN98	B	2	10	Polychaeta	0	0
09JAN98	B	3	3	Crustacea	1	0.02
09JAN98	B	3	3	Mollusca	5	0.48
09JAN98	B	3	3	Polychaeta	18	1.87
09JAN98	B	3	10	Polychaeta	1	0.6
09JAN98	C	1	3	Crustacea	1	0.01
09JAN98	C	1	3	Mollusca	3	0.11
09JAN98	C	1	3	Polychaeta	11	1.6
09JAN98	C	1	10	Mollusca	2	0.16
09JAN98	C	1	10	Polychaeta	5	4.49
09JAN98	C	2	3	Mollusca	4	0.26
09JAN98	C	2	3	Polychaeta	20	2.34
09JAN98	C	2	10	Rhynchocoela	1	0.02
09JAN98	C	2	10	Polychaeta	6	5.86
09JAN98	C	3	3	Crustacea	1	0.01
09JAN98	C	3	3	Mollusca	1	0.01
09JAN98	C	3	3	Rhynchocoela	2	0.22
09JAN98	C	3	3	Polychaeta	26	3.78
09JAN98	C	3	10	Polychaeta	9	2.62
09JAN98	D	1	3	Mollusca	4	0.17
09JAN98	D	1	3	Rhynchocoela	1	0.93
09JAN98	D	1	3	Other	1	0.05
09JAN98	D	1	3	Polychaeta	23	2.13
09JAN98	D	1	10	Mollusca	1	9.22
09JAN98	D	1	10	Rhynchocoela	2	1.42
09JAN98	D	1	10	Ophiuroidea	1	1.92
09JAN98	D	1	10	Polychaeta	3	1.69
09JAN98	D	2	3	Mollusca	4	0.28
09JAN98	D	2	3	Rhynchocoela	2	0.27
09JAN98	D	2	3	Other	1	0.06
09JAN98	D	2	3	Polychaeta	13	0.47
09JAN98	D	2	10	Mollusca	2	0.42
09JAN98	D	2	10	Rhynchocoela	2	0.6
09JAN98	D	2	10	Ophiuroidea	2	19.58
09JAN98	D	2	10	Polychaeta	16	13.91
09JAN98	D	3	3	MP	4	0.58
09JAN98	D	3	3	PP	14	1.01
09JAN98	D	3	10	CP	1	0.4
09JAN98	D	3	10	Ophiuroidea	1	3.19
09JAN98	D	3	10	PP	6	3.43
09JAN98	E	1	3	Rhynchocoela	2	0.15
09JAN98	E	1	3	Polychaeta	7	0.27
09JAN98	E	1	10	Polychaeta	1	0.63
09JAN98	E	2	3	Mollusca	2	0.1
09JAN98	E	2	3	Polychaeta	13	0.87
09JAN98	E	2	10	Hemicordata	1	37.33

09JAN98	E	2	10	Polychaeta	7	4.28
09JAN98	E	3	3	Mollusca	1	0.02
09JAN98	E	3	3	Polychaeta	19	0.48
09JAN98	E	3	10	Polychaeta	3	0.48
09JAN98	F	1	3	Crustacea	2	0.04
09JAN98	F	1	3	Polychaeta	3	0.95
09JAN98	F	1	10	Polychaeta	1	4.62
09JAN98	F	2	3	Crustacea	17	0.96
09JAN98	F	2	3	Mollusca	3	0.17
09JAN98	F	2	3	Polychaeta	21	2.25
09JAN98	F	2	10	Polychaeta	1	3.42
09JAN98	F	3	3	Crustacea	4	0.22
09JAN98	F	3	3	Mollusca	1	0.03
09JAN98	F	3	3	Rhynchocoela	1	0.02
09JAN98	F	3	3	Polychaeta	9	2.51
09JAN98	F	3	10	Polychaeta	1	0.35
01APR98	A	1	3	Crustacea	1	0.01
01APR98	A	1	3	Mollusca	7	1.34
01APR98	A	1	3	Polychaeta	35	2.99
01APR98	A	1	10	Polychaeta	8	3.13
01APR98	A	2	3	Mollusca	4	1.31
01APR98	A	2	3	Rhynchocoela	1	1.09
01APR98	A	2	3	Polychaeta	27	3.98
01APR98	A	2	10	Mollusca	1	2.21
01APR98	A	2	10	Rhynchocoela	1	1.51
01APR98	A	2	10	Polychaeta	1	0.15
01APR98	A	3	3	Mollusca	3	0.54
01APR98	A	3	3	Polychaeta	38	4.31
01APR98	A	3	10	Polychaeta	7	3.74
01APR98	B	1	3	Mollusca	2	1.11
01APR98	B	1	3	Polychaeta	7	1.07
01APR98	B	1	10	Polychaeta	1	0.71
01APR98	B	2	3	Crustacea	1	0.09
01APR98	B	2	3	Mollusca	1	0.02
01APR98	B	2	3	Polychaeta	18	2.83
01APR98	B	2	10	Polychaeta	4	1.23
01APR98	B	3	3	Crustacea	1	0.06
01APR98	B	3	3	Mollusca	1	0.01
01APR98	B	3	3	Polychaeta	40	4.06
01APR98	B	3	10	Rhynchocoela	1	6.26
01APR98	C	1	3	Crustacea	1	0.06
01APR98	C	1	3	Mollusca	16	4.62
01APR98	C	1	3	Other	1	0.62
01APR98	C	1	3	Polychaeta	30	3.55
01APR98	C	1	10	Polychaeta	9	4.28
01APR98	C	2	3	Mollusca	16	6.45
01APR98	C	2	3	Other	1	1.45
01APR98	C	2	3	Polychaeta	24	1.44
01APR98	C	2	10	Polychaeta	5	4.03
01APR98	C	3	3	Crustacea	2	0.02
01APR98	C	3	3	Mollusca	31	14.27

01APR98	C	3	3	Rhynchocoela	1	0.36
01APR98	C	3	3	Polychaeta	22	3.22
01APR98	C	3	10	Mollusca	1	0.9
01APR98	C	3	10	Polychaeta	6	11.11
01APR98	D	1	3	Crustacea	1	0.01
01APR98	D	1	3	Other	1	0.33
01APR98	D	1	3	Polychaeta	24	0.8
01APR98	D	1	10	Mollusca	1	3.01
01APR98	D	1	10	Polychaeta	6	17.62
01APR98	D	2	3	Mollusca	1	0.01
01APR98	D	2	3	Polychaeta	15	1.82
01APR98	D	2	10	Mollusca	5	0.47
01APR98	D	2	10	Rhynchocoela	1	1.16
01APR98	D	2	10	Ophiuroidea	1	0.15
01APR98	D	2	10	Polychaeta	2	15.66
01APR98	D	3	3	Crustacea	1	0.02
01APR98	D	3	3	Mollusca	11	0.43
01APR98	D	3	3	Rhynchocoela	1	0.16
01APR98	D	3	3	Ophiuroidea	1	14.48
01APR98	D	3	3	Polychaeta	15	0.83
01APR98	D	3	10	Mollusca	4	0.1
01APR98	D	3	10	Polychaeta	5	1.31
01APR98	E	1	3	Polychaeta	14	0.25
01APR98	E	1	10	Polychaeta	12	0.43
01APR98	E	2	3	Mollusca	2	0.04
01APR98	E	2	3	Polychaeta	39	1.2
01APR98	E	2	10	Polychaeta	13	1.74
01APR98	E	3	3	Mollusca	4	0.37
01APR98	E	3	3	Polychaeta	28	1.88
01APR98	E	3	10	Hemicordata	1	60.59
01APR98	E	3	10	Polychaeta	8	5.39
01APR98	F	1	3	Crustacea	3	0.19
01APR98	F	1	3	Mollusca	1	0.55
01APR98	F	1	3	Polychaeta	25	1.81
01APR98	F	1	10	Polychaeta	22	9.68
01APR98	F	2	3	Crustacea	1	0.01
01APR98	F	2	3	Polychaeta	43	3.24
01APR98	F	2	10	Rhynchocoela	1	0.41
01APR98	F	2	10	Polychaeta	11	1.73
01APR98	F	3	3	Crustacea	2	0.18
01APR98	F	3	3	Polychaeta	38	4.75
01APR98	F	3	10	Polychaeta	9	1.09

Guadalupe Estuary

Date	Station	Replicate	Section	Taxa	n	mg
28JUL97	A	1	3	Mollusca	3	1.63
28JUL97	A	1	3	Polychaeta	20	0.3
28JUL97	A	1	10	Chironomid larvae	1	0.12

28JUL97	A	1	10	Polychaeta	6	0.14
28JUL97	A	2	3	Mollusca	2	0.32
28JUL97	A	2	3	Polychaeta	9	0.17
28JUL97	A	2	10	Polychaeta	9	1.02
28JUL97	A	3	3	Chironomid larvae	1	0.1
28JUL97	A	3	3	Rhynchocoela	1	0.15
28JUL97	A	3	3	Other	1	0.06
28JUL97	A	3	3	Polychaeta	1	0.92
28JUL97	A	3	10	Chironomid larvae	1	0.11
28JUL97	B	1	3	Polychaeta	0	0
28JUL97	B	1	10	Polychaeta	3	1.29
28JUL97	B	2	3	Polychaeta	2	0.07
28JUL97	B	2	10	Polychaeta	11	3.48
28JUL97	B	3	3	Polychaeta	6	0.62
28JUL97	B	3	10	Polychaeta	2	1.18
28JUL97	C	1	3	Rhynchocoela	1	0.02
28JUL97	C	1	3	Polychaeta	14	1.04
28JUL97	C	1	10	Polychaeta	12	5.69
28JUL97	C	2	3	Mollusca	1	0.5
28JUL97	C	2	3	Polychaeta	9	3.03
28JUL97	C	2	10	Polychaeta	13	4.02
28JUL97	C	3	3	Rhynchocoela	1	0.09
28JUL97	C	3	3	Polychaeta	12	1.9
28JUL97	C	3	10	Polychaeta	8	2.52
28JUL97	D	1	3	Polychaeta	0	0
28JUL97	D	1	10	Polychaeta	2	0.19
28JUL97	D	2	3	Mollusca	1	1.11
28JUL97	D	2	3	Polychaeta	2	0.06
28JUL97	D	2	10	Polychaeta	0	0
28JUL97	D	3	3	Polychaeta	0	0
28JUL97	D	3	10	Polychaeta	5	1.03
16OCT97	A	1	3	Polychaeta	5	0.34
16OCT97	A	1	10	Polychaeta	0	0
16OCT97	A	2	3	Crustacea	1	0.01
16OCT97	A	2	3	Polychaeta	4	0.09
16OCT97	A	2	10	Polychaeta	0	0
16OCT97	A	3	3	Chironomid larvae	2	0.08
16OCT97	A	3	3	Mollusca	1	0.17
16OCT97	A	3	3	Polychaeta	2	0.26
16OCT97	A	3	10	Polychaeta	2	0.72
16OCT97	B	1	3	Polychaeta	15	2.73
16OCT97	B	1	10	Polychaeta	4	1.96
16OCT97	B	2	3	Polychaeta	8	1.37
16OCT97	B	2	10	Polychaeta	5	1.6
16OCT97	B	3	3	Polychaeta	3	3.36
16OCT97	B	3	10	Polychaeta	2	1.18
16OCT97	C	1	3	Polychaeta	2	1.62
16OCT97	C	1	10	Polychaeta	2	0.4
16OCT97	C	2	3	Mollusca	1	0.8
16OCT97	C	2	3	Polychaeta	10	0.48
16OCT97	C	2	10	Polychaeta	9	1.31
16OCT97	C	3	3	Polychaeta	10	0.52
16OCT97	C	3	10	Polychaeta	3	0.15
16OCT97	D	1	3	Rhynchocoela	1	0.04
16OCT97	D	1	3	Polychaeta	12	0.77
16OCT97	D	1	10	Crustacea	1	0.02
16OCT97	D	1	10	Polychaeta	2	0.82
16OCT97	D	2	3	Rhynchocoela	1	0.01
16OCT97	D	2	3	Polychaeta	4	0.09
16OCT97	D	2	10	Polychaeta	0	0
16OCT97	D	3	3	Polychaeta	13	1.17
16OCT97	D	3	10	Polychaeta	3	0.81
12JAN98	A	1	3	Chironomid larvae	1	0.1
12JAN98	A	1	3	Mollusca	2	0.06

12JAN98	A	1	3	Polychaeta	7	2.47
12JAN98	A	1	10	Polychaeta	1	0.9
12JAN98	A	2	3	Mollusca	1	0.24
12JAN98	A	2	3	Polychaeta	4	0.86
12JAN98	A	2	10	Polychaeta	0	0
12JAN98	A	3	3	Mollusca	5	0.11
12JAN98	A	3	3	Polychaeta	4	0.44
12JAN98	A	3	10	Polychaeta	1	0.03
12JAN98	B	1	3	Mollusca	9	0.64
12JAN98	B	1	3	Rhynchocoela	1	0.2
12JAN98	B	1	3	Polychaeta	17	1.22
12JAN98	B	1	10	Mollusca	1	3.76
12JAN98	B	1	10	Polychaeta	7	1.6
12JAN98	B	2	3	Mollusca	4	0.43
12JAN98	B	2	3	Rhynchocoela	1	0.38
12JAN98	B	2	3	Polychaeta	12	1.12
12JAN98	B	2	10	Polychaeta	1	0.02
12JAN98	B	3	3	Mollusca	1	0.06
12JAN98	B	3	3	Rhynchocoela	1	0.38
12JAN98	B	3	3	Polychaeta	17	1.08
12JAN98	B	3	10	Mollusca	4	8.48
12JAN98	B	3	10	Polychaeta	8	5.53
12JAN98	C	1	3	Mollusca	4	4.19
12JAN98	C	1	3	Rhynchocoela	1	0.36
12JAN98	C	1	3	Polychaeta	46	4.75
12JAN98	C	1	10	Polychaeta	4	1.94
12JAN98	C	2	3	Rhynchocoela	2	1.33
12JAN98	C	2	3	Polychaeta	28	2.95
12JAN98	C	2	10	Polychaeta	2	0.72
12JAN98	C	3	3	Mollusca	3	1.77
12JAN98	C	3	3	Rhynchocoela	1	0.3
12JAN98	C	3	3	Polychaeta	28	3.14
12JAN98	C	3	10	Polychaeta	2	0.42
12JAN98	D	1	3	Mollusca	1	0.11
12JAN98	D	1	3	Rhynchocoela	1	0.07
12JAN98	D	1	3	Polychaeta	28	4.48
12JAN98	D	1	10	Polychaeta	0	0
12JAN98	D	2	3	Crustacea	2	0.05
12JAN98	D	2	3	Mollusca	1	0.1
12JAN98	D	2	3	Polychaeta	31	2.44
12JAN98	D	2	10	Polychaeta	6	0.84
12JAN98	D	3	3	Mollusca	1	0.12
12JAN98	D	3	3	Rhynchocoela	1	0.28
12JAN98	D	3	3	Polychaeta	34	4.05
12JAN98	D	3	10	Polychaeta	1	0.13
02APR98	A	1	3	Chironomid larvae	1	0.02
02APR98	A	1	3	Mollusca	7	0.26
02APR98	A	1	3	Polychaeta	9	1.25
02APR98	A	1	10	Polychaeta	0	0
02APR98	A	2	3	Chironomid larvae	2	0.08
02APR98	A	2	3	Mollusca	19	1.09
02APR98	A	2	3	Polychaeta	28	4.36
02APR98	A	2	10	Chironomid larvae	1	0.15
02APR98	A	2	10	Polychaeta	4	1.35
02APR98	A	3	3	Crustacea	1	0.02
02APR98	A	3	3	Mollusca	10	13.41
02APR98	A	3	3	Polychaeta	23	2.72
02APR98	A	3	10	Polychaeta	1	0.08
02APR98	B	1	3	Mollusca	10	0.26
02APR98	B	1	3	Rhynchocoela	1	0.63
02APR98	B	1	3	Polychaeta	16	2.04
02APR98	B	1	10	Polychaeta	5	1.63
02APR98	B	2	3	Mollusca	23	0.99
02APR98	B	2	3	Rhynchocoela	1	0.02

02APR98	B	2	3	Polychaeta	15	2.36
02APR98	B	2	10	Polychaeta	4	3.05
02APR98	B	3	3	Crustacea	1	0.04
02APR98	B	3	3	Mollusca	12	1.44
02APR98	B	3	3	Polychaeta	16	2.23
02APR98	B	3	10	Rhynchocoela	1	0.01
02APR98	B	3	10	Polychaeta	9	2.88
02APR98	C	1	3	Mollusca	15	1.05
02APR98	C	1	3	Polychaeta	55	7.68
02APR98	C	1	10	Mollusca	1	18.77
02APR98	C	1	10	Polychaeta	6	0.7
02APR98	C	2	3	Mollusca	20	0.51
02APR98	C	2	3	Polychaeta	54	8.47
02APR98	C	2	10	Polychaeta	1	0.52
02APR98	C	3	3	Mollusca	26	4.71
02APR98	C	3	3	Rhynchocoela	1	0.73
02APR98	C	3	3	Polychaeta	46	4.96
02APR98	C	3	10	Mollusca	1	50.1
02APR98	C	3	10	Rhynchocoela	1	0.12
02APR98	C	3	10	Polychaeta	1	0.54
02APR98	D	1	3	Crustacea	1	0.04
02APR98	D	1	3	Mollusca	10	0.84
02APR98	D	1	3	Rhynchocoela	1	0.13
02APR98	D	1	3	Polychaeta	47	4.64
02APR98	D	1	10	Crustacea	1	0.59
02APR98	D	1	10	Mollusca	1	0.54
02APR98	D	1	10	Polychaeta	8	1.63
02APR98	D	2	3	Mollusca	18	1.82
02APR98	D	2	3	Rhynchocoela	1	0.23
02APR98	D	2	3	Polychaeta	38	2.63
02APR98	D	2	10	Polychaeta	3	4.88
02APR98	D	3	3	Mollusca	17	0.7
02APR98	D	3	3	Polychaeta	18	1.83
02APR98	D	3	10	Rhynchocoela	1	0.22
02APR98	D	3	10	Polychaeta	3	0.75

Species Data

Number(n) of individuals of macrofauna species found at a vertical section depth within each replicate core.

Lavaca-Colorado Estuary

Date	Station	Replicate	Section	Species	n
09JUL97	A	1	3	Streblospio benedicti	1
09JUL97	A	1	3	Mediomastus ambiseta	11
09JUL97	A	1	10	Mediomastus ambiseta	1
09JUL97	A	2	3	Rhynchocoela (unidentified)	1
09JUL97	A	2	3	Littoridina sphinctostoma	2
09JUL97	A	2	3	Mediomastus ambiseta	17
09JUL97	A	2	10	Macoma mitchelli	1
09JUL97	A	2	10	Mediomastus ambiseta	4
09JUL97	A	3	3	Streblospio benedicti	2
09JUL97	A	3	3	Chironomid larvae	1
09JUL97	A	3	3	Littoridina sphinctostoma	1
09JUL97	A	3	3	Mediomastus ambiseta	4
09JUL97	A	3	10	Macoma mitchelli	1
09JUL97	B	1	3	Streblospio benedicti	1
09JUL97	B	1	3	Mulinia lateralis	1
09JUL97	B	1	3	Mediomastus ambiseta	6
09JUL97	B	1	10	Capitella capitata	1
09JUL97	B	1	10	Mediomastus ambiseta	3
09JUL97	B	2	3	Streblospio benedicti	3
09JUL97	B	2	3	Mulinia lateralis	1
09JUL97	B	2	3	Mediomastus ambiseta	1
09JUL97	B	2	10	Rhynchocoela (unidentified)	1
09JUL97	B	2	10	Mediomastus ambiseta	4
09JUL97	B	3	3	Rhynchocoela (unidentified)	1
09JUL97	B	3	3	Streblospio benedicti	10
09JUL97	B	3	3	Mediomastus ambiseta	5
09JUL97	B	3	10	Mediomastus ambiseta	7
09JUL97	C	1	3	Cossura delta	2
09JUL97	C	1	3	Macoma mitchelli	1
09JUL97	C	1	3	Mediomastus ambiseta	4
09JUL97	C	1	10	Rhynchocoela (unidentified)	2
09JUL97	C	1	10	Cossura delta	1
09JUL97	C	1	10	Mediomastus ambiseta	6
09JUL97	C	1	10	Aricidea bryani	1
09JUL97	C	2	3	Oligochaetes (unidentified)	1
09JUL97	C	2	3	Streblospio benedicti	1
09JUL97	C	2	3	Cossura delta	1
09JUL97	C	2	3	Mediomastus ambiseta	3
09JUL97	C	2	10	Mediomastus ambiseta	4
09JUL97	C	3	3	Streblospio benedicti	1

09JUL97	C	3	3	Cossura delta	1
09JUL97	C	3	3	Gastropoda (unidentified)	1
09JUL97	C	3	3	Mediomastus ambiseta	4
09JUL97	C	3	3	Aricidea bryani	1
09JUL97	C	3	3	Cirrophorus lyra	1
09JUL97	C	3	10	Rhynchocoela (unidentified)	1
09JUL97	C	3	10	Gyptis vittata	1
09JUL97	C	3	10	Lumbrineris parvapedata	1
09JUL97	C	3	10	Paraprionospio pinnata	1
09JUL97	C	3	10	Mediomastus ambiseta	8
09JUL97	D	1	3	Rhynchocoela (unidentified)	1
09JUL97	D	1	3	Minuspio cirrifera	1
09JUL97	D	1	3	Apseudes sp. A	1
09JUL97	D	1	3	Mediomastus ambiseta	2
09JUL97	D	1	10	Rhynchocoela (unidentified)	3
09JUL97	D	1	10	Oligochaetes (unidentified)	1
09JUL97	D	1	10	Schistomeringos rudolphi	1
09JUL97	D	1	10	Minuspio cirrifera	3
09JUL97	D	1	10	Corbula contracta	1
09JUL97	D	1	10	Periploma margaritaceum	3
09JUL97	D	1	10	Ophiuroidea (unidentified)	1
09JUL97	D	1	10	Periploma cf. orbiculare	2
09JUL97	D	2	3	Anthozoa (unidentified)	1
09JUL97	D	2	3	Rhynchocoela (unidentified)	1
09JUL97	D	2	3	Oligochaetes (unidentified)	1
09JUL97	D	2	3	Gyptis vittata	1
09JUL97	D	2	3	Streblospio benedicti	4
09JUL97	D	2	3	Paraprionospio pinnata	2
09JUL97	D	2	3	Minuspio cirrifera	3
09JUL97	D	2	3	Cossura delta	2
09JUL97	D	2	3	Mediomastus ambiseta	4
09JUL97	D	2	10	Rhynchocoela (unidentified)	2
09JUL97	D	2	10	Oligochaetes (unidentified)	3
09JUL97	D	2	10	Ancistrosyllis jonesi	2
09JUL97	D	2	10	Sigambra bassi	2
09JUL97	D	2	10	Gyptis vittata	2
09JUL97	D	2	10	Minuspio cirrifera	8
09JUL97	D	2	10	Cossura delta	1
09JUL97	D	2	10	Maldanidae (unidentified)	1
09JUL97	D	2	10	Corbula contracta	1
09JUL97	D	2	10	Periploma margaritaceum	8
09JUL97	D	2	10	Ophiuroidea (unidentified)	2
09JUL97	D	2	10	Periploma cf. orbiculare	3
09JUL97	D	3	3	Ancistrosyllis jonesi	1
09JUL97	D	3	3	Streblospio benedicti	1
09JUL97	D	3	3	Cossura delta	1
09JUL97	D	3	3	Corbula contracta	1
09JUL97	D	3	3	Mediomastus ambiseta	4
09JUL97	D	3	10	Rhynchocoela (unidentified)	6
09JUL97	D	3	10	Oligochaetes (unidentified)	7
09JUL97	D	3	10	Sigambra bassi	3

09JUL97	D	3	10	Sigambra tentaculata	1
09JUL97	D	3	10	Gyptis vittata	1
09JUL97	D	3	10	Polydora caulleryi	1
09JUL97	D	3	10	Minuspio cirrifera	1
09JUL97	D	3	10	Magelona phyllisae	1
09JUL97	D	3	10	Cossura delta	1
09JUL97	D	3	10	Corbula contracta	1
09JUL97	D	3	10	Periploma margaritaceum	3
09JUL97	D	3	10	Ophiuroidea (unidentified)	1
09JUL97	D	3	10	Mediomastus ambiseta	2
09JUL97	E	1	3	Oligochaetes (unidentified)	1
09JUL97	E	1	3	Cossura delta	3
09JUL97	E	1	10	Sigambra tentaculata	1
09JUL97	E	1	10	Cossura delta	3
09JUL97	E	2	3	Cossura delta	6
09JUL97	E	2	10	Cossura delta	1
09JUL97	E	3	3	Oligochaetes (unidentified)	1
09JUL97	E	3	3	Cossura delta	1
09JUL97	E	3	3	Cirrophorus lyra	1
09JUL97	E	3	10	Oligochaetes (unidentified)	1
09JUL97	E	3	10	Sigambra tentaculata	3
09JUL97	E	3	10	Paraprionospio pinnata	1
09JUL97	E	3	10	Cossura delta	2
09JUL97	F	1	3	Streblospio benedicti	7
09JUL97	F	1	3	Mediomastus ambiseta	2
09JUL97	F	1	10	Parandalia ocularis	1
09JUL97	F	1	10	Mediomastus ambiseta	1
09JUL97	F	2	3	Mediomastus ambiseta	3
09JUL97	F	2	10	Parandalia ocularis	1
09JUL97	F	2	10	Mediomastus ambiseta	5
09JUL97	F	3	3	Rhynchocoela (unidentified)	1
09JUL97	F	3	3	Mediomastus ambiseta	2
09JUL97	F	3	10	Mediomastus ambiseta	5
17OCT97	A	1	3	Streblospio benedicti	8
17OCT97	A	1	3	Mediomastus ambiseta	6
17OCT97	A	1	10	Capitella capitata	1
17OCT97	A	1	10	Mediomastus ambiseta	1
17OCT97	A	2	3	Rhynchocoela (unidentified)	1
17OCT97	A	2	3	Streblospio benedicti	11
17OCT97	A	2	3	Mediomastus ambiseta	8
17OCT97	A	2	10	Mediomastus ambiseta	4
17OCT97	A	3	3	Streblospio benedicti	3
17OCT97	A	3	3	Chironomid larvae	1
17OCT97	A	3	3	Mediomastus ambiseta	2
17OCT97	A	3	3	Potamanthidae (unidentified)	1
17OCT97	A	3	10	Mediomastus ambiseta	6
17OCT97	B	1	3	Chironomid larvae	1
17OCT97	B	1	3	Mediomastus ambiseta	3
17OCT97	B	1	10	Parandalia ocularis	1
17OCT97	B	1	10	Mediomastus ambiseta	8
17OCT97	B	2	3	Streblospio benedicti	2

17OCT97	B	2	3	Mediomastus ambiseta	3
17OCT97	B	2	10	Capitella capitata	1
17OCT97	B	2	10	Mediomastus ambiseta	5
17OCT97	B	3	3	Streblospio benedicti	1
17OCT97	B	3	3	Paraprionospio pinnata	1
17OCT97	B	3	3	Mediomastus ambiseta	1
17OCT97	B	3	10	Parandalia ocularis	1
17OCT97	B	3	10	Mediomastus ambiseta	7
17OCT97	C	1	3	Streblospio benedicti	3
17OCT97	C	1	3	Pseudodiaptomus coronatus	1
17OCT97	C	1	3	Cyclaspis varians	1
17OCT97	C	1	3	Ophiuroidea (unidentified)	1
17OCT97	C	1	3	Mediomastus ambiseta	5
17OCT97	C	1	10	Rhynchocoela (unidentified)	2
17OCT97	C	1	10	Streblospio benedicti	1
17OCT97	C	1	10	Spiochaetopterus costarum	1
17OCT97	C	1	10	Cossura delta	2
17OCT97	C	1	10	Maldanidae (unidentified)	1
17OCT97	C	1	10	Mediomastus ambiseta	15
17OCT97	C	1	10	Aricidea bryani	1
17OCT97	C	2	3	Streblospio benedicti	1
17OCT97	C	2	3	Cossura delta	1
17OCT97	C	2	3	Mulinia lateralis	1
17OCT97	C	2	3	Mediomastus ambiseta	2
17OCT97	C	2	10	Paraprionospio pinnata	1
17OCT97	C	2	10	Cossura delta	1
17OCT97	C	2	10	Mediomastus ambiseta	5
17OCT97	C	3	3	Mediomastus ambiseta	4
17OCT97	C	3	10	Sigambra tentaculata	1
17OCT97	C	3	10	Paraprionospio pinnata	1
17OCT97	C	3	10	Mediomastus ambiseta	5
17OCT97	D	1	3	Rhynchocoela (unidentified)	3
17OCT97	D	1	3	Oligochaetes (unidentified)	4
17OCT97	D	1	3	Gyptis vittata	1
17OCT97	D	1	3	Streblospio benedicti	7
17OCT97	D	1	3	Minuspio cirrifera	1
17OCT97	D	1	3	Cossura delta	1
17OCT97	D	1	3	Melinna maculata	1
17OCT97	D	1	3	Mediomastus ambiseta	2
17OCT97	D	1	10	Rhynchocoela (unidentified)	2
17OCT97	D	1	10	Streblospio benedicti	1
17OCT97	D	1	10	Ophiuroidea (unidentified)	1
17OCT97	D	1	10	Periploma cf. orbiculare	1
17OCT97	D	1	10	Ninoe nigripes	1
17OCT97	D	2	3	Streblospio benedicti	7
17OCT97	D	2	3	Cossura delta	3
17OCT97	D	2	3	Corbula contracta	1
17OCT97	D	2	3	Mediomastus ambiseta	4
17OCT97	D	2	10	Rhynchocoela (unidentified)	1
17OCT97	D	2	10	Oligochaetes (unidentified)	4
17OCT97	D	2	10	Paleanotus heteroseta	1

17OCT97	D	2	10	Ancistrosyllis jonesi	3
17OCT97	D	2	10	Sigambra tentaculata	1
17OCT97	D	2	10	Gyptis vittata	2
17OCT97	D	2	10	Paraprionospio pinnata	2
17OCT97	D	2	10	Minuspio cirrifera	3
17OCT97	D	2	10	Ophiuroidea (unidentified)	1
17OCT97	D	2	10	Periploma cf. orbiculare	4
17OCT97	D	2	10	Naineris sp. A	1
17OCT97	D	2	10	Mediomastus ambiseta	3
17OCT97	D	2	10	Ninoe nigripes	1
17OCT97	D	3	3	Rhynchocoela (unidentified)	2
17OCT97	D	3	3	Oligochaetes (unidentified)	1
17OCT97	D	3	3	Sigambra tentaculata	1
17OCT97	D	3	3	Streblospio benedicti	9
17OCT97	D	3	3	Minuspio cirrifera	1
17OCT97	D	3	3	Cossura delta	6
17OCT97	D	3	3	Periploma cf. orbiculare	1
17OCT97	D	3	3	Mediomastus ambiseta	7
17OCT97	D	3	10	Rhynchocoela (unidentified)	1
17OCT97	D	3	10	Oligochaetes (unidentified)	3
17OCT97	D	3	10	Sigambra tentaculata	1
17OCT97	D	3	10	Minuspio cirrifera	1
17OCT97	D	3	10	Cossura delta	1
17OCT97	D	3	10	Branchioasychis americana	1
17OCT97	D	3	10	Ophiuroidea (unidentified)	1
17OCT97	D	3	10	Periploma cf. orbiculare	5
17OCT97	D	3	10	Naineris sp. A	1
17OCT97	D	3	10	Mediomastus ambiseta	1
17OCT97	E	1	3	Streblospio benedicti	8
17OCT97	E	1	3	Paraprionospio pinnata	1
17OCT97	E	1	3	Mediomastus ambiseta	4
17OCT97	E	1	10	Rhynchocoela (unidentified)	1
17OCT97	E	1	10	Oligochaetes (unidentified)	1
17OCT97	E	1	10	Glycinde solitaria	1
17OCT97	E	1	10	Paraprionospio pinnata	2
17OCT97	E	1	10	Mediomastus ambiseta	4
17OCT97	E	2	3	Streblospio benedicti	10
17OCT97	E	2	3	Mediomastus ambiseta	11
17OCT97	E	2	10	Rhynchocoela (unidentified)	1
17OCT97	E	2	10	Paraprionospio pinnata	1
17OCT97	E	2	10	Mediomastus ambiseta	3
17OCT97	E	2	10	Aricidea bryani	1
17OCT97	E	3	3	Streblospio benedicti	13
17OCT97	E	3	3	Schizocardium sp.	1
17OCT97	E	3	3	Turbellaria (unidentified)	3
17OCT97	E	3	3	Mediomastus ambiseta	6
17OCT97	E	3	10	Rhynchocoela (unidentified)	1
17OCT97	E	3	10	Streblospio benedicti	1
17OCT97	E	3	10	Paraprionospio pinnata	3
17OCT97	E	3	10	Mysidopsis bahia	1
17OCT97	E	3	10	Mediomastus ambiseta	14

17OCT97	F	1	3	Streblospio benedicti	6
17OCT97	F	1	3	Mediomastus ambiseta	12
17OCT97	F	1	10	Rhynchocoela (unidentified)	1
17OCT97	F	1	10	Sigambra bassi	1
17OCT97	F	1	10	Paraprionospio pinnata	1
17OCT97	F	1	10	Parandalia ocularis	1
17OCT97	F	1	10	Mediomastus ambiseta	4
17OCT97	F	2	3	Streblospio benedicti	2
17OCT97	F	2	3	Paraprionospio pinnata	1
17OCT97	F	2	3	Mediomastus ambiseta	14
17OCT97	F	2	10	Mediomastus ambiseta	1
17OCT97	F	3	3	Streblospio benedicti	2
17OCT97	F	3	3	Paraprionospio pinnata	2
17OCT97	F	3	3	Mediomastus ambiseta	10
17OCT97	F	3	10	Mediomastus ambiseta	2
09JAN98	A	1	3	Polydora ligni	1
09JAN98	A	1	3	Streblospio benedicti	9
09JAN98	A	1	3	Corophium louisianum	2
09JAN98	A	1	3	Macoma mitchelli	7
09JAN98	A	1	3	Mediomastus ambiseta	23
09JAN98	A	1	10	Polydora ligni	1
09JAN98	A	1	10	Mediomastus ambiseta	1
09JAN98	A	2	3	Rhynchocoela (unidentified)	1
09JAN98	A	2	3	Streblospio benedicti	2
09JAN98	A	2	3	Mulinia lateralis	1
09JAN98	A	2	3	Hobsonia florida	1
09JAN98	A	2	3	Mediomastus ambiseta	7
09JAN98	A	2	10	Rhynchocoela (unidentified)	1
09JAN98	A	2	10	Mediomastus ambiseta	1
09JAN98	A	3	3	Mulinia lateralis	2
09JAN98	A	3	3	Macoma mitchelli	4
09JAN98	A	3	3	Mediomastus ambiseta	16
09JAN98	A	3	10	No species observed	0
09JAN98	B	1	3	Eteone heteropoda	1
09JAN98	B	1	3	Streblospio benedicti	1
09JAN98	B	1	3	Haploscoloplos foliosus	2
09JAN98	B	1	3	Ostracoda (unidentified)	1
09JAN98	B	1	3	Macoma mitchelli	5
09JAN98	B	1	3	Mediomastus ambiseta	10
09JAN98	B	1	10	Mediomastus ambiseta	1
09JAN98	B	2	3	Rhynchocoela (unidentified)	1
09JAN98	B	2	3	Streblospio benedicti	4
09JAN98	B	2	3	Macoma mitchelli	4
09JAN98	B	2	3	Mediomastus ambiseta	18
09JAN98	B	2	10	No species observed	0
09JAN98	B	3	3	Streblospio benedicti	2
09JAN98	B	3	3	Haploscoloplos foliosus	1
09JAN98	B	3	3	Ostracoda (unidentified)	1
09JAN98	B	3	3	Macoma mitchelli	5
09JAN98	B	3	3	Mediomastus ambiseta	15
09JAN98	B	3	10	Mediomastus ambiseta	1

09JAN98	C	1	3	Gyptis vittata	1
09JAN98	C	1	3	Streblospio benedicti	1
09JAN98	C	1	3	Paraprionospio pinnata	2
09JAN98	C	1	3	Haploscoloplos foliosus	1
09JAN98	C	1	3	Mulinia lateralis	2
09JAN98	C	1	3	Cyclopoid copepod (commensal)	1
09JAN98	C	1	3	Eulimostoma sp.	1
09JAN98	C	1	3	Mediomastus ambiseta	6
09JAN98	C	1	10	Paraprionospio pinnata	1
09JAN98	C	1	10	Cossura delta	1
09JAN98	C	1	10	Caecum johnsoni	2
09JAN98	C	1	10	Mediomastus ambiseta	3
09JAN98	C	2	3	Glycinde solitaria	1
09JAN98	C	2	3	Streblospio benedicti	3
09JAN98	C	2	3	Paraprionospio pinnata	1
09JAN98	C	2	3	Haploscoloplos foliosus	2
09JAN98	C	2	3	Cossura delta	1
09JAN98	C	2	3	Mulinia lateralis	3
09JAN98	C	2	3	Macoma mitchelli	1
09JAN98	C	2	3	Hobsonia florida	1
09JAN98	C	2	3	Mediomastus ambiseta	11
09JAN98	C	2	10	Rhynchocoela (unidentified)	1
09JAN98	C	2	10	Glycinde solitaria	1
09JAN98	C	2	10	Paraprionospio pinnata	2
09JAN98	C	2	10	Mediomastus ambiseta	3
09JAN98	C	3	3	Rhynchocoela (unidentified)	2
09JAN98	C	3	3	Ancistrosyllis papillosa	2
09JAN98	C	3	3	Lumbrineris parvapedata	1
09JAN98	C	3	3	Streblospio benedicti	1
09JAN98	C	3	3	Paraprionospio pinnata	2
09JAN98	C	3	3	Cossura delta	2
09JAN98	C	3	3	Pseudodiaptomus coronatus	1
09JAN98	C	3	3	Eulimostoma sp.	1
09JAN98	C	3	3	Mediomastus ambiseta	18
09JAN98	C	3	10	Paraprionospio pinnata	1
09JAN98	C	3	10	Cossura delta	2
09JAN98	C	3	10	Mediomastus ambiseta	6
09JAN98	D	1	3	Rhynchocoela (unidentified)	1
09JAN98	D	1	3	Oligochaetes (unidentified)	3
09JAN98	D	1	3	Glycinde solitaria	1
09JAN98	D	1	3	Polydora caulleryi	1
09JAN98	D	1	3	Streblospio benedicti	3
09JAN98	D	1	3	Paraprionospio pinnata	1
09JAN98	D	1	3	Minuspio cirrifera	4
09JAN98	D	1	3	Haploscoloplos foliosus	1
09JAN98	D	1	3	Cossura delta	3
09JAN98	D	1	3	Phoronis architecta	1
09JAN98	D	1	3	Pelecypoda (unidentified)	1
09JAN98	D	1	3	Periploma cf. orbiculare	3
09JAN98	D	1	3	Mediomastus ambiseta	6
09JAN98	D	1	10	Rhynchocoela (unidentified)	2

09JAN98	D	1	10	Paraprionospio pinnata	1
09JAN98	D	1	10	Ophiuroidea (unidentified)	1
09JAN98	D	1	10	Periploma cf. orbiculare	1
09JAN98	D	1	10	Mediomastus ambiseta	2
09JAN98	D	2	3	Rhynchocoela (unidentified)	2
09JAN98	D	2	3	Gyptis vittata	1
09JAN98	D	2	3	Streblospio benedicti	1
09JAN98	D	2	3	Cossura delta	6
09JAN98	D	2	3	Phoronis architecta	1
09JAN98	D	2	3	Pelecypoda (unidentified)	1
09JAN98	D	2	3	Hobsonia florida	1
09JAN98	D	2	3	Periploma cf. orbiculare	3
09JAN98	D	2	3	Mediomastus ambiseta	4
09JAN98	D	2	10	Rhynchocoela (unidentified)	2
09JAN98	D	2	10	Oligochaetes (unidentified)	1
09JAN98	D	2	10	Ancistrosyllis jonesi	1
09JAN98	D	2	10	Lumbrineris parvapedata	1
09JAN98	D	2	10	Minuspio cirrifera	4
09JAN98	D	2	10	Cossura delta	1
09JAN98	D	2	10	Ophiuroidea (unidentified)	2
09JAN98	D	2	10	Periploma cf. orbiculare	2
09JAN98	D	2	10	Naineris sp. A	3
09JAN98	D	2	10	Mediomastus ambiseta	5
09JAN98	D	3	3	Oligochaetes (unidentified)	1
09JAN98	D	3	3	Ancistrosyllis jonesi	1
09JAN98	D	3	3	Streblospio benedicti	1
09JAN98	D	3	3	Minuspio cirrifera	2
09JAN98	D	3	3	Cossura delta	2
09JAN98	D	3	3	Abra aequalis	1
09JAN98	D	3	3	Periploma cf. orbiculare	3
09JAN98	D	3	3	Mediomastus ambiseta	7
09JAN98	D	3	10	Sigambra tentaculata	1
09JAN98	D	3	10	Minuspio cirrifera	1
09JAN98	D	3	10	Ophiuroidea (unidentified)	1
09JAN98	D	3	10	Apseudes sp. A	1
09JAN98	D	3	10	Naineris sp. A	1
09JAN98	D	3	10	Mediomastus ambiseta	3
09JAN98	E	1	3	Rhynchocoela (unidentified)	2
09JAN98	E	1	3	Mediomastus ambiseta	7
09JAN98	E	1	10	Paraprionospio pinnata	1
09JAN98	E	2	3	Glycinde solitaria	1
09JAN98	E	2	3	Streblospio benedicti	1
09JAN98	E	2	3	Eulimostoma sp.	2
09JAN98	E	2	3	Mediomastus ambiseta	11
09JAN98	E	2	10	Gyptis vittata	1
09JAN98	E	2	10	Glycinde solitaria	1
09JAN98	E	2	10	Paraprionospio pinnata	1
09JAN98	E	2	10	Schizocardium sp.	1
09JAN98	E	2	10	Ancistrosyllis cf. falcata	1
09JAN98	E	2	10	Mediomastus ambiseta	3
09JAN98	E	3	3	Streblospio benedicti	1

09JAN98	E	3	3	Nuculana acuta	1
09JAN98	E	3	3	Mediomastus ambiseta	18
09JAN98	E	3	10	Cossura delta	1
09JAN98	E	3	10	Mediomastus ambiseta	2
09JAN98	F	1	3	Ostracoda (unidentified)	2
09JAN98	F	1	3	Mediomastus ambiseta	3
09JAN98	F	1	10	Paraprionospio pinnata	1
09JAN98	F	2	3	Streblospio benedicti	7
09JAN98	F	2	3	Mulinia lateralis	2
09JAN98	F	2	3	Ostracoda (unidentified)	17
09JAN98	F	2	3	Eulimostoma sp.	1
09JAN98	F	2	3	Parandalia ocularis	1
09JAN98	F	2	3	Mediomastus ambiseta	13
09JAN98	F	2	10	Paraprionospio pinnata	1
09JAN98	F	3	3	Rhynchocoela (unidentified)	1
09JAN98	F	3	3	Streblospio benedicti	4
09JAN98	F	3	3	Mulinia lateralis	1
09JAN98	F	3	3	Ostracoda (unidentified)	4
09JAN98	F	3	3	Mediomastus ambiseta	5
09JAN98	F	3	10	Mediomastus ambiseta	1
01APR98	A	1	3	Streblospio benedicti	10
01APR98	A	1	3	Monoculodes sp.	1
01APR98	A	1	3	Hobsonia florida	1
01APR98	A	1	3	Rangia cuneata	7
01APR98	A	1	3	Mediomastus ambiseta	24
01APR98	A	1	10	Mediomastus ambiseta	8
01APR98	A	2	3	Rhynchocoela (unidentified)	1
01APR98	A	2	3	Streblospio benedicti	3
01APR98	A	2	3	Rangia cuneata	3
01APR98	A	2	3	Littoridina sphinctostoma	1
01APR98	A	2	3	Mediomastus ambiseta	24
01APR98	A	2	10	Rhynchocoela (unidentified)	1
01APR98	A	2	10	Macoma mitchelli	1
01APR98	A	2	10	Mediomastus ambiseta	1
01APR98	A	3	3	Streblospio benedicti	10
01APR98	A	3	3	Mulinia lateralis	2
01APR98	A	3	3	Hobsonia florida	1
01APR98	A	3	3	Rangia cuneata	1
01APR98	A	3	3	Mediomastus ambiseta	27
01APR98	A	3	10	Capitella capitata	1
01APR98	A	3	10	Parandalia ocularis	1
01APR98	A	3	10	Mediomastus ambiseta	5
01APR98	B	1	3	Streblospio benedicti	3
01APR98	B	1	3	Mulinia lateralis	2
01APR98	B	1	3	Mediomastus ambiseta	4
01APR98	B	1	10	Sigambra cf. wassi	1
01APR98	B	2	3	Streblospio benedicti	2
01APR98	B	2	3	Ostracoda (unidentified)	1
01APR98	B	2	3	Macoma mitchelli	1
01APR98	B	2	3	Mediomastus ambiseta	16
01APR98	B	2	10	Mediomastus ambiseta	4

01APR98	B	3	3	Oligochaetes (unidentified)	1
01APR98	B	3	3	Streblospio benedicti	4
01APR98	B	3	3	Mulinia lateralis	1
01APR98	B	3	3	Ostracoda (unidentified)	1
01APR98	B	3	3	Mediomastus ambiseta	35
01APR98	B	3	10	Rhynchocoela (unidentified)	1
01APR98	C	1	3	Anthozoa (unidentified)	1
01APR98	C	1	3	Oligochaetes (unidentified)	1
01APR98	C	1	3	Glycinde solitaria	1
01APR98	C	1	3	Paraprionospio pinnata	2
01APR98	C	1	3	Haploscoloplos fragilis	1
01APR98	C	1	3	Mulinia lateralis	15
01APR98	C	1	3	Eulimostoma sp.	1
01APR98	C	1	3	Oxyurostylis sp.	1
01APR98	C	1	3	Mediomastus ambiseta	25
01APR98	C	1	10	Sigambra bassi	1
01APR98	C	1	10	Gyptis vittata	1
01APR98	C	1	10	Cossura delta	1
01APR98	C	1	10	Mediomastus ambiseta	5
01APR98	C	1	10	Aricidea bryani	1
01APR98	C	2	3	Gyptis vittata	1
01APR98	C	2	3	Cossura delta	1
01APR98	C	2	3	Mulinia lateralis	14
01APR98	C	2	3	Eulimostoma sp.	1
01APR98	C	2	3	Macoma mitchelli	1
01APR98	C	2	3	Hobsonia florida	1
01APR98	C	2	3	Turbellaria (unidentified)	1
01APR98	C	2	3	Mediomastus ambiseta	21
01APR98	C	2	10	Gyptis vittata	1
01APR98	C	2	10	Haploscoloplos fragilis	1
01APR98	C	2	10	Maldanidae (unidentified)	1
01APR98	C	2	10	Mediomastus ambiseta	2
01APR98	C	3	3	Rhynchocoela (unidentified)	1
01APR98	C	3	3	Oligochaetes (unidentified)	1
01APR98	C	3	3	Gyptis vittata	1
01APR98	C	3	3	Glycinde solitaria	2
01APR98	C	3	3	Paraprionospio pinnata	1
01APR98	C	3	3	Haploscoloplos fragilis	1
01APR98	C	3	3	Mulinia lateralis	30
01APR98	C	3	3	Monoculodes sp.	1
01APR98	C	3	3	Nuculana concentrica	1
01APR98	C	3	3	Oxyurostylis sp.	1
01APR98	C	3	3	Mediomastus ambiseta	16
01APR98	C	3	10	Paraprionospio pinnata	1
01APR98	C	3	10	Haploscoloplos fragilis	1
01APR98	C	3	10	Cossura delta	3
01APR98	C	3	10	Polinices duplicatus	1
01APR98	C	3	10	Mediomastus ambiseta	1
01APR98	D	1	3	Cossura delta	3
01APR98	D	1	3	Pseudodiaptomus coronatus	1
01APR98	D	1	3	Phoronis architecta	1

01APR98	D	1	3	Mediomastus ambiseta	21
01APR98	D	1	10	Oligochaetes (unidentified)	1
01APR98	D	1	10	Minuspio cirrifera	1
01APR98	D	1	10	Cossura delta	2
01APR98	D	1	10	Periploma cf. orbiculare	1
01APR98	D	1	10	Mediomastus ambiseta	2
01APR98	D	2	3	Cossura delta	1
01APR98	D	2	3	Isolda pulchella	1
01APR98	D	2	3	Mulinia lateralis	1
01APR98	D	2	3	Mediomastus ambiseta	12
01APR98	D	2	3	Malmgreniella taylori	1
01APR98	D	2	10	Rhynchocoela (unidentified)	1
01APR98	D	2	10	Sigambra tentaculata	1
01APR98	D	2	10	Periploma margaritaceum	5
01APR98	D	2	10	Ophiuroidea (unidentified)	1
01APR98	D	2	10	Mediomastus ambiseta	1
01APR98	D	3	3	Rhynchocoela (unidentified)	1
01APR98	D	3	3	Oligochaetes (unidentified)	2
01APR98	D	3	3	Ancistrosyllis jonesi	1
01APR98	D	3	3	Spiochaetopterus costarum	1
01APR98	D	3	3	Mysella planulata	1
01APR98	D	3	3	Mulinia lateralis	1
01APR98	D	3	3	Periploma margaritaceum	7
01APR98	D	3	3	Pseudodiaptomus coronatus	1
01APR98	D	3	3	Ophiuroidea (unidentified)	1
01APR98	D	3	3	Periploma cf. orbiculare	2
01APR98	D	3	3	Mediomastus ambiseta	11
01APR98	D	3	10	Oligochaetes (unidentified)	1
01APR98	D	3	10	Minuspio cirrifera	2
01APR98	D	3	10	Periploma margaritaceum	4
01APR98	D	3	10	Mediomastus ambiseta	2
01APR98	E	1	3	Streblospio benedicti	1
01APR98	E	1	3	Mediomastus ambiseta	13
01APR98	E	1	10	Polydora caulleryi	10
01APR98	E	1	10	Cossura delta	1
01APR98	E	1	10	Mediomastus ambiseta	1
01APR98	E	2	3	Diopatra cuprea	1
01APR98	E	2	3	Streblospio benedicti	4
01APR98	E	2	3	Paraprionospio pinnata	1
01APR98	E	2	3	Mulinia lateralis	1
01APR98	E	2	3	Eulimostoma sp.	1
01APR98	E	2	3	Mediomastus ambiseta	33
01APR98	E	2	10	Sigambra bassi	1
01APR98	E	2	10	Glycinde solitaria	3
01APR98	E	2	10	Polydora caulleryi	3
01APR98	E	2	10	Cossura delta	1
01APR98	E	2	10	Mediomastus ambiseta	5
01APR98	E	3	3	Ancistrosyllis jonesi	1
01APR98	E	3	3	Glycinde solitaria	1
01APR98	E	3	3	Streblospio benedicti	4
01APR98	E	3	3	Cossura delta	1

01APR98	E	3	3	Mysella planulata	1
01APR98	E	3	3	Mulinia lateralis	1
01APR98	E	3	3	Nuculana concentrica	2
01APR98	E	3	3	Mediomastus ambiseta	21
01APR98	E	3	10	Gyptis vittata	1
01APR98	E	3	10	Polydora caulleryi	4
01APR98	E	3	10	Paraprionospio pinnata	1
01APR98	E	3	10	Schizocardium sp.	1
01APR98	E	3	10	Mediomastus ambiseta	2
01APR98	F	1	3	Streblospio benedicti	11
01APR98	F	1	3	Mulinia lateralis	1
01APR98	F	1	3	Ostracoda (unidentified)	3
01APR98	F	1	3	Nereidae (unidentified)	5
01APR98	F	1	3	Mediomastus ambiseta	9
01APR98	F	1	10	Glycinde solitaria	1
01APR98	F	1	10	Paraprionospio pinnata	1
01APR98	F	1	10	Mediomastus ambiseta	20
01APR98	F	2	3	Streblospio benedicti	15
01APR98	F	2	3	Edotea montosa	1
01APR98	F	2	3	Nereidae (unidentified)	2
01APR98	F	2	3	Mediomastus ambiseta	26
01APR98	F	2	10	Rhynchocoela (unidentified)	1
01APR98	F	2	10	Mediomastus ambiseta	11
01APR98	F	3	3	Streblospio benedicti	9
01APR98	F	3	3	Capitella capitata	1
01APR98	F	3	3	Ostracoda (unidentified)	2
01APR98	F	3	3	Nereidae (unidentified)	1
01APR98	F	3	3	Mediomastus ambiseta	27
01APR98	F	3	10	Mediomastus ambiseta	9

Guadalupe Estuary

Date	Station	Replicate	Section	Species	n
28JUL97	A	1	3	Mulinia lateralis	1
28JUL97	A	1	3	Littoridina sphinctostoma	2
28JUL97	A	1	3	Mediomastus ambiseta	20
28JUL97	A	1	10	Chironomid larvae	1
28JUL97	A	1	10	Mediomastus ambiseta	6
28JUL97	A	2	3	Littoridina sphinctostoma	2
28JUL97	A	2	3	Mediomastus ambiseta	9
28JUL97	A	2	10	Parandalia ocularis	1
28JUL97	A	2	10	Mediomastus ambiseta	8
28JUL97	A	3	3	Rhynchocoela (unidentified)	1
28JUL97	A	3	3	Chironomid larvae	1
28JUL97	A	3	3	Chironomid pupae	1
28JUL97	A	3	3	Parandalia ocularis	1
28JUL97	A	3	10	Chironomid larvae	1
28JUL97	B	1	3	No species observed	0

28JUL97	B	1	10	Mediomastus ambiseta	3
28JUL97	B	2	3	Streblospio benedicti	1
28JUL97	B	2	3	Hobsonia florida	1
28JUL97	B	2	10	Mediomastus ambiseta	11
28JUL97	B	3	3	Streblospio benedicti	3
28JUL97	B	3	3	Hobsonia florida	1
28JUL97	B	3	3	Mediomastus ambiseta	2
28JUL97	B	3	10	Mediomastus ambiseta	2
28JUL97	C	1	3	Rhynchocoela (unidentified)	1
28JUL97	C	1	3	Streblospio benedicti	4
28JUL97	C	1	3	Mediomastus ambiseta	10
28JUL97	C	1	10	Mediomastus ambiseta	12
28JUL97	C	2	3	Streblospio benedicti	6
28JUL97	C	2	3	Capitella capitata	1
28JUL97	C	2	3	Rangia cuneata	1
28JUL97	C	2	3	Mediomastus ambiseta	2
28JUL97	C	2	10	Mediomastus ambiseta	13
28JUL97	C	3	3	Rhynchocoela (unidentified)	1
28JUL97	C	3	3	Streblospio benedicti	4
28JUL97	C	3	3	Mediomastus ambiseta	8
28JUL97	C	3	10	Mediomastus ambiseta	8
28JUL97	D	1	3	No species observed	0
28JUL97	D	1	10	Polydora ligni	1
28JUL97	D	1	10	Mediomastus ambiseta	1
28JUL97	D	2	3	Streblospio benedicti	2
28JUL97	D	2	3	Rangia cuneata	1
28JUL97	D	2	10	No species observed	0
28JUL97	D	3	3	No species observed	0
28JUL97	D	3	10	Parandalia ocularis	5
16OCT97	A	1	3	Streblospio benedicti	5
16OCT97	A	1	10	No species observed	0
16OCT97	A	2	3	Streblospio benedicti	4
16OCT97	A	2	3	Hemicyclops sp.	1
16OCT97	A	2	10	No species observed	0
16OCT97	A	3	3	Streblospio benedicti	1
16OCT97	A	3	3	Chironomid larvae	2
16OCT97	A	3	3	Littoridina sphinctostoma	1
16OCT97	A	3	3	Mediomastus ambiseta	1
16OCT97	A	3	10	Parandalia ocularis	2
16OCT97	B	1	3	Streblospio benedicti	14
16OCT97	B	1	3	Mediomastus ambiseta	1
16OCT97	B	1	10	Mediomastus ambiseta	4
16OCT97	B	2	3	Streblospio benedicti	7
16OCT97	B	2	3	Mediomastus ambiseta	1
16OCT97	B	2	10	Mediomastus ambiseta	5
16OCT97	B	3	3	Mediomastus ambiseta	3
16OCT97	B	3	10	Mediomastus ambiseta	2
16OCT97	C	1	3	Mediomastus ambiseta	2
16OCT97	C	1	10	Streblospio benedicti	1
16OCT97	C	1	10	Mediomastus ambiseta	1
16OCT97	C	2	3	Rhynchocoela (unidentified)	1

16OCT97	C	2	3	Streblospio benedicti	3
16OCT97	C	2	3	Macoma mitchelli	1
16OCT97	C	2	3	Mediomastus ambiseta	6
16OCT97	C	2	10	Mediomastus ambiseta	9
16OCT97	C	3	3	Streblospio benedicti	2
16OCT97	C	3	3	Mediomastus ambiseta	8
16OCT97	C	3	10	Mediomastus ambiseta	3
16OCT97	D	1	3	Rhynchocoela (unidentified)	1
16OCT97	D	1	3	Mediomastus ambiseta	12
16OCT97	D	1	10	Hemicyclops sp.	1
16OCT97	D	1	10	Hobsonia florida	1
16OCT97	D	1	10	Mediomastus ambiseta	1
16OCT97	D	2	3	Rhynchocoela (unidentified)	1
16OCT97	D	2	3	Streblospio benedicti	1
16OCT97	D	2	3	Mediomastus ambiseta	3
16OCT97	D	2	10	No species observed	0
16OCT97	D	3	3	Streblospio benedicti	1
16OCT97	D	3	3	Mediomastus ambiseta	12
16OCT97	D	3	10	Mediomastus ambiseta	3
12JAN98	A	1	3	Streblospio benedicti	5
12JAN98	A	1	3	Chironomid larvae	1
12JAN98	A	1	3	Hobsonia florida	2
12JAN98	A	1	3	Rangia cuneata	1
12JAN98	A	1	3	Littoridina sphinctostoma	1
12JAN98	A	1	10	Hobsonia florida	1
12JAN98	A	2	3	Streblospio benedicti	1
12JAN98	A	2	3	Hobsonia florida	2
12JAN98	A	2	3	Littoridina sphinctostoma	1
12JAN98	A	2	3	Parandalia ocularis	1
12JAN98	A	2	10	No species observed	0
12JAN98	A	3	3	Streblospio benedicti	2
12JAN98	A	3	3	Hobsonia florida	2
12JAN98	A	3	3	Rangia cuneata	4
12JAN98	A	3	3	Littoridina sphinctostoma	1
12JAN98	A	3	10	Polydora ligni	1
12JAN98	B	1	3	Rhynchocoela (unidentified)	1
12JAN98	B	1	3	Streblospio benedicti	5
12JAN98	B	1	3	Macoma mitchelli	9
12JAN98	B	1	3	Mediomastus ambiseta	12
12JAN98	B	1	10	Macoma mitchelli	1
12JAN98	B	1	10	Mediomastus ambiseta	7
12JAN98	B	2	3	Rhynchocoela (unidentified)	1
12JAN98	B	2	3	Eteone heteropoda	1
12JAN98	B	2	3	Streblospio benedicti	2
12JAN98	B	2	3	Mulinia lateralis	1
12JAN98	B	2	3	Macoma mitchelli	3
12JAN98	B	2	3	Mediomastus ambiseta	9
12JAN98	B	2	10	Streblospio benedicti	1
12JAN98	B	3	3	Rhynchocoela (unidentified)	1
12JAN98	B	3	3	Streblospio benedicti	5
12JAN98	B	3	3	Macoma mitchelli	1

12JAN98	B	3	3	Hobsonia florida	2
12JAN98	B	3	3	Mediomastus ambiseta	10
12JAN98	B	3	10	Macoma mitchelli	2
12JAN98	B	3	10	Littoridina sphinctostoma	2
12JAN98	B	3	10	Parandalia ocularis	5
12JAN98	B	3	10	Mediomastus ambiseta	3
12JAN98	C	1	3	Rhynchocoela (unidentified)	1
12JAN98	C	1	3	Streblospio benedicti	8
12JAN98	C	1	3	Scolelepis texana	1
12JAN98	C	1	3	Macoma mitchelli	4
12JAN98	C	1	3	Parandalia ocularis	1
12JAN98	C	1	3	Mediomastus ambiseta	36
12JAN98	C	1	10	Parandalia ocularis	1
12JAN98	C	1	10	Mediomastus ambiseta	3
12JAN98	C	2	3	Rhynchocoela (unidentified)	2
12JAN98	C	2	3	Streblospio benedicti	7
12JAN98	C	2	3	Mediomastus ambiseta	21
12JAN98	C	2	10	Mediomastus ambiseta	2
12JAN98	C	3	3	Rhynchocoela (unidentified)	1
12JAN98	C	3	3	Streblospio benedicti	6
12JAN98	C	3	3	Macoma mitchelli	3
12JAN98	C	3	3	Mediomastus ambiseta	22
12JAN98	C	3	10	Parandalia ocularis	1
12JAN98	C	3	10	Mediomastus ambiseta	1
12JAN98	D	1	3	Rhynchocoela (unidentified)	1
12JAN98	D	1	3	Streblospio benedicti	2
12JAN98	D	1	3	Paraprionospio pinnata	1
12JAN98	D	1	3	Capitella capitata	1
12JAN98	D	1	3	Macoma mitchelli	1
12JAN98	D	1	3	Mediomastus ambiseta	24
12JAN98	D	1	10	No species observed	0
12JAN98	D	2	3	Streblospio benedicti	5
12JAN98	D	2	3	Monoculodes sp.	1
12JAN98	D	2	3	Hemicyclops sp.	1
12JAN98	D	2	3	Macoma mitchelli	1
12JAN98	D	2	3	Mediomastus ambiseta	26
12JAN98	D	2	10	Polydora ligni	1
12JAN98	D	2	10	Streblospio benedicti	1
12JAN98	D	2	10	Mediomastus ambiseta	4
12JAN98	D	3	3	Rhynchocoela (unidentified)	1
12JAN98	D	3	3	Streblospio benedicti	4
12JAN98	D	3	3	Scolelepis texana	1
12JAN98	D	3	3	Macoma mitchelli	1
12JAN98	D	3	3	Mediomastus ambiseta	29
12JAN98	D	3	10	Mediomastus ambiseta	1
02APR98	A	1	3	Polydora websteri	1
02APR98	A	1	3	Streblospio benedicti	2
02APR98	A	1	3	Chironomid larvae	1
02APR98	A	1	3	Hobsonia florida	6
02APR98	A	1	3	Rangia cuneata	4
02APR98	A	1	3	Littoridina sphinctostoma	3

02APR98	A	1	10	No species observed	0
02APR98	A	2	3	Polydora websteri	1
02APR98	A	2	3	Streblospio benedicti	1
02APR98	A	2	3	Chironomid larvae	2
02APR98	A	2	3	Hobsonia florida	26
02APR98	A	2	3	Rangia cuneata	13
02APR98	A	2	3	Littoridina sphinctostoma	6
02APR98	A	2	10	Polydora ligni	1
02APR98	A	2	10	Chironomid larvae	1
02APR98	A	2	10	Parandalia ocularis	1
02APR98	A	2	10	Mediomastus ambiseta	2
02APR98	A	3	3	Streblospio benedicti	3
02APR98	A	3	3	Corophium louisianum	1
02APR98	A	3	3	Hobsonia florida	20
02APR98	A	3	3	Rangia cuneata	8
02APR98	A	3	3	Littoridina sphinctostoma	2
02APR98	A	3	10	Hobsonia florida	1
02APR98	B	1	3	Rhynchocoela (unidentified)	1
02APR98	B	1	3	Streblospio benedicti	8
02APR98	B	1	3	Littoridina sphinctostoma	10
02APR98	B	1	3	Mediomastus ambiseta	8
02APR98	B	1	10	Capitella capitata	1
02APR98	B	1	10	Mediomastus ambiseta	4
02APR98	B	2	3	Rhynchocoela (unidentified)	1
02APR98	B	2	3	Streblospio benedicti	5
02APR98	B	2	3	Capitella capitata	1
02APR98	B	2	3	Rangia cuneata	2
02APR98	B	2	3	Littoridina sphinctostoma	21
02APR98	B	2	3	Mediomastus ambiseta	9
02APR98	B	2	10	Capitella capitata	1
02APR98	B	2	10	Mediomastus ambiseta	3
02APR98	B	3	3	Streblospio benedicti	5
02APR98	B	3	3	Monoculodes sp.	1
02APR98	B	3	3	Rangia cuneata	3
02APR98	B	3	3	Littoridina sphinctostoma	9
02APR98	B	3	3	Parandalia ocularis	1
02APR98	B	3	3	Mediomastus ambiseta	10
02APR98	B	3	10	Rhynchocoela (unidentified)	1
02APR98	B	3	10	Capitella capitata	1
02APR98	B	3	10	Parandalia ocularis	1
02APR98	B	3	10	Mediomastus ambiseta	7
02APR98	C	1	3	Streblospio benedicti	3
02APR98	C	1	3	Mulinia lateralis	12
02APR98	C	1	3	Ensis minor	1
02APR98	C	1	3	Rangia cuneata	1
02APR98	C	1	3	Littoridina sphinctostoma	1
02APR98	C	1	3	Mediomastus ambiseta	52
02APR98	C	1	10	Macoma mitchelli	1
02APR98	C	1	10	Mediomastus ambiseta	6
02APR98	C	2	3	Streblospio benedicti	1
02APR98	C	2	3	Mulinia lateralis	9

02APR98	C	2	3	Rangia cuneata	1
02APR98	C	2	3	Littoridina sphinctostoma	10
02APR98	C	2	3	Mediomastus ambiseta	53
02APR98	C	2	10	Mediomastus ambiseta	1
02APR98	C	3	3	Rhynchocoela (unidentified)	1
02APR98	C	3	3	Streblospio benedicti	8
02APR98	C	3	3	Capitella capitata	1
02APR98	C	3	3	Mulinia lateralis	21
02APR98	C	3	3	Rangia cuneata	2
02APR98	C	3	3	Littoridina sphinctostoma	3
02APR98	C	3	3	Mediomastus ambiseta	37
02APR98	C	3	10	Rhynchocoela (unidentified)	1
02APR98	C	3	10	Gyptis vittata	1
02APR98	C	3	10	Macoma mitchelli	1
02APR98	D	1	3	Rhynchocoela (unidentified)	1
02APR98	D	1	3	Eteone heteropoda	2
02APR98	D	1	3	Streblospio benedicti	3
02APR98	D	1	3	Scoloplos texana	1
02APR98	D	1	3	Mulinia lateralis	6
02APR98	D	1	3	Cyclaspis varians	1
02APR98	D	1	3	Littoridina sphinctostoma	4
02APR98	D	1	3	Mediomastus ambiseta	41
02APR98	D	1	10	Scoloplos texana	1
02APR98	D	1	10	Pinnixa sp.	1
02APR98	D	1	10	Tagelus plebeius	1
02APR98	D	1	10	Parandalia ocularis	5
02APR98	D	1	10	Mediomastus ambiseta	2
02APR98	D	2	3	Rhynchocoela (unidentified)	1
02APR98	D	2	3	Eteone heteropoda	3
02APR98	D	2	3	Streblospio benedicti	1
02APR98	D	2	3	Mulinia lateralis	4
02APR98	D	2	3	Nassarius acutus	1
02APR98	D	2	3	Eulimostoma sp.	1
02APR98	D	2	3	Littoridina sphinctostoma	12
02APR98	D	2	3	Mediomastus ambiseta	34
02APR98	D	2	10	Paraprionospio pinnata	1
02APR98	D	2	10	Parandalia ocularis	1
02APR98	D	2	10	Mediomastus ambiseta	1
02APR98	D	3	3	Eteone heteropoda	1
02APR98	D	3	3	Streblospio benedicti	1
02APR98	D	3	3	Mulinia lateralis	3
02APR98	D	3	3	Ensis minor	1
02APR98	D	3	3	Eulimostoma sp.	1
02APR98	D	3	3	Littoridina sphinctostoma	12
02APR98	D	3	3	Mediomastus ambiseta	16
02APR98	D	3	10	Rhynchocoela (unidentified)	1
02APR98	D	3	10	Mediomastus ambiseta	3

Sediment Elemental Composition

Middle of section depth in cm, Nitrogen and Carbon in % dry weight of sediment, porosity % wet weight of sediment.

Lower Laguna Madre

Date	Replicate	Section	N	C	Porosity
12MAY98	1	1	0.018	0.907	27.01
12MAY98	1	3	0.020	1.126	38.15
12MAY98	1	6	0.031	1.335	30.07
12MAY98	1	11	0.024	2.045	27.23
12MAY98	1	16	0.086	2.641	34.24
12MAY98	1	20	0.072	2.516	28.88
12MAY98	1	40	0.074	2.329	24.42
12MAY98	1	60	0.051	2.561	30.03
12MAY98	1	80	0.016	2.153	35.43
12MAY98	1	100	0.016	1.835	20.44
12MAY98	2	1	0.105	2.820	28.26
12MAY98	2	3	0.025	0.660	29.25
12MAY98	2	6	0.077	2.051	23.83
12MAY98	2	11	0.048	1.258	35.19
12MAY98	2	16	0.032	1.058	28.97
12MAY98	2	20	0.016	0.614	28.70
12MAY98	2	40	0.015	0.776	22.11
12MAY98	2	60	0.007	0.319	19.42
12MAY98	2	80	0.008	0.254	21.34
12MAY98	2	100	0.037	2.094	24.99
11MAY98	3	1	0.067	2.602	45.32
11MAY98	3	3	0.058	2.297	30.59
11MAY98	3	6	0.072	3.403	22.24
11MAY98	3	11	0.074	2.873	36.88
11MAY98	3	16	0.076	3.047	26.97
11MAY98	3	20	0.096	3.242	27.41
11MAY98	3	40	0.031	1.591	21.77
11MAY98	3	60	0.035	2.649	26.46
11MAY98	3	80	0.055	2.781	26.92
11MAY98	4	1	0.042	0.979	77.72
11MAY98	4	3	0.058	1.545	25.17
11MAY98	4	6	0.069	1.898	33.66
11MAY98	4	11	0.053	1.642	44.85
11MAY98	4	16	0.069	2.205	43.10
11MAY98	4	20	0.054	2.389	37.34
11MAY98	4	40	0.025	2.370	35.71
11MAY98	4	60	0.022	2.285	36.90
11MAY98	4	80	0.014	1.584	45.91
11MAY98	4	100	0.019	1.603	37.52
11MAY98	5	1	0.003	5.521	56.65
11MAY98	5	3	0.099	2.478	36.18

11MAY98	5	6	0.129	3.384	31.93
11MAY98	5	11	0.002	3.877	26.67
11MAY98	5	16	0.125	3.285	25.51
11MAY98	5	20	0.112	3.253	28.75
11MAY98	5	40	0.090	2.803	24.25
11MAY98	5	60	0.002	4.155	21.49
11MAY98	5	80	0.018	0.976	27.64
11MAY98	5	100	0.018	1.131	22.18
11MAY98	6	1	0.037	1.282	47.52
11MAY98	6	3	0.075	1.993	55.42
11MAY98	6	6	0.098	2.465	52.82
11MAY98	6	11	0.084	2.459	66.47
11MAY98	6	16	0.069	2.310	68.25
11MAY98	6	20	0.053	2.082	49.28
11MAY98	6	40	0.044	2.597	32.67
11MAY98	6	60	0.002	2.947	72.07
11MAY98	6	80	0.002	5.188	49.28
11MAY98	6	100	0.001	2.039	39.62

Average Vertical Distribution of N Content (%) among Stations Within Estuaries

Section	N	C	Porosity
1	0.045	2.35	47.1
3	0.056	1.68	35.8
6	0.079	2.42	32.4
11	0.048	2.36	39.5
16	0.076	2.42	37.8
20	0.067	2.35	33.4
40	0.047	2.08	26.8
60	0.020	2.49	34.4
80	0.019	2.16	34.4
100	0.018	1.74	28.9

DISCUSSION

Conditions in Current Sampling Year

An El Niño event occurred in 1997. Consequently, salinities were very low during summer, fall and winter 1997 (Figs. 2 and 3). Salinities were near zero in the most river-influenced stations (A) in the Lavaca-Colorado (Fig. 2) and Guadalupe (Fig. 3) Estuaries. Only the secondary bays (Lavaca and Upper San Antonio Bays) were affected, indicating the total volume of water was not great.

Through much of the year, there was a complete salinity gradient from fresh (near zero) to sea water strength (near 30) in the Lavaca-Colorado Estuary. Station F (near the mouth of the Colorado River) was near zero and like Station A (near the mouth of the Lavaca River) only during July 1997. Thereafter, salinities at Station F were similar to salinities near Station C (where Lavaca Bay meets Matagorda Bay). Salinities rose substantially from January 1998 through July 1998 at all stations. Slightly lower salinities in all stations, save A, in April 1998 indicate a spring freshet event on top of the El Niño event. By July 1998, the difference in salinity between Station A and Station D were minimal.

Upper San Antonio Bay (Stations A and B) were similar throughout the year, and were always fresher than Lower San Antonio Bay (Stations C and D). Salinities at Station A (near the mouth of the Guadalupe River) remained close to zero from July 1997 through April 1998. Salinities rose substantially from April 1998 through July 1998 at all stations. Slightly lower salinities in all stations, save A, in April 1998 indicate a spring freshet event on top of the El Niño event. By July 1998, the difference in salinity between Station A and Station C were still high.

Lavaca-Colorado Estuary

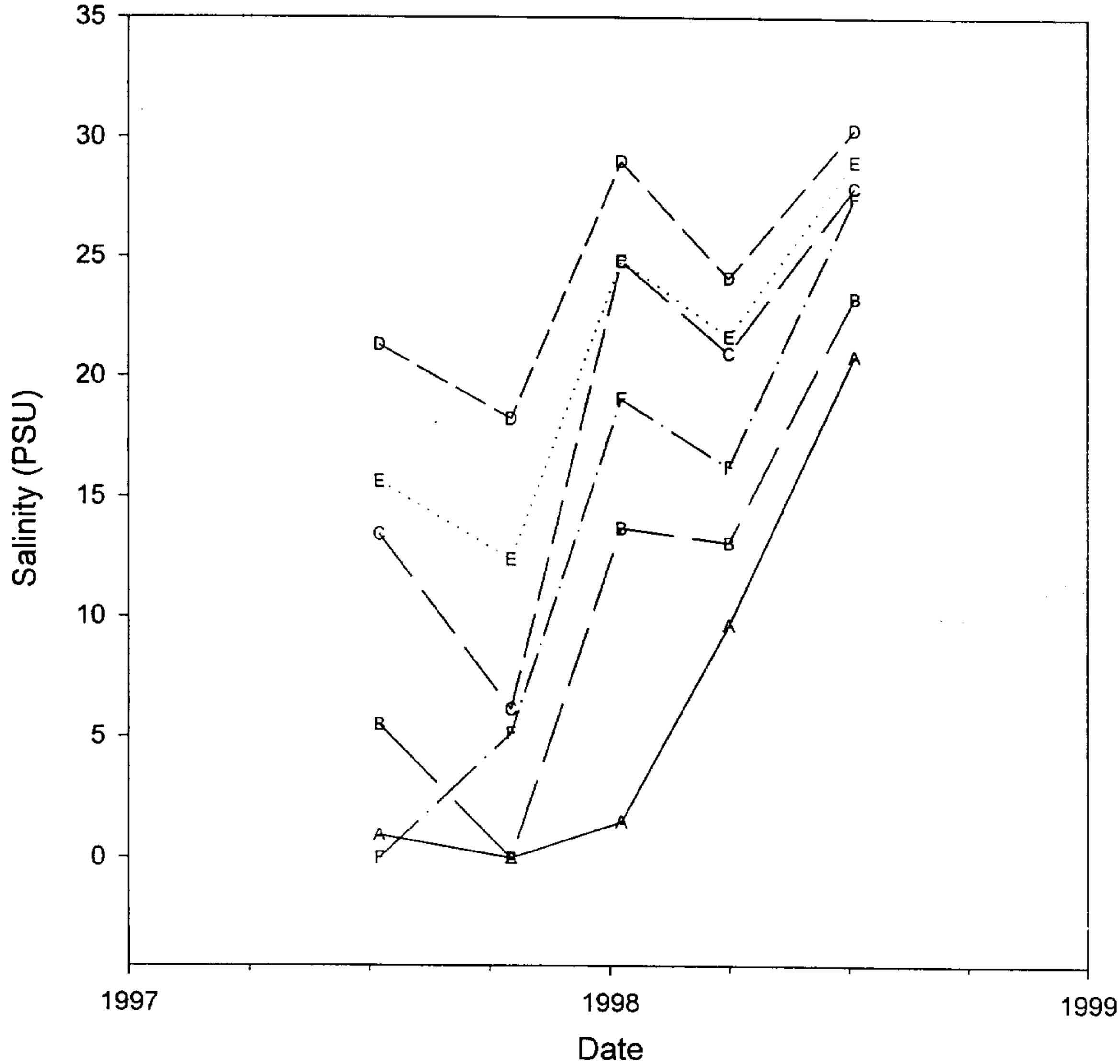


Figure 2. Salinity change at stations in Lavaca-Colorado Estuary during the sampling period.

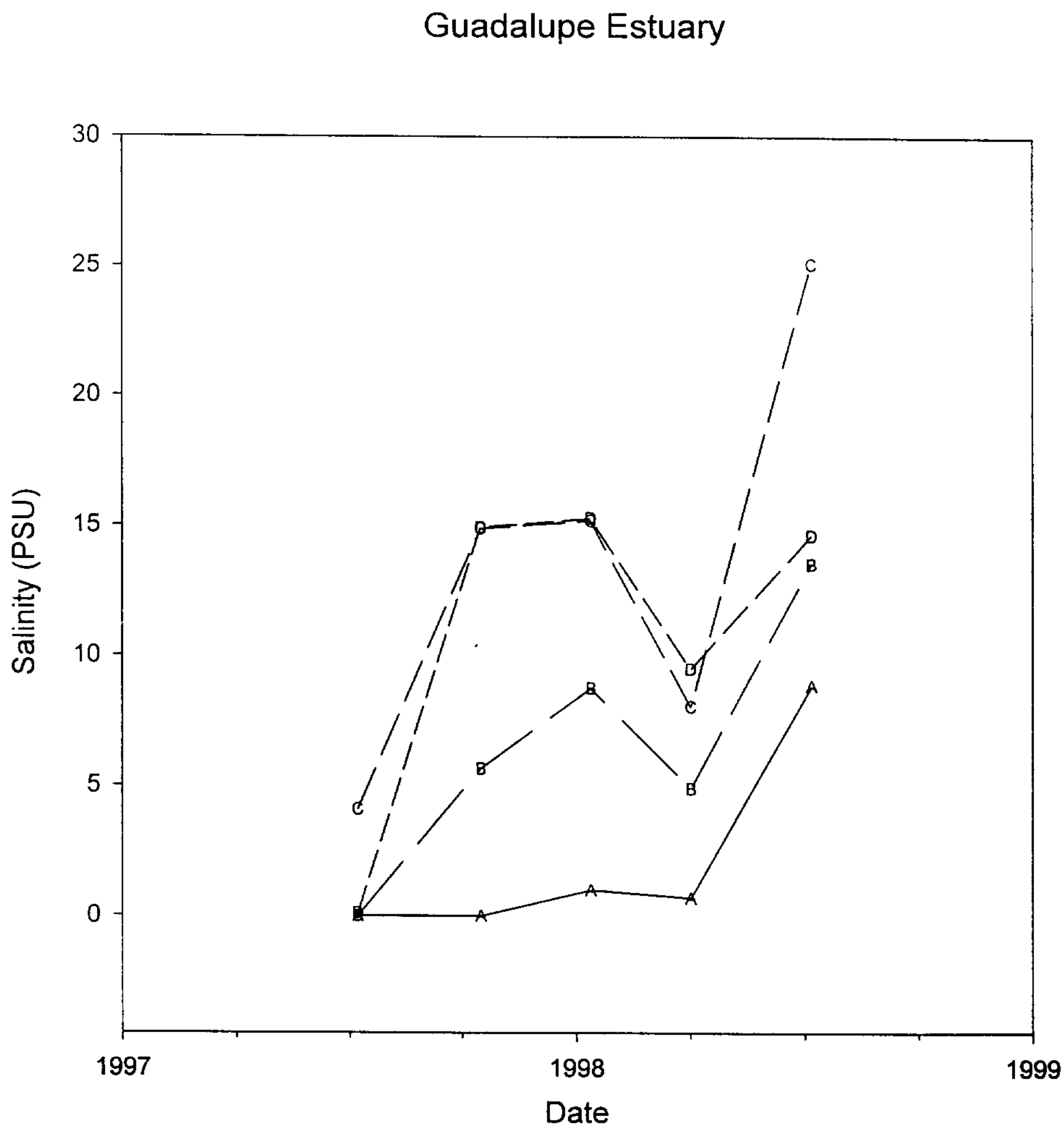


Figure 3. Salinity change at stations in Guadalupe Estuary during the sampling period.

Benthic Response in Current Sampling Year

The response to the El Niño event in 1997 is evident in the biomass (Fig. 4) and abundance (Fig. 5) changes in the Lavaca-Colorado Estuary. The pattern at the most ocean-influenced station (D) in the Lavaca-Colorado Estuary was different from all other stations. This station, near the Pass of the Matagorda Ship Channel, had the highest biomass and abundance from July 1997 through January 1998 when salinities were moderate (20 -25 psu, Fig. 2). As salinities decreased from January 1998 to April 1998 due to the El Niño event, biomass and abundance decreased at station D, but increased in all other stations. The overall influence of inflow is demonstrated by the trend among these stations, except for D. The influence of the Lavaca and Colorado Rivers appears to be similar, because stations A and F exhibited similar responses over the year.

The response to the El Niño event in 1997 is also evident in the biomass (Fig. 6) and abundance (Fig. 7) changes in the Guadalupe Estuary. As salinities increased from July 1997 to October 1997, abundance and biomass decreased. As salinities decreased from January 1998 to April 1998 due to the El Niño event, biomass and abundance increased in all stations. The overall influence of inflow is demonstrated by the trend in abundances among these stations. Stations C and D had higher abundances that stations A and B. Station differences were not evident for biomass, except for April 1998, when biomass at station C soared.

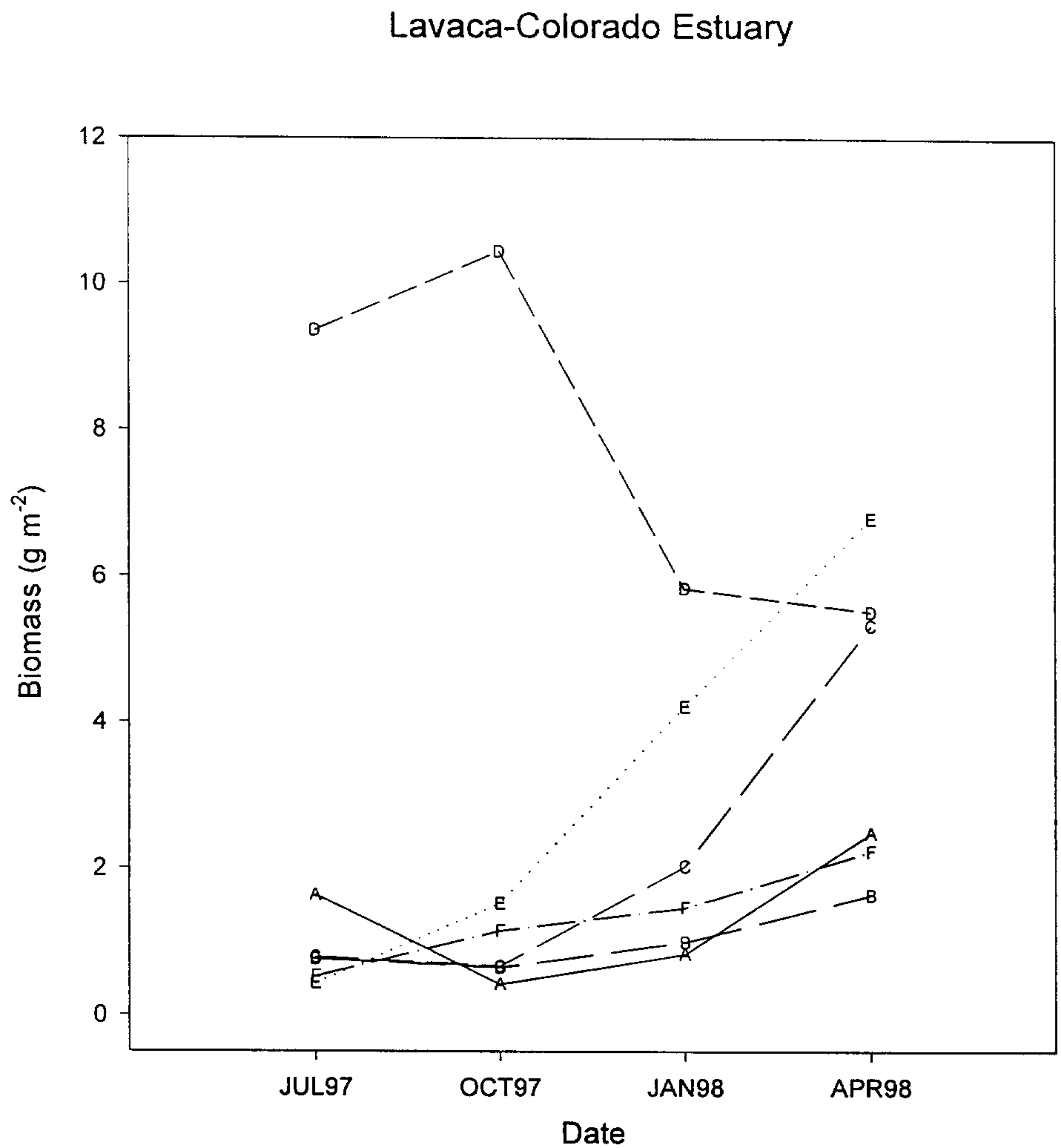


Figure 4. Macrofauna biomass change at stations in Lavaca-Colorado Estuary during the sampling period.

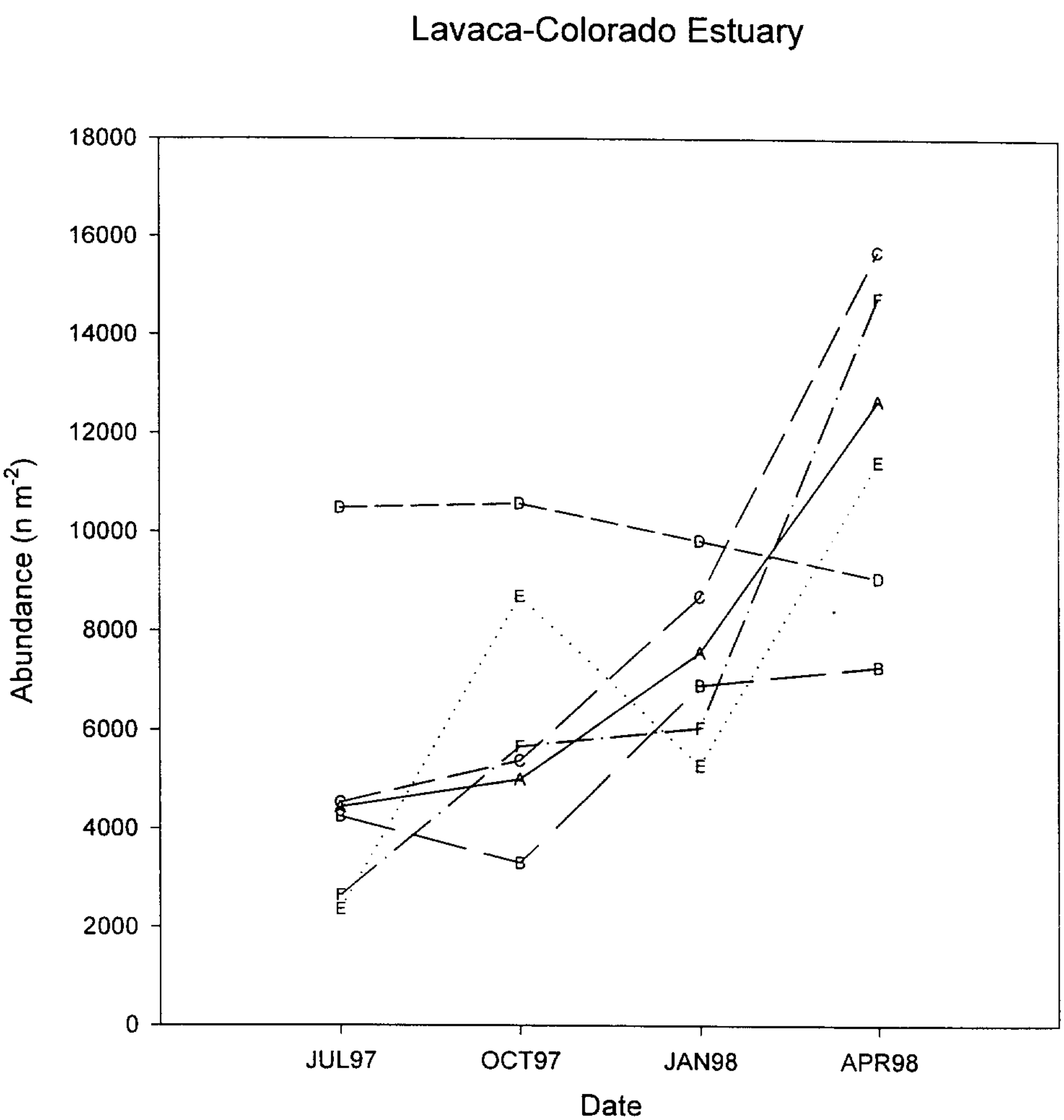


Figure 5. Macrofauna abundance change at stations in Lavaca-Colorado Estuary during the sampling period.

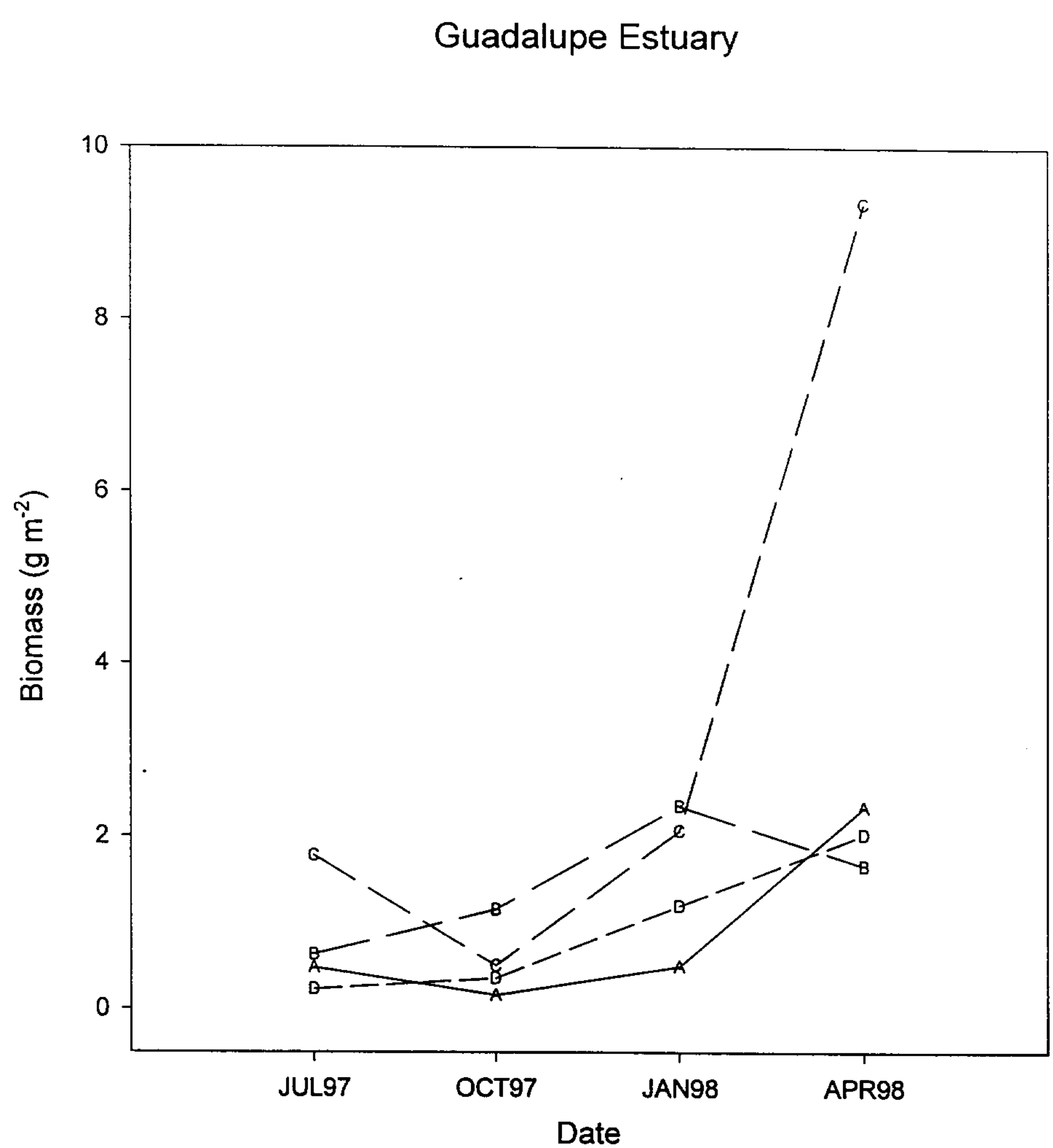


Figure 6. Macrofauna biomass change at stations in Guadalupe Estuary during the sampling period.

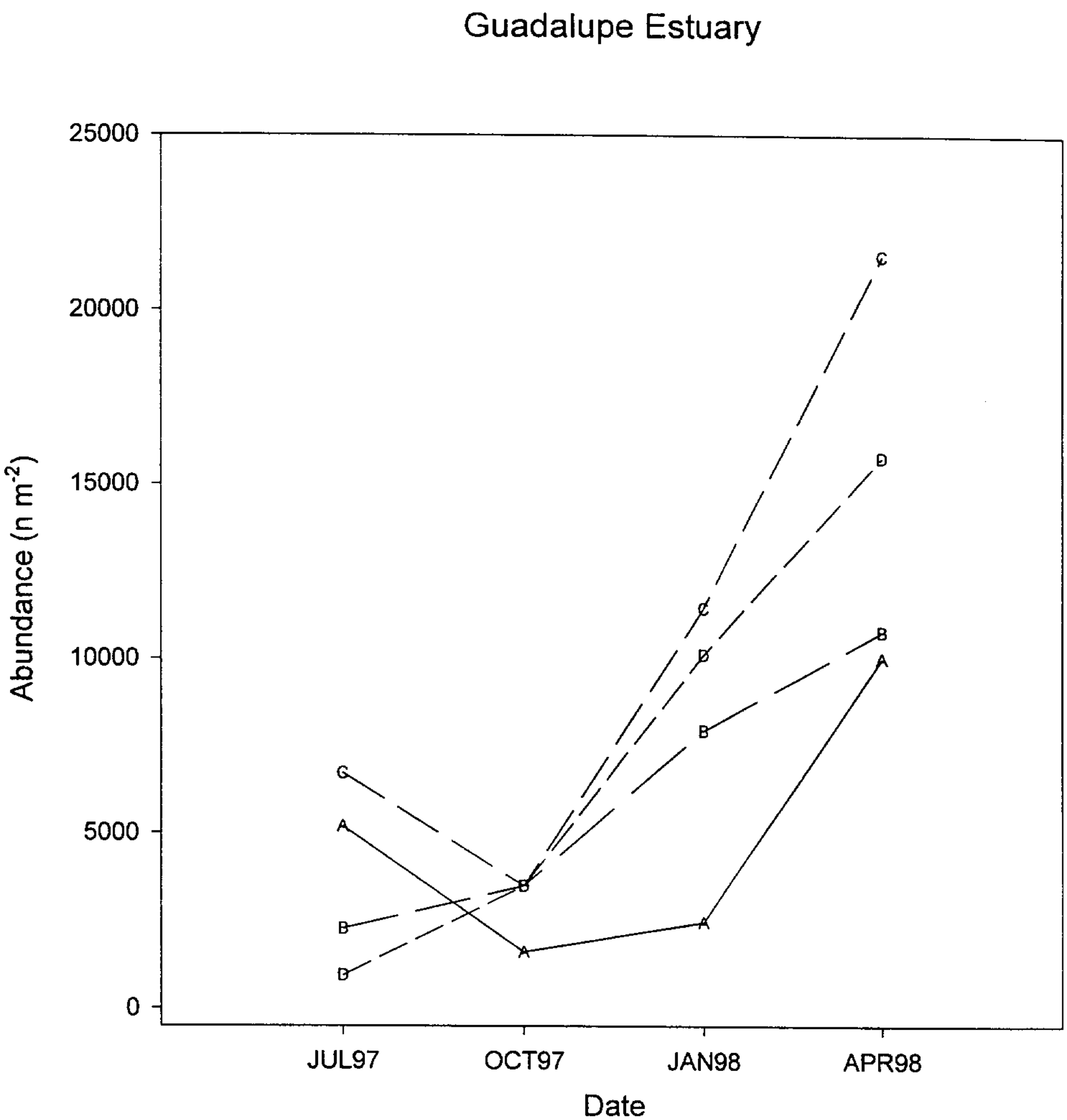


Figure 7. Macrofauna abundance change at stations in Guadalupe Estuary during the sampling period.

Long-Term Change in Benthos

The Lavaca-Colorado and Guadalupe Estuaries are similar in the amount of freshwater inflow they receive, but different in two key attributes. The Lavaca-Colorado Estuary (910 km^2 at mean tide) is almost twice as large as the Guadalupe Estuary (579 km^2 at mean tide). The Lavaca-Colorado also has direct exchange of marine water with the Gulf of Mexico via Pass Cavallo and the Matagorda Ship Channel. In contrast, exchange in the Guadalupe Estuary is restricted by Cedar Bayou and is predominantly north-south exchange through the Intracoastal Waterway. The Lavaca-Colorado Estuary has higher salinities (average 19.4 ppt from 1988-1998; Figs. 8 and 9) than the Guadalupe (average 13.9 ppt from 1987-1998; Figs. 10 and 11), which is smaller and has restricted exchange. This indicates that freshwater inflow has a greater effect on the upper part of San Antonio Bay than on Lavaca Bay. This conclusion is supported by several pieces of data. The salinity time series show that at any given time the salinities are lower in the Guadalupe, both estuarine-wide, and particularly at stations A and B in both estuaries. The amount of total carbon in sediments is much greater in the Guadalupe than in the Lavaca-Colorado (Montagna, 1991). Carbon content of Lavaca-Colorado sediments and Guadalupe-station D sediments are about 1%, but carbon content in the Guadalupe at station C is 3%, and at stations A and B around 4%. The carbon data indicate that organic matter is being trapped or not exported from the Guadalupe Estuary. Profiles of nitrogen content exhibit the same trends found in carbon, but there is less difference in total nitrogen content between the estuaries, both being about 0.05% (Montagna, 1991). Sediment texture is similar in both estuaries, and are characterized by silt-clay sediments, with increasing grain sizes from the upper to the lower parts of the estuaries.

Macrofauna abundance and biomass is generally larger in the Guadalupe Estuary than in the Lavaca-Colorado Estuary. The average abundance in the Lavaca-Colorado among all times and stations was 11,200 individuals$\cdot m^{-2}$, and the average biomass was 4.5 $g\cdot m^{-2}$. The average abundance in the Guadalupe among all times and stations was 20,800 individuals$\cdot m^{-2}$, and the average biomass was 6.4 $g\cdot m^{-2}$. The differences between the estuaries is probably due to the greater ratio of the volume of inflow relative to size of the bays. Diversity is generally greater in the Lavaca-Colorado Estuary (average 16 species found per station-date sampling period) than in the Guadalupe Estuary (average 11 species found per station-date sampling period). These results indicate that freshwater inflow is less diluted by marine water in the Guadalupe Estuary, so we find higher benthic productivity. The greater Gulf exchange in the Lavaca-Colorado leads to more oceanic species present in the that estuary, so we find higher diversity.

The time series data show that there are large year-to-year fluctuations in both estuaries for freshwater inflow (Fig. 12). We have a continuous cycle of drought and flood conditions. The flood cycles are coincident with El Niño events in the western Pacific Ocean. So, climatic cycles in Texas are apparently caused by global changes. These cycles regulate freshwater inflow, and thus, directly affect the biological communities. The variability in the freshwater inflow cycle results in predictable changes in the estuary. The effects of recent El Niño events are obvious in the two estuaries. Salinities declined dramatically with the El Niño events in 1986-7, 1992-3, and 1997-8. The 1986 and 1992 events had larger effects in the Guadalupe

Estuary, and the 1997 event had a larger effect in the Lavaca-Colorado Estuary.

Our study of the Guadalupe Estuary demonstrates the biological effects of this El Niño driven cycle. Flood conditions introduce nutrient rich waters into the estuary which result in lower salinity. This happened in the spring of 1987. During these periods the spatial extent of the freshwater fauna is increased, and the estuarine fauna replaced the marine fauna in the lower end of the estuary. The high level of nutrients stimulated a burst of benthic productivity (of predominantly freshwater and estuarine organisms) in the spring and summer of 1988. This was followed by a transition to a drought period with low inflow resulting in higher salinities, lower nutrients, marine fauna, decreased productivity and abundances. At first, the marine fauna responded with a burst of productivity as the remaining nutrients are utilized, but eventually nutrients are depleted resulting in lower densities from 1989 to 1990. There was a rain event in the spring of 1991, with flooding and high freshwater inflows. However, the flood was not nearly as great as the one in 1987. Yet, the biological response in terms of biomass in the summer of 1991 was even larger. The response of abundance was small and hardly noticeable. However, continuous heavy rainfall from winter through spring and into early summer did not reoccur until 1991. This cycle, similar to the 1987 cycle, repeated in the winter 1991 to the spring of 1992, with flooding and high freshwater inflows. Most recently, the cycle appears similar for 1997, with lower salinities and biomass relative to 1995-6. If the cycle holds, then 1999 should yield high biomass as a result of the 1997-8 El Niño event.

Macrofauna responded to annual variation in freshwater inflow in a similar fashion in the Lavaca-Colorado Estuary. Abundances and biomass were high in the spring of 1988, one year after the flood of 1987 (Figures 8 and 9). Both declined with increasing salinities in the last half of 1988. Abundances have remained relatively constant since 1989. Biomass rose again with lower salinities in the Spring of 1989, and decreased steadily through the drought of 1989-1990. Spring runoff in both 1990 and 1991 resulted in increased biomass. Salinities during 1987 are unknown, so the spring of 1991 is the lowest recorded salinity in this record.

A longer record is available for station A in Lavaca Bay of the Lavaca-Colorado Estuary. These data illustrate that the long-term trend is more obvious, and that records of eight years duration are much more revealing than records of only three years. There was a wet period in spring of 1985 that was of the same magnitude as the spring of 1991. We do not have two cycles of prolonged wet periods such as the spring of 1992. Prior to 1986-87, there was an El Niño in 1982-83. We might have caught the tail end of that event in the spring of 1984. Abundances were low during both wet periods, and increased in 1986 following the first wet period. The period in early 1988, following the flood of 1987, had the highest abundances. 1989 through 1990 was generally dry with high salinities. The large flood of spring 1993 resulted in densities increasing throughout the period of 1994-5. Densities are currently low, but should increase as a result of current low salinities.

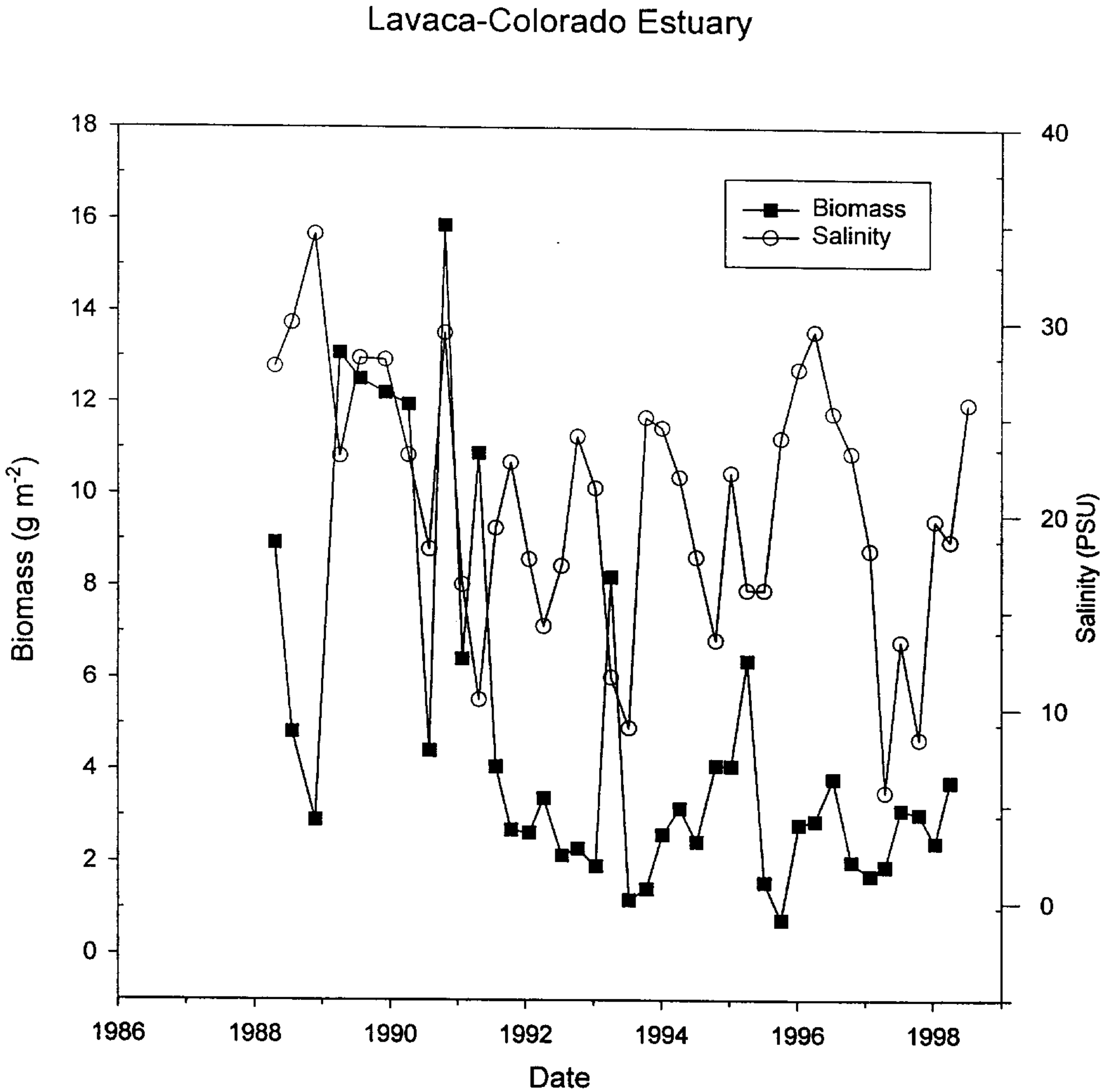


Figure 8. Long-term macrofauna biomass and salinity change in Lavaca-Colorado Estuary. Estuarine-wide average for stations A - D.

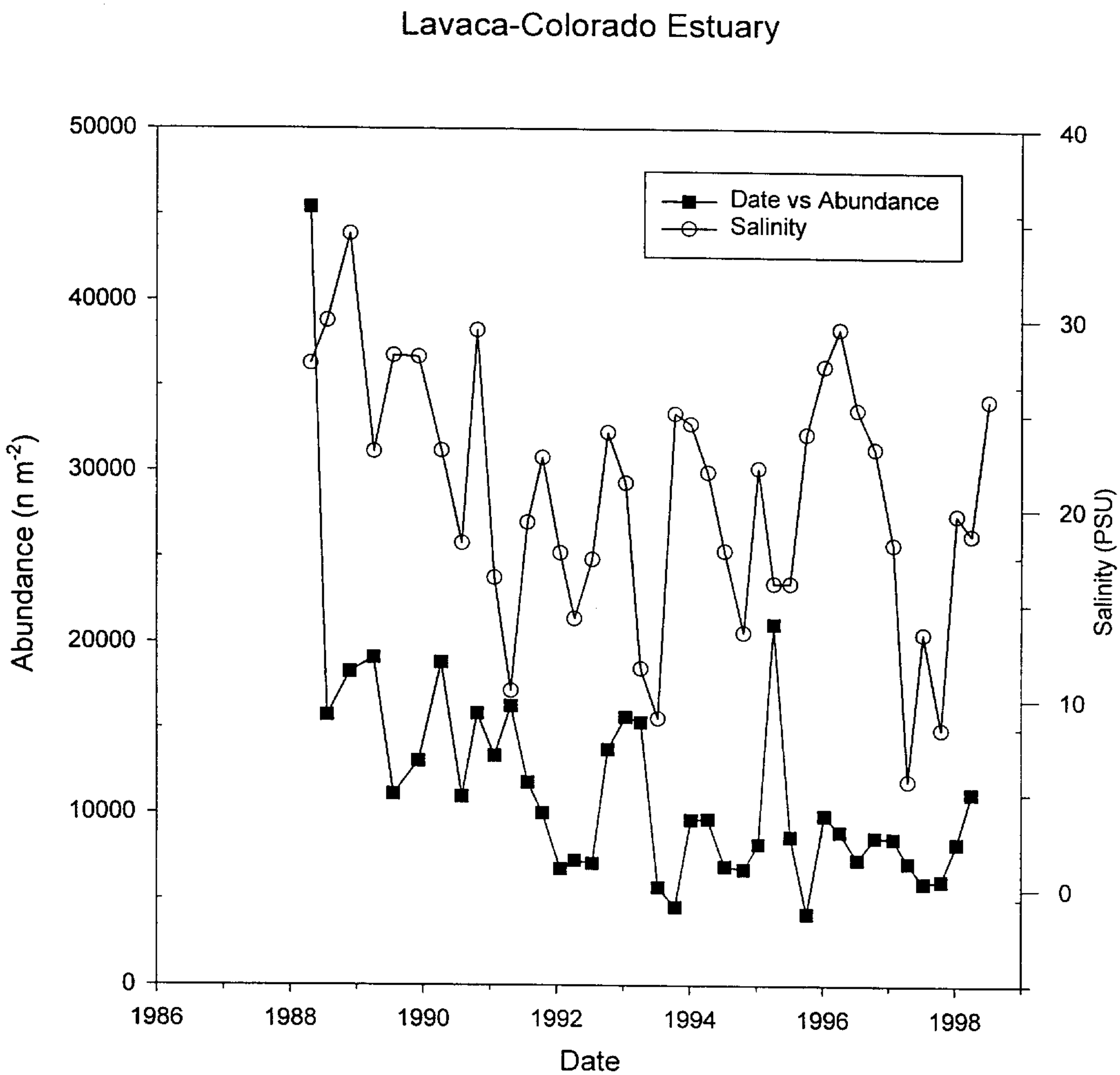


Figure 9. Long-term macrofauna abundance and salinity change in Lavaca-Colorado Estuary. Estuarine-wide average for stations A - D.

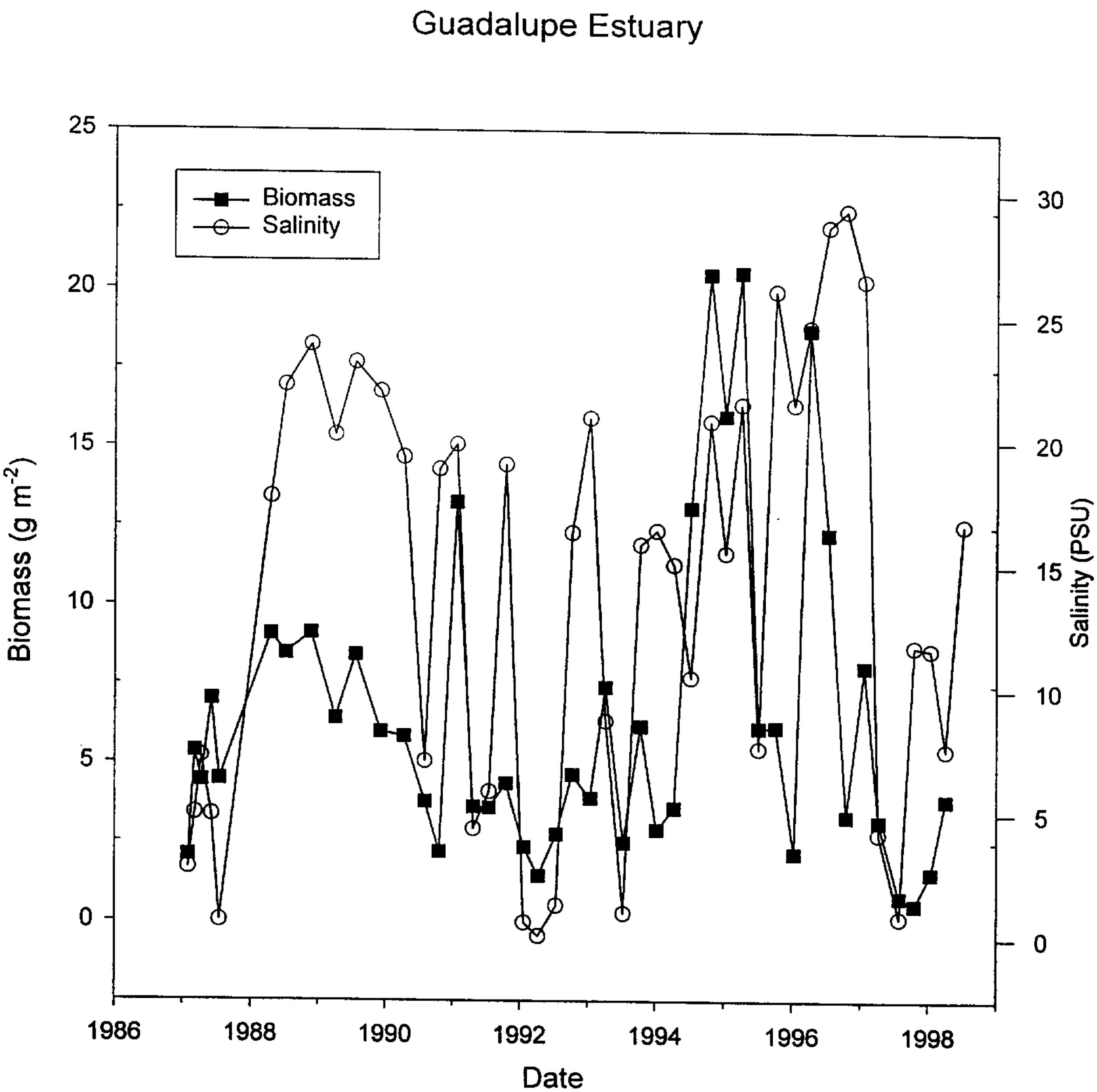


Figure 10. Long-term macrofauna biomass and salinity change in Guadalupe Estuary. Estuarine-wide average for stations A - D.

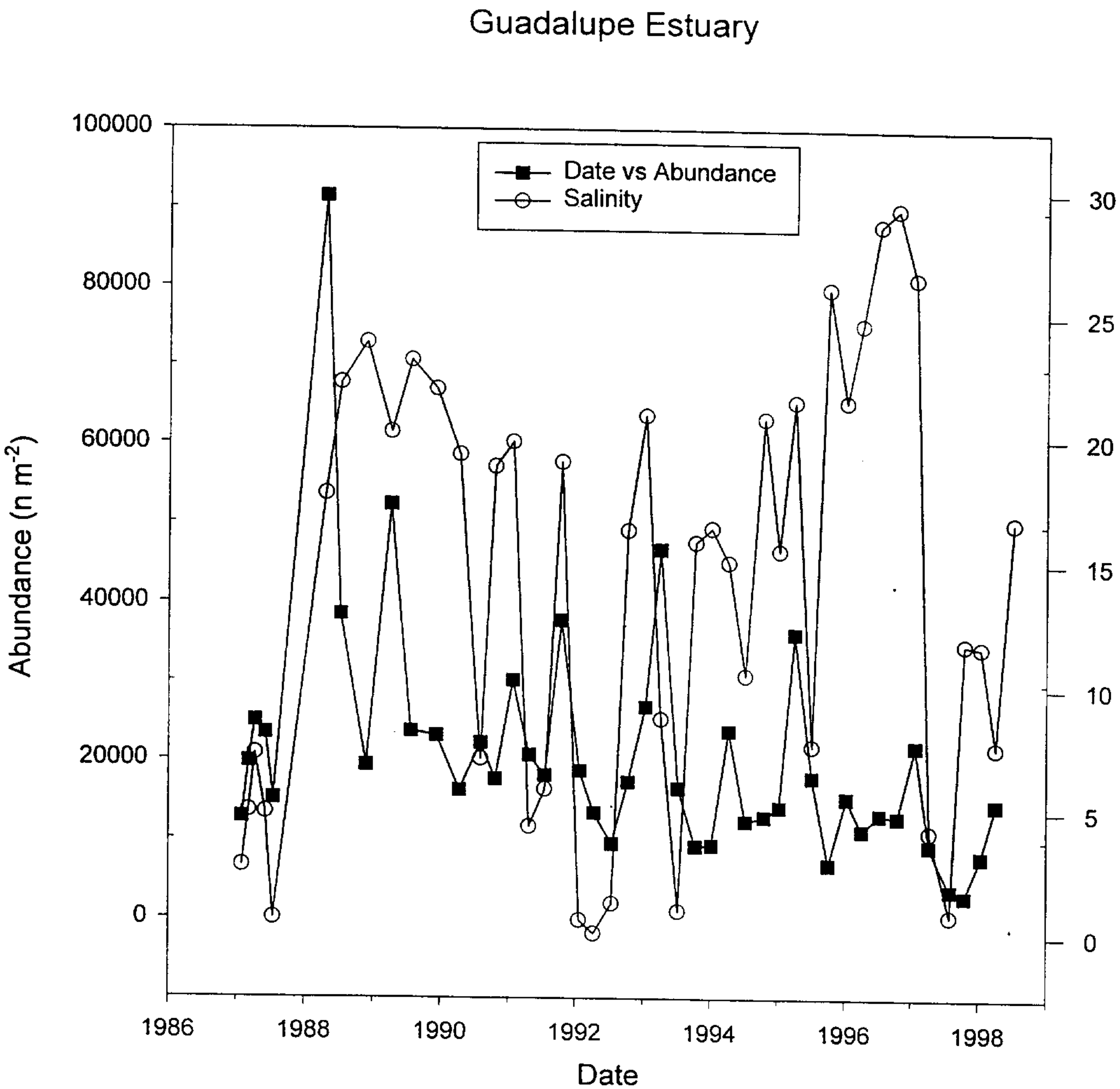


Figure 11. Long-term macrofauna abundance and salinity change in Guadalupe Estuary. Estuarine-wide average for stations A - D.

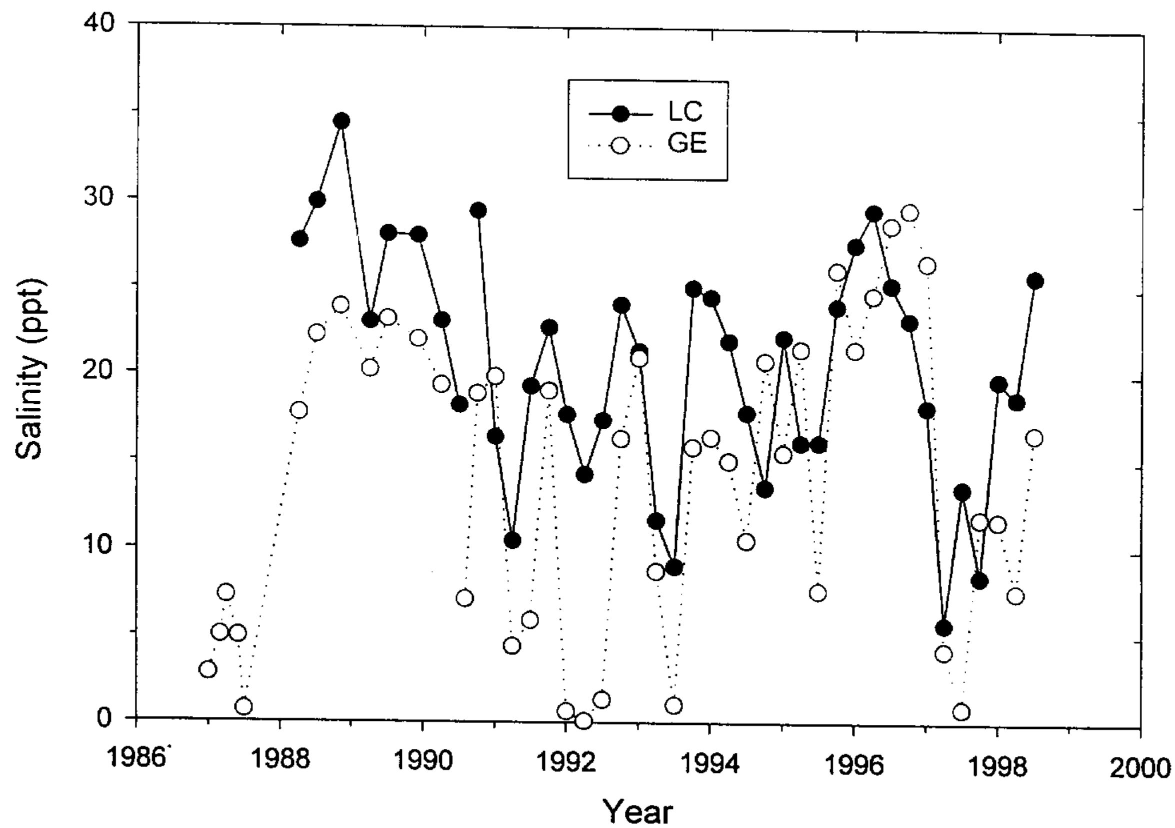


Figure 12. Long-term salinity change in the Lavaca-Colorado and Guadalupe Estuaries. Estuarine-wide average for stations A - D.

Nitrogen Losses

If nitrogen enters bays via rivers and is buried, then we would expect higher nitrogen values in sediments at the head of estuaries. This is because rivers empty into the secondary bay, and more nitrogen should be trapped in the upper reaches of the bay. The trends in all Texas estuaries confirm this hypothesis (Montagna 1997). The Laguna Madre may be an exception. The Lower Laguna Madre has river influence from the Arroyo Colorado River, but the primary and secondary bay structure does not exist in the lagoon (Figure 13). However, both nitrogen (Figure 14) and carbon (Figure 15) do appear to have higher concentrations in sediments near the Arroyo Colorado (stations 1 and 2) than away from it (stations 5 and 6).

If nitrogen is utilized, or transformed in the biologically active labile zone, then there should be higher values in upper layers of sediment and lower values at lower layers in the refractory zone. This hypothesis is confirmed by the trends seen in the estuary-wide average nitrogen content (Figure 16). The labile zone appears to be between 20 and 40 cm in Lower Laguna Madre (Figure 16) as it is in most Texas estuaries (Montagna,1997). Nitrogen content in most Texas estuarine sediment is 0.08 to 0.15 percent at the surface, and declines to 0.04 to 0.08 percent. Lower Laguna Madre is lower, but has a similar trend with 0.05 to 0.08 percent at the surface, and declines to 0.02 to 0.04 percent. That the refractory zone is as deep as 40 cm is surprising, but this could be due to anthropogenic influences, e.g., shrimping and dredging. It is very difficult to know how much area sampled is subject to these disturbances. An alternative hypothesis to a labile and refractory zone is that there is simply more nitrogen coming into bays today than at previous times. This would also explain the vertical distribution of nitrogen content in sediments. In contrast, Upper Laguna Madre has a much higher nitrogen content, 0.2 at the surface and 0.15 at depth (Montagna, 1997). Both Upper and Lower Laguna have seagrass detritus, so it is not obvious why the Upper is higher than the Lower. Perhaps the more saline conditions in Upper Laguna Madre are preserving nitrogen.

Man can influence another key component that affects nitrogen loss. In general, it is thought that the sedimentation rate in Texas estuaries is about 1 cm per 100 years (Behrens, 1980). However, recent water projects, particularly dams, have probably decreased this rate. An average nitrogen background level, i.e., the average content at about 40 cm is about 0.05%. The average surface nitrogen content is about 0.1%, so the change between the labile and refractory zone is a factor of 2. This implies that half of the nitrogen arriving at the sediment surface is lost to the system via burial.

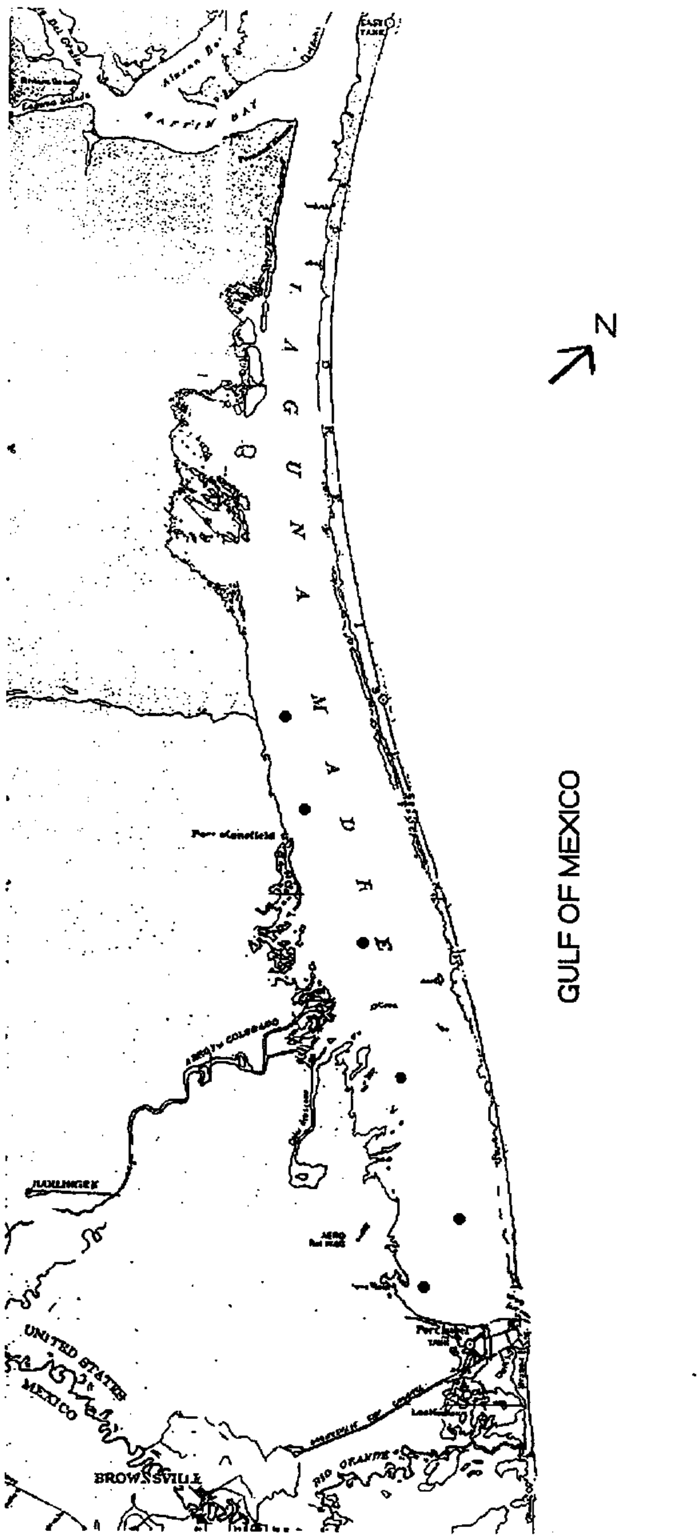


Figure 13. Map of samples sites to determine sediment nitrogen values in Lower Laguna Madre.

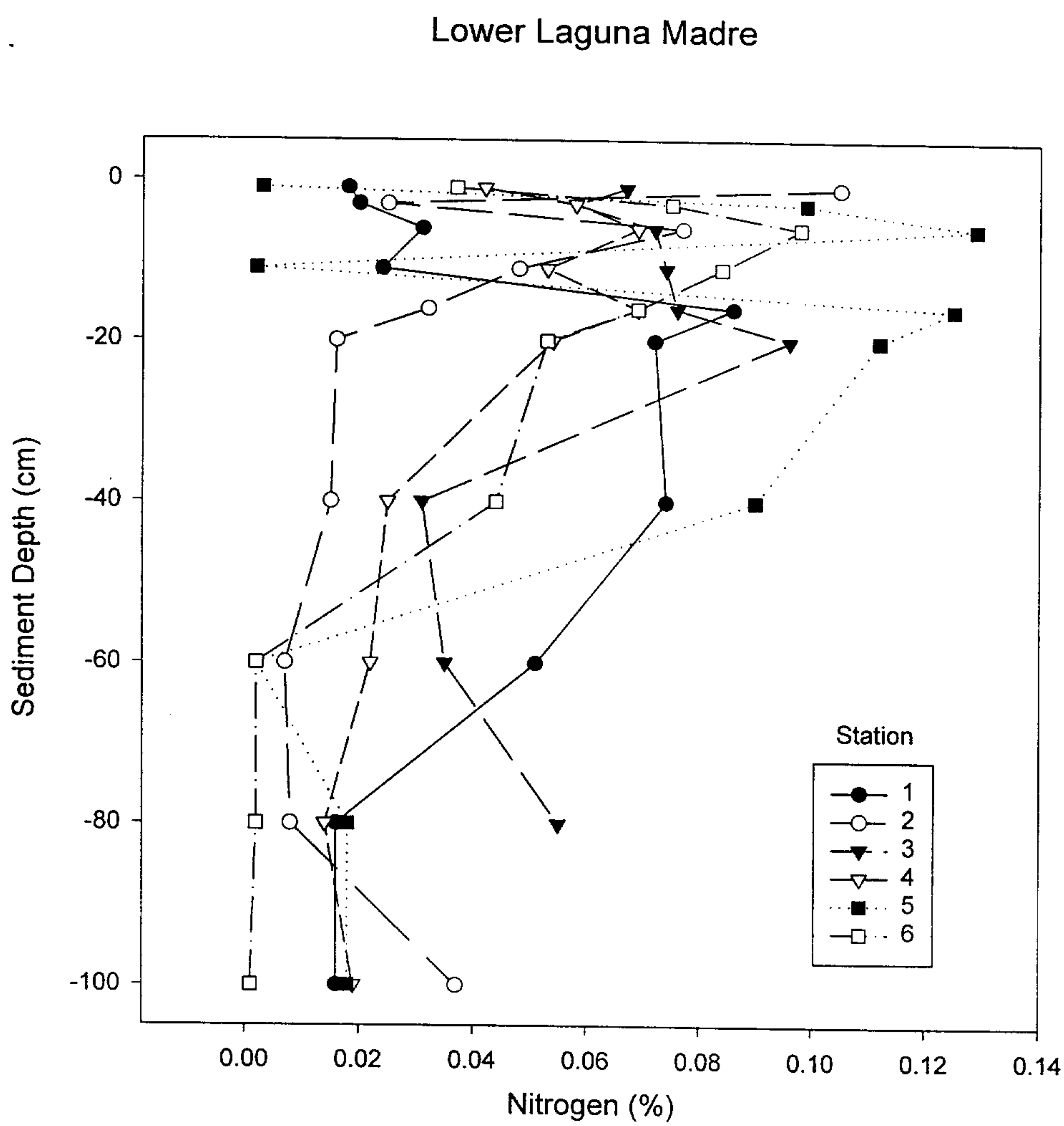


Figure 14. Nitrogen content of Lower Laguna Madre Sediments.

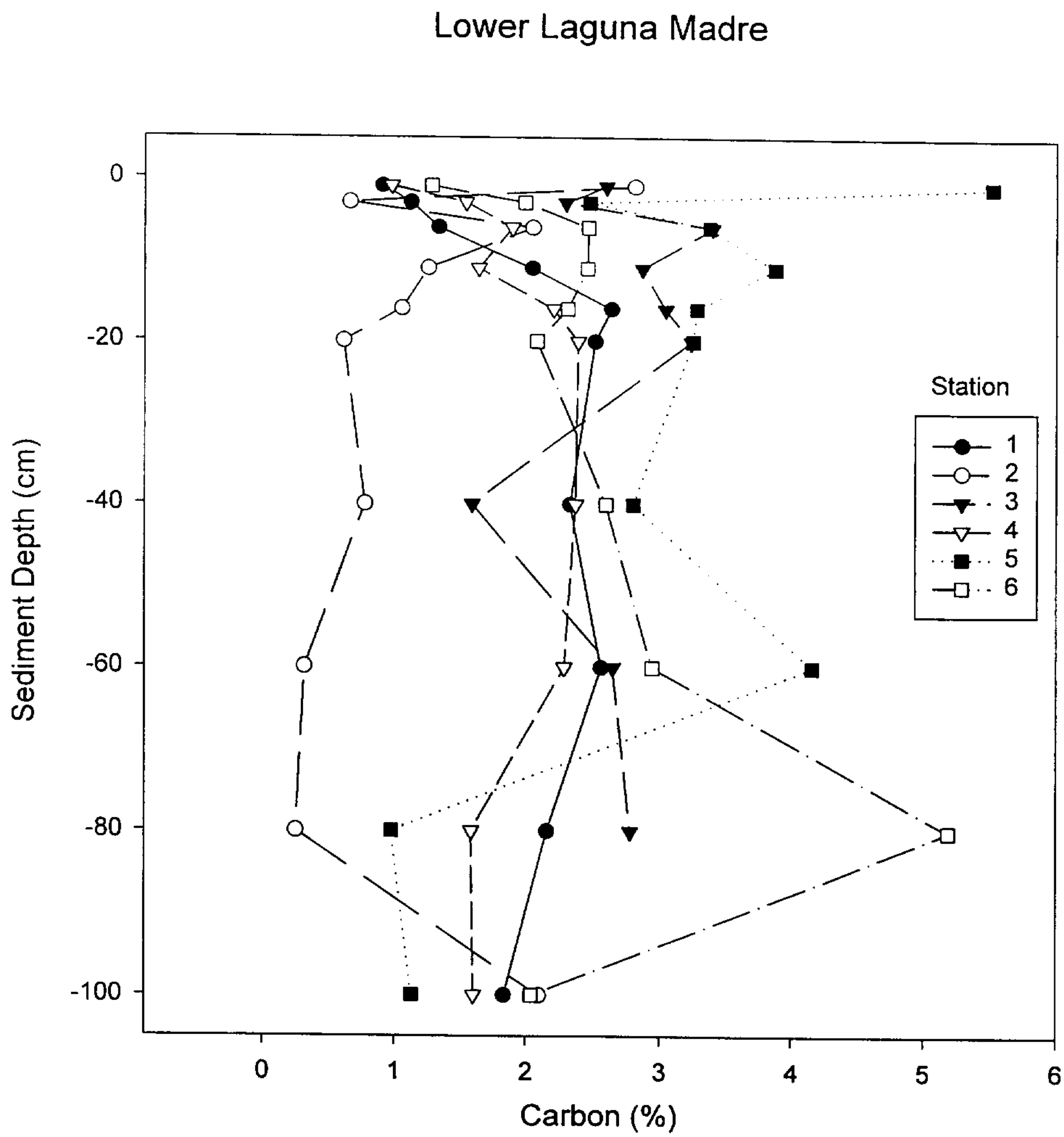


Figure 15. Carbon content of Lower Laguna Madre Sediments.

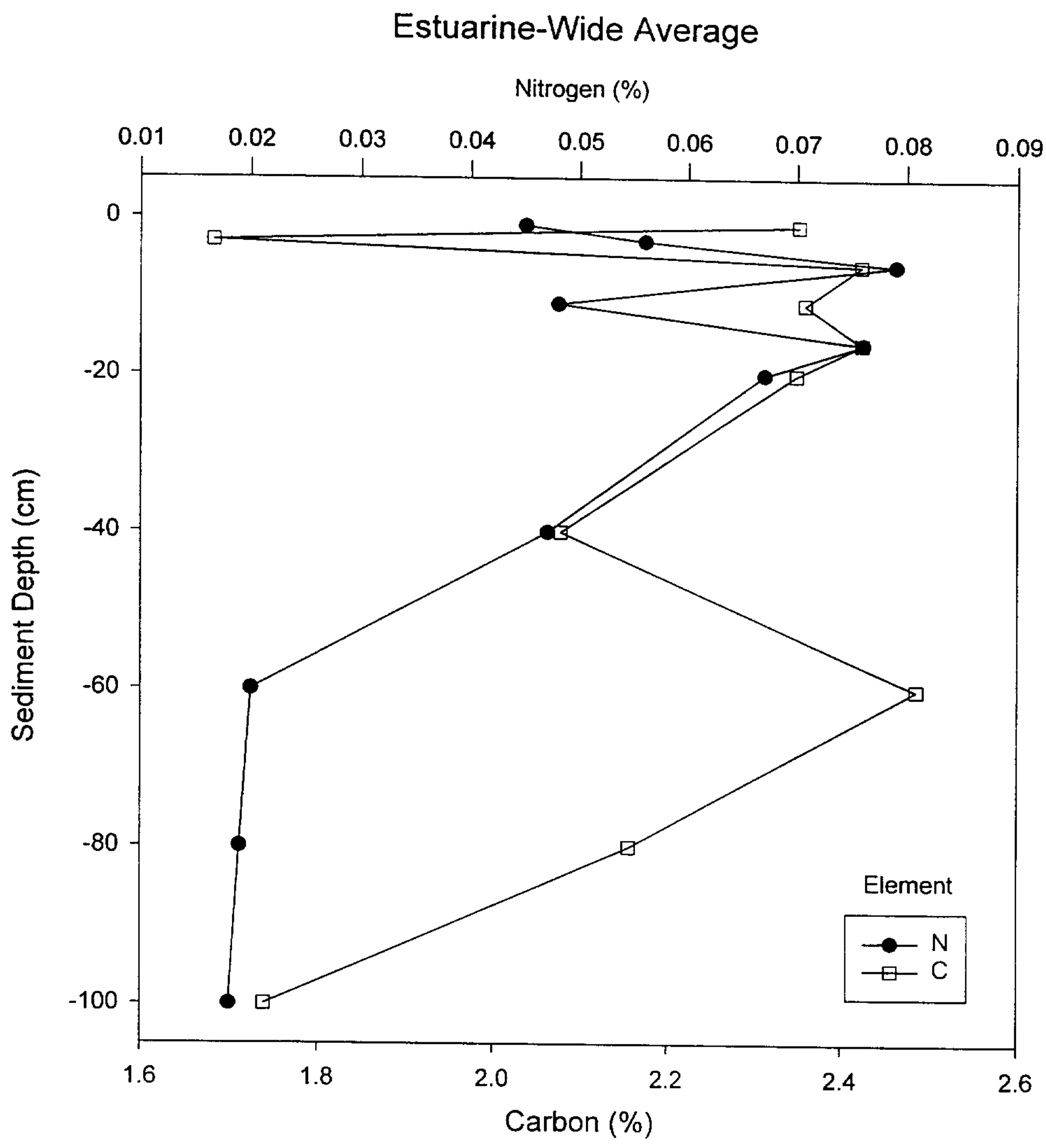


Figure 16. Average nitrogen and carbon content in Lower Laguna Madre Sediments.

CONCLUSION

The main difference between the Guadalupe and Lavaca-Colorado Estuaries relate to both size and Gulf exchange. Freshwater inflow has a larger impact on the smaller-restricted Guadalupe Estuary than in the Lavaca-Colorado. Both the smaller size and restricted inflow have synergistic effects, thus the Guadalupe is generally fresher and has higher carbon content than the Lavaca-Colorado. These conditions lead to higher benthic productivity in the Guadalupe Estuary. On the other hand, higher salinities and invasion of marine species is responsible for a more diverse community in Lavaca-Colorado Estuary. There is long-term, year-to-year variability in inflow that drives benthic community succession, and results in different levels of productivity from year-to-year. It is now apparent that the long-term changes may be related to global climate cycles, e.g., El Niño events in the western Pacific Ocean. Eventually, we will have sufficient data to model these responses to derive quantitative estimates of productivity versus inflow.

Typically, nitrogen is lost within the top 20 cm of sediment. However, in Lower Laguna Madre sediments, profiles of nitrogen content decline with depth beyond the top 20 cm to a depth of 60 cm.

REFERENCES

Behrens, E.W. 1980. On sedimentation rates and porosity. Marine Geology Letters, 35:M11-M16.

Folk, R. L. 1964. Petrology of sedimentary rocks. Hemphill's Press. Austin, TX. 155 pp.

Jones, R.S., J.J. Cullen, R.G. Lane, W. Yoon, R.A. Rosson, R.D. Kalke, S.A. Holt and C.R. Arnold. 1986. Studies of freshwater inflow effects on the Lavaca River Delta and Lavaca Bay, TX. Report to the Texas Water Development Board. The University of Texas Marine Science Institute, Port Aransas, TX. 423 pp.

Kalke, R.D. and Montagna, P.A. 1991. The effect of freshwater inflow on macrobenthos in the Lavaca River Delta and Upper Lavaca Bay, Texas. *Contributions in Marine Science*, 32:49-71.

Montagna, P.A. 1989. Nitrogen Process Studies (NIPS): the effect of freshwater inflow on benthos communities and dynamics. Technical Report No. TR/89-011, Marine Science Institute, The University of Texas, Port Aransas, TX, 370 pp.

Montagna, P.A. 1991. Predicting long-term effects of freshwater inflow on macrobenthos in the Lavaca-Colorado and Guadalupe Estuaries. Year 2. Technical Report No. TR/91-004, Marine Science Institute, The University of Texas, Port Aransas, TX, 78 pp.

Montagna, P.A. 1997. Effect of freshwater inflow on macrobenthos productivity and nitrogen losses in Texas estuaries. Final report to Texas Water Development Board, Contract No. 97-483-199, University of Texas Marine Science Institute Technical Report Number TR/97-02, Port Aransas, Texas. 157 pp.

Montagna, P.A. and R.D. Kalke. 1992. The Effect of Freshwater Inflow on Meiofaunal and Macrofaunal Populations in the Guadalupe and Nueces Estuaries, Texas. *Estuaries*, 15:307-326.

Montagna, P.A. and R.D. Kalke. 1995. Ecology of infaunal Mollusca in south Texas estuaries. *American Malacological Bulletin* 11:163-175.

Montagna, P.A., and Li, J. 1996. Modeling and monitoring long-term change in macrobenthos in Texas estuaries. Final Report to the Texas Water Devlopment Board. University of Texas at Austin, Marine Science Institute, Technical Report No. TR/96-001, Port Aransas, Texas, 149 pp.

Montagna, P.A. and W.B. Yoon. 1991. The effect of freshwater inflow on meiofaunal consumption of sediment bacteria and microphytobenthos in San Antonio Bay, Texas USA. *Estuarine and Coastal Shelf Science*, 33:529-547.

SAS Institute, Incorporated. 1985. *SAS/STAT Guide for Personal Computers*, Version 6 Edition. Cary, NC:SAS Institute Inc., 378 pp.

Texas Department of Water Resources. 1980a. Lavaca-Tres Palacios Estuary: A study of influence of freshwater inflows. Publication LP-106. Texas Department of Water Resources, Austin, Texas. 325 p.

Texas Department of Water Resources. 1980b. Guadalupe Estuary: A study of influence of freshwater inflows. Texas Department of Water Resources, Austin, Texas. Publication LP-107. 321 p.