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

Paul A. Montagna, Principal Investigator
TWDB Contract No. 99-483-267
Technical Report Number TR/99-01

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FINAL REPORT

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by

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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, 98-483-233, and most recently 99-483-267.

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 (99-483-267) 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

For current year's contract

Scientific Publications

Ritter, M.C. and P.A. Montagna. 1999. Seasonal hypoxia and models of benthic response in a Texas bay. *Estuaries* 22:7-20.

Twilley, R.R., J. Cowan, T. Miller-Way, P.A. Montagna and B Mortazavi. 1999. Benthic nutrient fluxes in selected estuaries in the Gulf of Mexico. In: Bianchi, T.S., Pennock, J.R. and R. Twilley, Biogeochemistry of Gulf of Mexico Estuaries, John Wiley & Sons, Inc. Pp. 163 - 209.

Technical Reports

Montagna, P.A. 1998. Effect of freshwater inflow on macrobenthos productivity and nitrogen losses in Texas estuaries. Final report to Texas Water Development Board, Contract No. 98-483-233, University of Texas Marine Science Institute Technical Report Number TR/98-03, Port Aransas, Texas. 61 pp.

*Oral Presenetations (*Invited seminars)*

*Montagna, P.A. "Texas Lagoonal Estuaries." Benthos of Coastal Seas Workshop, supported by the National Science Foundation (NSF) and the Luso-American Foundation (FLAD), April 18-21 1999, Lisbon, Portugal.

Montagna, P.A. "Using benthic infauna data to assess risk" American Society of Limnology and Oceanoraphy, Santa Fe, New Mexico. February 1 - 5, 1999.

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. Carrol 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 Carrol handles very well. Dr. Steve Jarvis, Mr. Robert Burgess, Mr. Chris Kalke aided in field collections. This work has also benefitted by discussions with colleagues at the Texas Water Development Board (TWDB), e.g., William Longley, David Brock, and Gary Powell who have provided much help and guidance.

The Texas estuarine research reported here has been supplemented by many other projects. The most interesting trend is that we have moved from monitoring and evaluating freshwater inflows to using diverted, restored, or returned inflows to enhance and restore wetland areas of estuaries. Two such projects are currently under way. The U.S. Bureau of Reclamation has funded studies on the effect of freshwater diversion to Rincon Bayou to restore the Nueces Delta Marsh. The City of Corpus Christi has funded a biological monitoring program of the Allison Waste Water Treatment Plant diversion project to restore an area of the Nueces Delta Marsh with returned inflows. 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 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 over time.

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 nine 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 (Fig. 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} ($3.080 \pm 1.686 \times 10^6$ 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} ($2.750 \pm 1.901 \times 10^6$ 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) (Fig. 3). Depths of stations A, B, C, and D were 1.3 m, 2.0 m, 3.1 m, and 4.2 m, respectively. Four 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} ($2.347 \pm 1.295 \times 10^6$ 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} ($2.127 \pm 1.396 \times 10^6$ ac-ft y^{-1}) (TDWR, 1980b; TWDB unpublished data). This system was studied from January through July 1987 and sampling commenced again in 1990.

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 shallo
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.

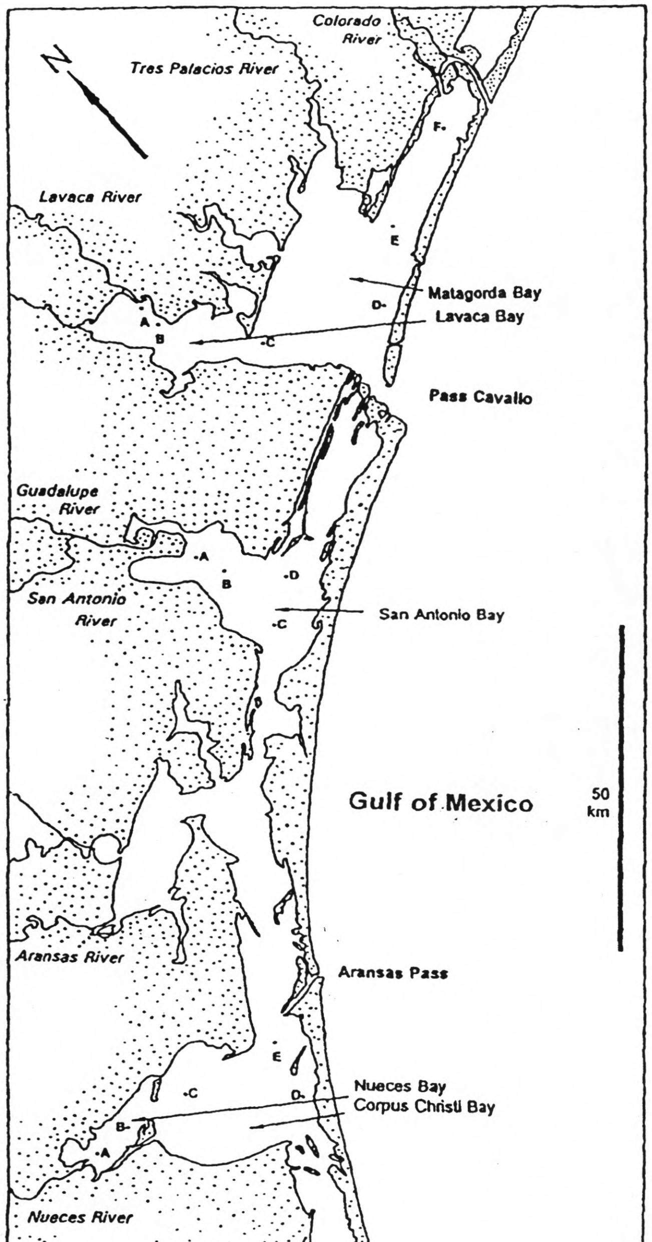

Figure 1. The Texas Coastal Bend lagoonal estuaries with major rivers, tidal inlets, and station locations.

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
Upper Laguna Madre	189	27.20.994	97.23.543
	135	27.26.983	97.20.437
Baffin Bay	6	27.16.605	97.25.655
	24	27.15.833	97.33.085

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
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
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	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
12OCT98	A	0.00	5	4.3	8.40	25.07	7.76	7.44	0.232
12OCT98	A	1.50	5	7.4	13.72	25.02	7.66	6.20	0.239
12OCT98	B	0.00	7	7.0	12.73	24.68	8.02	8.77	0.221
12OCT98	B	2.20	7	12.1	20.70	25.36	7.80	6.30	0.230
12OCT98	C	0.00	15	15.4	25.50	25.61	8.06	8.55	0.221
12OCT98	C	3.10	15	24.5	38.50	25.69	7.93	6.41	0.229
12OCT98	D	0.00	22	21.9	34.80	25.78	8.09	8.48	0.216
12OCT98	D	4.20	22	31.4	48.20	26.70	7.85	5.85	0.222
12OCT98	E	0.00	20	19.7	31.80	25.74	8.09	8.90	0.206
12OCT98	E	3.30	20	29.8	46.00	26.49	7.72	3.11	0.221
12OCT98	F	0.00	14	14.0	23.50	25.95	7.88	8.83	0.195
12OCT98	F	1.20	14	21.2	34.20	25.25	7.46	1.47	0.216
05JAN99	A	0.00	12	14.3	24.00	7.88	8.23	10.33	0.179
05JAN99	A	1.20	12	15.1	24.80	8.73	8.24	9.85	0.180
05JAN99	B	0.00	7	12.2	20.70	7.25	8.32	10.60	0.178
05JAN99	B	1.70	7	20.0	32.40	9.06	8.29	9.21	0.183
05JAN99	C	0.00	16	20.6	33.10	9.52	8.23	9.28	0.177
05JAN99	C	2.50	16	22.8	36.20	10.17	8.22	8.58	0.179
05JAN99	D	0.00	20	22.6	35.90	9.93	8.27	9.05	0.176
05JAN99	D	3.70	20	29.2	45.20	12.63	8.15	7.65	0.180
05JAN99	E	0.00	17	19.0	30.70	9.38	8.39	9.64	0.177
05JAN99	E	2.80	17	19.3	31.20	9.11	8.38	9.13	0.178
05JAN99	F	0.00	7	10.0	17.00	9.04	8.44	10.66	0.180
05JAN99	F	0.70	7	16.4	26.70	9.12	8.36	8.45	0.185
06APR99	A	0.00	10	12.7	21.50	21.89	8.17	7.40	0.161
06APR99	A	1.20	.	12.9	21.80	22.00	8.18	7.34	0.168

06APR99	B	0.00	14	16.0	26.60	22.20	8.28	7.39	0.180
06APR99	B	2.10	.	16.5	27.00	22.23	8.23	6.83	0.186
06APR99	C	0.00	22	24.4	38.40	22.57	8.18	6.83	0.190
06APR99	C	3.10	.	24.5	38.60	22.55	8.18	6.45	0.187
06APR99	D	0.00	25	26.6	41.50	22.36	8.29	7.17	0.183
06APR99	D	4.40	.	27.1	42.20	22.40	8.30	6.73	0.186
06APR99	E	0.00	23	25.1	39.40	22.74	8.37	8.08	0.190
06APR99	E	3.60	.	26.4	41.30	22.39	8.24	5.89	0.196
06APR99	F	0.00	15	16.7	27.40	23.21	8.22	8.42	0.189
06APR99	F	1.40	.	16.8	27.60	23.20	8.33	7.93	0.189

Guadalupe Estuary

Date	STA	z	SAL(R)	SAL(M)	COND	TEMP	pH	DO	ORP
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	.
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	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	.
13OCT98	A	1.20	2	2.1	4.66	25.90	.	6.30	.
13OCT98	B	0.00	5	4.6	8.82	26.86	.	9.31	.
13OCT98	B	1.60	5	9.3	16.10	25.57	.	6.07	.
13OCT98	C	0.00	14	13.2	22.30	26.00	.	7.84	.
13OCT98	C	2.00	14	13.8	23.10	25.94	.	6.11	.
13OCT98	D	0.00	18	18.3	29.70	25.77	.	6.93	.
13OCT98	D	1.60	18	18.3	29.70	25.76	.	6.93	.
13OCT98	E	0.00	20	20.5	32.90	25.78	.	7.25	.
13OCT98	E	2.30	20	21.2	33.90	25.76	.	7.07	.
13OCT98	F	0.00	14	13.9	23.30	26.67	.	7.38	.
13OCT98	F	1.40	14	17.5	28.60	26.55	.	5.82	.
06JAN99	A	0.00	0	0.0	0.85	12.96	8.34	9.72	0.203
06JAN99	A	0.70	0	0.0	0.88	10.11	8.34	10.21	0.205
06JAN99	B	0.00	0	0.2	1.47	11.50	8.59	10.95	0.196
06JAN99	B	1.20	0	2.0	4.56	8.99	8.45	10.46	0.205
06JAN99	C	0.00	0	1.3	3.30	11.67	8.65	12.40	0.194
06JAN99	C	1.50	0	4.9	9.49	9.02	8.44	10.17	0.205
06JAN99	D	0.00	4	5.4	10.07	10.22	7.63	11.57	0.171
06JAN99	D	1.10	4	11.6	20.30	9.46	7.87	10.58	0.184
07APR99	A	0.00	2	3.5	7.00	24.79	.	8.60	.
07APR99	A	1.40	.	3.6	7.30	24.72	.	8.21	.
07APR99	B	0.00	8	9.3	16.30	24.30	.	8.46	.
07APR99	B	1.80	.	11.4	19.20	24.30	.	6.70	.
07APR99	C	0.00	11	13.5	22.70	23.99	.	8.14	.
07APR99	C	2.10	.	13.6	22.90	23.92	.	7.71	.
07APR99	D	0.00	14	15.2	25.20	23.81	.	8.47	.
07APR99	D	1.60	.	16.7	27.60	23.63	.	7.56	.

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
06JUL98	A	0	0.671	53	0.224	0.000	0.744
06JUL98	A	1.3	0.503	26	0.167	0.000	0.193
06JUL98	B	0	0.336	40	0.216	0.000	0.240
06JUL98	B	1.9	0.336	35	0.444	0.000	0.619
06JUL98	C	0	0.252	24	0.186	0.000	0.273
06JUL98	C	3	0.235	23	0.192	0.000	0.321
06JUL98	D	0	0.235	23	0.167	0.000	0.116
06JUL98	D	4.1	0.218	16	0.141	0.000	0.132
06JUL98	E	0	0.185	23	0.222	0.000	0.148
06JUL98	E	3.4	0.235	22	0.228	0.000	0.133
06JUL98	F	0	0.889	81	1.198	2.807	2.026
06JUL98	F	1.3	1.376	70	1.257	2.489	3.477
12OCT98	A	0	2.305	161	3.437	8.358	2.378
12OCT98	A	1.5	2.357	148	3.928	6.728	4.101
12OCT98	B	0	0.418	140	2.626	3.167	1.236
12OCT98	B	2.2	1.112	126	2.838	1.610	3.077
12OCT98	C	0	0.847	97	0.234	0.000	1.082
12OCT98	C	3.1	0.667	57	0.511	0.000	1.157
12OCT98	D	0	0.541	66	0.208	0.000	0.912
12OCT98	D	4.2	0.416	23	0.763	0.581	0.684
12OCT98	E	0	0.656	80	0.192	0.000	0.574
12OCT98	E	3.3	1.074	41	0.898	0.000	1.676
12OCT98	F	0	2.156	112	0.509	5.388	0.859
12OCT98	F	1.2	3.128	101	1.236	4.661	4.113
05JAN99	A	0	1.134	63	0.325	0.944	1.500
05JAN99	A	1.2	1.250	64	0.412	0.162	1.579
05JAN99	B	0	1.130	66	0.292	1.177	1.321
05JAN99	B	1.7	0.922	69	0.286	0.000	1.400
05JAN99	C	0	1.073	75	0.197	0.000	1.547
05JAN99	C	2.5	1.417	67	0.750	0.000	2.067
05JAN99	D	0	1.885	68	0.319	0.000	2.180
05JAN99	D	3.7	0.975	30	0.541	0.913	2.530
05JAN99	E	0	1.074	40	0.214	0.000	1.595
05JAN99	E	2.8	1.129	36	0.353	0.000	1.607
05JAN99	F	0	2.078	28	0.461	12.57	1.484
05JAN99	F	0.7	2.703	26	0.921	6.454	2.983
06APR99	A	0	0.870	94	0.547	4.540	1.817
06APR99	A	1.2	1.003	82	0.578	4.388	5.355
06APR99	B	0	0.747	76	0.399	1.013	2.529
06APR99	B	2.1	0.880	56	0.793	1.692	3.697
06APR99	C	0	1.013	22	0.670	0.650	2.428

06APR99	C	3.1	1.790	24	1.956	2.376	4.375
06APR99	D	0	0.604	11	0.312	0.168	1.853
06APR99	D	4.4	0.491	9	0.299	0.060	1.735
06APR99	E	0	0.604	11	0.318	0.367	1.685
06APR99	E	3.6	1.923	14	1.903	0.453	3.768
06APR99	F	0	1.125	43	0.787	13.09	2.058
06APR99	F	1.4	1.739	49	0.994	15.00	2.719

Guadalupe Estuary

Date	Station	Depth	PO_4	SIO_4	NO_2	NO_3	NH_4
07JUL98	A	0	2.181	159	0.157	0.326	0.421
07JUL98	A	1.1	2.349	129	0.164	0.000	0.942
07JUL98	B	0	2.181	108	0.219	0.000	0.278
07JUL98	B	1.6	2.383	107	0.374	0.000	0.641
07JUL98	C	0	0.503	79	0.175	0.000	0.072
07JUL98	C	1.8	0.671	79	0.223	0.000	0.230
07JUL98	D	0	2.517	116	0.204	0.000	0.103
07JUL98	D	1.4	1.510	61	0.168	0.000	0.009
12OCT98	A	0	7.427	116	1.826	37.64	3.164
12OCT98	A	1.2	7.398	100	2.027	39.44	3.510
12OCT98	B	0	4.978	146	0.796	16.37	1.055
12OCT98	B	1.6	4.919	132	0.850	12.62	1.418
12OCT98	C	0	2.616	147	0.221	0.000	0.951
12OCT98	C	2	2.605	146	0.464	0.000	1.331
12OCT98	D	0	1.293	115	0.332	0.000	1.055
12OCT98	D	1.6	1.311	115	0.282	0.000	0.951
12OCT98	E	0	0.680	85	0.170	0.000	0.847
12OCT98	E	2.3	0.745	83	0.277	0.000	0.830
12OCT98	F	0	2.604	141	0.142	0.000	0.968
12OCT98	F	1.4	2.479	132	0.448	0.000	1.418
06JAN99	A	0	3.158	102	0.525	69.73	2.864
06JAN99	A	0.7	3.836	154	0.478	67.58	5.480
06JAN99	B	0	2.110	101	0.320	40.82	0.912
06JAN99	B	1.2	2.612	66	0.563	24.53	1.499
06JAN99	C	0	2.816	133	0.301	29.69	0.686
06JAN99	C	1.5	2.608	38	0.471	9.735	1.509
06JAN99	D	0	2.679	27	0.490	14.33	1.812
06JAN99	D	1.1	2.042	31	0.411	3.701	1.654
07APR99	A	0	4.491	135	1.441	59.82	1.080
07APR99	A	1.4	4.992	160	1.570	57.34	0.894
07APR99	B	0	2.486	62	0.376	32.33	0.842
07APR99	B	1.8	2.046	64	0.363	19.68	2.044
07APR99	C	0	1.831	94	0.624	10.23	4.058
07APR99	C	2.1	1.841	67	0.632	10.85	1.942
07APR99	D	0	1.422	77	0.474	3.160	1.483
07APR99	D	1.6	1.422	74	0.538	0.000	2.652

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
06JUL98	A	1	3	Polychaeta	15	0.69
06JUL98	A	1	10	Polychaeta	29	6.41
06JUL98	A	2	3	Mollusca	1	0.03
06JUL98	A	2	3	Polychaeta	15	2.08
06JUL98	A	2	10	Polychaeta	23	5.68
06JUL98	A	3	3	Crustacea	1	0.01
06JUL98	A	3	3	Mollusca	3	0.56
06JUL98	A	3	3	Polychaeta	29	2.04
06JUL98	A	3	10	Polychaeta	18	2.79
06JUL98	B	1	3	Polychaeta	10	0.57
06JUL98	B	1	10	Polychaeta	7	1.48
06JUL98	B	2	3	Mollusca	1	0.02
06JUL98	B	2	3	Polychaeta	12	1.17
06JUL98	B	2	10	Polychaeta	5	0.85
06JUL98	B	3	3	Mollusca	1	0.03
06JUL98	B	3	3	Polychaeta	10	1.29
06JUL98	B	3	10	Polychaeta	6	0.96
06JUL98	C	1	3	Crustacea	1	0.02
06JUL98	C	1	3	Mollusca	3	2.41
06JUL98	C	1	3	Rhynchocoela	1	0.1
06JUL98	C	1	3	Polychaeta	3	1.44
06JUL98	C	1	3	Sipunculida	1	0.12
06JUL98	C	1	10	Rhynchocoela	1	0.45
06JUL98	C	1	10	Polychaeta	13	5.85
06JUL98	C	2	3	Crustacea	1	0.01
06JUL98	C	2	3	Mollusca	1	0.02
06JUL98	C	2	3	Rhynchocoela	2	0.04
06JUL98	C	2	3	Polychaeta	4	2.16
06JUL98	C	2	10	Mollusca	1	0.02
06JUL98	C	2	10	Polychaeta	13	9.51
06JUL98	C	3	3	Mollusca	2	0.33
06JUL98	C	3	3	Polychaeta	9	3.88
06JUL98	C	3	10	Polychaeta	8	4.87
06JUL98	D	1	3	Polychaeta	6	18.92
06JUL98	D	1	10	Polychaeta	1	0.01
06JUL98	D	2	3	Mollusca	1	0.29
06JUL98	D	2	3	Rhynchocoela	1	0.01
06JUL98	D	2	3	Polychaeta	4	0.15
06JUL98	D	2	10	Crustacea	2	1.18
06JUL98	D	2	10	Mollusca	1	4.79
06JUL98	D	2	10	Rhynchocoela	5	3.08
06JUL98	D	2	10	Ophiuroidea	1	11.05
06JUL98	D	2	10	Polychaeta	9	2.47

06JUL98	D	3	3	Crustacea	1	2.68
06JUL98	D	3	3	Polychaeta	2	0.03
06JUL98	D	3	3	Sipunculida	1	0.92
06JUL98	D	3	10	Mollusca	1	0.09
06JUL98	D	3	10	Ophiuroidea	1	5.2
06JUL98	D	3	10	Polychaeta	2	20.78
06JUL98	E	1	3	Mollusca	1	0.1
06JUL98	E	1	3	Polychaeta	2	0.43
06JUL98	E	1	10	Polychaeta	3	0.65
06JUL98	E	2	3	Polychaeta	0	0
06JUL98	E	2	10	Polychaeta	3	0.8
06JUL98	E	3	3	Polychaeta	2	0.52
06JUL98	E	3	10	Ophiuroidea	1	1.1
06JUL98	E	3	10	Polychaeta	4	0.33
06JUL98	F	1	3	Crustacea	1	0.07
06JUL98	F	1	3	Rhynchocoela	1	0.06
06JUL98	F	1	3	Polychaeta	24	1.85
06JUL98	F	1	10	Rhynchocoela	1	0.08
06JUL98	F	1	10	Polychaeta	7	0.57
06JUL98	F	2	3	Mollusca	1	0.07
06JUL98	F	2	3	Rhynchocoela	1	0.3
06JUL98	F	2	3	Polychaeta	11	0.57
06JUL98	F	2	10	Mollusca	1	0.14
06JUL98	F	2	10	Rhynchocoela	1	0.16
06JUL98	F	2	10	Polychaeta	8	1.03
06JUL98	F	3	3	Polychaeta	13	0.52
06JUL98	F	3	10	Polychaeta	4	0.31
12OCT98	A	1	3	Polychaeta	17	4.59
12OCT98	A	1	10	Polychaeta	21	5.14
12OCT98	A	2	3	Polychaeta	10	1.96
12OCT98	A	2	10	Rhynchocoela	1	2.77
12OCT98	A	2	10	Polychaeta	14	4.02
12OCT98	A	3	3	Crustacea	1	0.04
12OCT98	A	3	3	Polychaeta	10	0.96
12OCT98	A	3	10	Polychaeta	43	8.97
12OCT98	B	1	3	Polychaeta	7	3.62
12OCT98	B	1	10	Polychaeta	19	3.03
12OCT98	B	2	3	Polychaeta	13	1.59
12OCT98	B	2	10	Rhynchocoela	1	0.02
12OCT98	B	2	10	Polychaeta	17	3.91
12OCT98	B	3	3	Polychaeta	23	1.79
12OCT98	B	3	10	Polychaeta	7	1.71
12OCT98	C	1	3	Mollusca	2	1.39
12OCT98	C	1	3	Polychaeta	21	1.02
12OCT98	C	1	10	Polychaeta	11	7.66
12OCT98	C	2	3	Polychaeta	14	0.48
12OCT98	C	2	10	Polychaeta	9	4.33
12OCT98	C	3	3	Mollusca	1	0.03
12OCT98	C	3	3	Polychaeta	27	1.25
12OCT98	C	3	10	Rhynchocoela	1	0.1
12OCT98	C	3	10	Polychaeta	15	2.92

12OCT98	D	1	3	Mollusca	1	0.08
12OCT98	D	1	3	Polychaeta	12	0.3
12OCT98	D	1	10	Mollusca	4	0.14
12OCT98	D	1	10	Rhynchocoela	2	1.94
12OCT98	D	1	10	Polychaeta	2	0.11
12OCT98	D	2	3	Crustacea	13	0.55
12OCT98	D	2	3	Polychaeta	8	0.33
12OCT98	D	2	10	Crustacea	2	2.34
12OCT98	D	2	10	Mollusca	5	0.38
12OCT98	D	2	10	Ophiuroidea	1	5.96
12OCT98	D	2	10	Polychaeta	12	0.77
12OCT98	D	3	3	Crustacea	1	0.02
12OCT98	D	3	3	Rhynchocoela	2	0.03
12OCT98	D	3	3	Polychaeta	11	0.34
12OCT98	D	3	10	Mollusca	10	0.39
12OCT98	D	3	10	Rhynchocoela	1	2.98
12OCT98	D	3	10	Ophiuroidea	1	20.79
12OCT98	D	3	10	Polychaeta	12	1.01
12OCT98	E	1	3	Polychaeta	21	1.09
12OCT98	E	1	10	Polychaeta	76	7.76
12OCT98	E	2	3	Polychaeta	24	0.64
12OCT98	E	2	10	Polychaeta	8	4.39
12OCT98	E	3	3	Mollusca	2	0.02
12OCT98	E	3	3	Rhynchocoela	1	0.02
12OCT98	E	3	3	Polychaeta	20	0.96
12OCT98	E	3	10	Polychaeta	34	6.96
12OCT98	F	1	3	Other	1	0.02
12OCT98	F	1	3	Polychaeta	9	0.75
12OCT98	F	1	10	Polychaeta	4	0.21
12OCT98	F	2	3	Polychaeta	2	0.08
12OCT98	F	2	10	Polychaeta	2	0.09
12OCT98	F	3	3	Polychaeta	13	0.37
12OCT98	F	3	10	Polychaeta	3	0.14
05JAN99	A	1	3	Rhynchocoela	1	0.64
05JAN99	A	1	3	Polychaeta	19	2.6
05JAN99	A	1	10	Polychaeta	0	0
05JAN99	A	2	3	Polychaeta	14	1.28
05JAN99	A	2	10	Polychaeta	0	0
05JAN99	A	3	3	Polychaeta	16	2.4
05JAN99	A	3	10	Polychaeta	2	0.61
05JAN99	B	1	3	Mollusca	1	0.03
05JAN99	B	1	3	Rhynchocoela	1	0.15
05JAN99	B	1	3	Polychaeta	3	0.26
05JAN99	B	1	10	Polychaeta	0	0
05JAN99	B	2	3	Polychaeta	10	1.06
05JAN99	B	2	10	Rhynchocoela	1	0.08
05JAN99	B	3	3	Rhynchocoela	1	0.4
05JAN99	B	3	3	Polychaeta	4	0.49
05JAN99	B	3	10	Polychaeta	0	0
05JAN99	C	1	3	Mollusca	2	0.09
05JAN99	C	1	3	Polychaeta	14	1.57

05JAN99	C	1	10	Rhynchocoela	2	1.85
05JAN99	C	1	10	Polychaeta	10	3.48
05JAN99	C	2	3	Mollusca	3	0.26
05JAN99	C	2	3	Polychaeta	11	0.61
05JAN99	C	2	10	Polychaeta	11	6.59
05JAN99	C	3	3	Rhynchocoela	1	0.3
05JAN99	C	3	3	Polychaeta	3	0.21
05JAN99	C	3	10	Rhynchocoela	1	0.15
05JAN99	C	3	10	Polychaeta	12	2.44
05JAN99	D	1	3	Mollusca	2	0.07
05JAN99	D	1	3	Other	1	0.01
05JAN99	D	1	3	Polychaeta	10	0.22
05JAN99	D	1	10	Crustacea	2	0.85
05JAN99	D	1	10	Mollusca	2	0.04
05JAN99	D	1	10	Rhynchocoela	3	3.7
05JAN99	D	1	10	Ophiuroidea	1	1.44
05JAN99	D	1	10	Polychaeta	10	16.31
05JAN99	D	2	3	Crustacea	2	0.3
05JAN99	D	2	3	Mollusca	4	0.09
05JAN99	D	2	3	Polychaeta	15	0.27
05JAN99	D	2	10	Crustacea	4	2.22
05JAN99	D	2	10	Mollusca	23	0.96
05JAN99	D	2	10	Rhynchocoela	1	2.56
05JAN99	D	2	10	Ophiuroidea	1	7.94
05JAN99	D	2	10	Polychaeta	17	10.11
05JAN99	D	3	3	Mollusca	1	0.01
05JAN99	D	3	3	Polychaeta	8	0.8
05JAN99	D	3	10	Mollusca	4	0.12
05JAN99	D	3	10	Ophiuroidea	1	8.11
05JAN99	D	3	10	Polychaeta	9	2.52
05JAN99	E	1	3	Polychaeta	11	0.47
05JAN99	E	1	10	Polychaeta	7	8
05JAN99	E	2	3	Crustacea	1	0.01
05JAN99	E	2	3	Rhynchocoela	1	0.23
05JAN99	E	2	3	Polychaeta	6	0.37
05JAN99	E	2	10	Polychaeta	8	4.53
05JAN99	E	3	3	Rhynchocoela	1	0.09
05JAN99	E	3	3	Polychaeta	20	0.61
05JAN99	E	3	10	Rhynchocoela	1	1.41
05JAN99	E	3	10	Polychaeta	13	4.95
05JAN99	F	1	3	Polychaeta	39	2.38
05JAN99	F	1	10	Polychaeta	9	1.26
05JAN99	F	2	3	Polychaeta	28	1.19
05JAN99	F	2	10	Polychaeta	1	0.22
05JAN99	F	3	3	Crustacea	1	0.01
05JAN99	F	3	3	Mollusca	1	0.03
05JAN99	F	3	3	Polychaeta	29	1.59
05JAN99	F	3	10	Polychaeta	3	0.85
06APR99	A	1	3	Crustacea	1	0.01
06APR99	A	1	3	Rhynchocoela	2	0.17

06APR99	A	1	3	Polychaeta	5	0.15
06APR99	A	1	10	Polychaeta	1	0.24
06APR99	A	2	3	Rhynchocoela	3	1.77
06APR99	A	2	3	Polychaeta	17	2.5
06APR99	A	2	10	Rhynchocoela	1	0.74
06APR99	A	2	10	Polychaeta	8	5.58
06APR99	A	3	3	Mollusca	1	0.03
06APR99	A	3	3	Rhynchocoela	1	0.05
06APR99	A	3	3	Polychaeta	11	2.43
06APR99	A	3	10	Polychaeta	3	0.27
06APR99	B	1	3	Rhynchocoela	1	0.11
06APR99	B	1	3	Polychaeta	6	0.99
06APR99	B	1	10	Polychaeta	1	0.08
06APR99	B	2	3	Crustacea	1	0.04
06APR99	B	2	3	Mollusca	1	0.11
06APR99	B	2	3	Polychaeta	9	0.17
06APR99	B	2	10	Rhynchocoela	1	0.17
06APR99	B	2	10	Polychaeta	7	1.4
06APR99	B	3	3	Crustacea	1	0.01
06APR99	B	3	3	Polychaeta	11	2.13
06APR99	B	3	10	Polychaeta	4	1.53
06APR99	C	1	3	Polychaeta	1	0.21
06APR99	C	1	10	Polychaeta	1	0.08
06APR99	C	2	3	Polychaeta	1	0.07
06APR99	C	2	10	Polychaeta	6	1.01
06APR99	C	3	3	Crustacea	1	0.02
06APR99	C	3	3	Polychaeta	1	0.07
06APR99	C	3	10	Polychaeta	3	0.21
06APR99	D	1	3	Crustacea	2	0.07
06APR99	D	1	3	Mollusca	3	1.51
06APR99	D	1	3	Polychaeta	3	0.22
06APR99	D	1	10	Crustacea	2	1.51
06APR99	D	1	10	Mollusca	6	2.77
06APR99	D	1	10	Rhynchocoela	1	1.16
06APR99	D	1	10	Ophiuroidea	1	6.63
06APR99	D	1	10	Polychaeta	15	25.73
06APR99	D	2	3	Crustacea	49	1.8
06APR99	D	2	3	Hemicordata	1	0.08
06APR99	D	2	3	Mollusca	1	0.42
06APR99	D	2	3	Rhynchocoela	1	0.03
06APR99	D	2	3	Polychaeta	7	0.35
06APR99	D	2	10	Crustacea	32	3.29
06APR99	D	2	10	Mollusca	6	0.88
06APR99	D	2	10	Rhynchocoela	2	1.24
06APR99	D	2	10	Other	1	0.17
06APR99	D	2	10	Ophiuroidea	2	21.38
06APR99	D	2	10	Polychaeta	16	0.77
06APR99	D	3	3	Crustacea	25	0.5
06APR99	D	3	3	Hemicordata	3	1.14
06APR99	D	3	3	Mollusca	3	1.52
06APR99	D	3	3	Other	1	0.2

06APR99	D	3	3	Ophiuroidea	1	0.02
06APR99	D	3	3	Polychaeta	5	3.75
06APR99	D	3	10	Crustacea	26	3.15
06APR99	D	3	10	Mollusca	7	0.62
06APR99	D	3	10	Rhynchocoela	1	0.35
06APR99	D	3	10	Ophiuroidea	1	6.38
06APR99	D	3	10	Polychaeta	2	1.31
06APR99	E	1	3	Hemicordata	3	1.16
06APR99	E	1	3	Polychaeta	5	0.69
06APR99	E	1	10	Polychaeta	8	2.51
06APR99	E	2	3	Crustacea	2	9.89
06APR99	E	2	3	Hemicordata	3	0.33
06APR99	E	2	3	Other	1	0.16
06APR99	E	2	3	Polychaeta	5	0.24
06APR99	E	2	10	Hemicordata	1	1.05
06APR99	E	2	10	Ophiuroidea	1	3.5
06APR99	E	2	10	Polychaeta	12	4.51
06APR99	E	3	3	Hemicordata	6	1.82
06APR99	E	3	3	Mollusca	1	0.05
06APR99	E	3	3	Rhynchocoela	1	0.04
06APR99	E	3	3	Other	1	0.02
06APR99	E	3	3	Polychaeta	7	0.4
06APR99	E	3	10	Hemicordata	1	0.37
06APR99	E	3	10	Mollusca	2	1.12
06APR99	E	3	10	Other	1	0.21
06APR99	E	3	10	Polychaeta	9	1.97
06APR99	F	1	3	Crustacea	7	0.71
06APR99	F	1	3	Polychaeta	32	4.28
06APR99	F	1	10	Mollusca	1	0.09
06APR99	F	1	10	Polychaeta	5	0.58
06APR99	F	2	3	Crustacea	10	0.68
06APR99	F	2	3	Polychaeta	29	2.77
06APR99	F	2	10	Polychaeta	25	3.48
06APR99	F	3	3	Crustacea	2	0.16
06APR99	F	3	3	Mollusca	1	0.02
06APR99	F	3	3	Polychaeta	25	2.11
06APR99	F	3	10	Rhynchocoela	1	0.14
06APR99	F	3	10	Polychaeta	22	2.97

Guadalupe Estuary

Date	Station	Replicate	Section	Taxa	n	mg
07JUL98	A	1	3	Crustacea	1	0.05
07JUL98	A	1	3	Mollusca	46	11.94
07JUL98	A	1	3	Polychaeta	10	0.61
07JUL98	A	1	10	Mollusca	1	0.07
07JUL98	A	1	10	Polychaeta	3	2.85
07JUL98	A	2	3	Crustacea	2	0.08
07JUL98	A	2	3	Chironomid larvae	1	0.05

07JUL98	A	2	3	Mollusca	61	24.59
07JUL98	A	2	3	Polychaeta	5	0.19
07JUL98	A	2	10	Polychaeta	1	0.11
07JUL98	A	3	3	Crustacea	3	0.18
07JUL98	A	3	3	Mollusca	27	16.54
07JUL98	A	3	3	Polychaeta	6	0.2
07JUL98	A	3	10	Mollusca	1	0.11
07JUL98	B	1	3	Crustacea	1	0.14
07JUL98	B	1	3	Mollusca	9	1.68
07JUL98	B	1	3	Rhynchocoela	1	0.09
07JUL98	B	1	3	Polychaeta	29	3.4
07JUL98	B	1	10	Polychaeta	0	0
07JUL98	B	2	3	Mollusca	6	0.04
07JUL98	B	2	3	Polychaeta	17	2.94
07JUL98	B	2	10	Polychaeta	2	0.18
07JUL98	B	3	3	Mollusca	17	2.97
07JUL98	B	3	3	Polychaeta	15	0.64
07JUL98	B	3	10	Polychaeta	20	5.94
07JUL98	C	1	3	Crustacea	1	0.02
07JUL98	C	1	3	Mollusca	3	0.46
07JUL98	C	1	3	Polychaeta	26	1.66
07JUL98	C	1	10	Mollusca	1	0.05
07JUL98	C	1	10	Polychaeta	11	1.65
07JUL98	C	2	3	Mollusca	4	0.78
07JUL98	C	2	3	Polychaeta	18	1.67
07JUL98	C	2	10	Polychaeta	3	0.51
07JUL98	C	3	3	Crustacea	2	0.02
07JUL98	C	3	3	Mollusca	5	0.85
07JUL98	C	3	3	Polychaeta	40	1.74
07JUL98	C	3	10	Polychaeta	11	1.81
07JUL98	D	1	3	Crustacea	1	0.05
07JUL98	D	1	3	Mollusca	1	0.02
07JUL98	D	1	3	Polychaeta	14	1.35
07JUL98	D	1	10	Polychaeta	5	0.84
07JUL98	D	2	3	Crustacea	1	0.01
07JUL98	D	2	3	Polychaeta	18	1.03
07JUL98	D	2	10	Polychaeta	5	2.19
07JUL98	D	3	3	Polychaeta	13	1.04
07JUL98	D	3	10	Rhynchocoela	1	4.76
07JUL98	D	3	10	Polychaeta	5	0.32
13OCT98	A	1	3	Crustacea	1	1.72
13OCT98	A	1	3	Mollusca	8	3.61
13OCT98	A	1	3	Polychaeta	7	0.34
13OCT98	A	1	10	Polychaeta	2	1.53
13OCT98	A	2	3	Mollusca	6	7.7
13OCT98	A	2	3	Rhynchocoela	1	0.07
13OCT98	A	2	3	Polychaeta	16	1.09
13OCT98	A	2	10	Rhynchocoela	1	0.21
13OCT98	A	2	10	Polychaeta	3	1.71
13OCT98	A	3	3	Mollusca	7	1.2
13OCT98	A	3	3	Rhynchocoela	1	10.1

13OCT98	A	3	3	Polychaeta	17	0.78
13OCT98	A	3	10	Polychaeta	0	0
13OCT98	B	1	3	Polychaeta	19	3.04
13OCT98	B	1	10	Polychaeta	13	2.1
13OCT98	B	2	3	Mollusca	5	1.15
13OCT98	B	2	3	Polychaeta	25	4.97
13OCT98	B	2	10	Polychaeta	5	1.74
13OCT98	B	3	3	Mollusca	3	3.23
13OCT98	B	3	3	Polychaeta	12	4.19
13OCT98	B	3	10	Polychaeta	12	3.35
13OCT98	C	1	3	Crustacea	1	0.02
13OCT98	C	1	3	Mollusca	2	1.23
13OCT98	C	1	3	Polychaeta	20	0.56
13OCT98	C	1	10	Rhynchocoela	1	0.2
13OCT98	C	1	10	Polychaeta	9	1.81
13OCT98	C	2	3	Polychaeta	23	0.53
13OCT98	C	2	10	Polychaeta	18	1.84
13OCT98	C	3	3	Mollusca	1	0.07
13OCT98	C	3	3	Polychaeta	28	1
13OCT98	C	3	10	Rhynchocoela	1	14.24
13OCT98	C	3	10	Polychaeta	4	0.15
13OCT98	D	1	3	Crustacea	1	0.02
13OCT98	D	1	3	Polychaeta	8	0.64
13OCT98	D	1	10	Crustacea	3	0.08
13OCT98	D	2	3	Mollusca	1	0.04
13OCT98	D	2	3	Polychaeta	7	0.35
13OCT98	D	2	10	Polychaeta	2	1.46
13OCT98	D	3	3	Crustacea	1	0.02
13OCT98	D	3	3	Rhynchocoela	1	0.37
13OCT98	D	3	3	Other	1	0.09
13OCT98	D	3	3	Polychaeta	13	0.72
13OCT98	D	3	10	Crustacea	2	0.03
13OCT98	D	3	10	Polychaeta	4	0.09
13OCT98	E	1	3	Rhynchocoela	1	0.1
13OCT98	E	1	3	Polychaeta	12	2.88
13OCT98	E	1	10	Rhynchocoela	1	0.86
13OCT98	E	1	10	Polychaeta	4	1.94
13OCT98	E	2	3	Rhynchocoela	1	0.03
13OCT98	E	2	3	Polychaeta	10	0.85
13OCT98	E	2	10	Polychaeta	5	3.27
13OCT98	E	3	3	Polychaeta	3	0.33
13OCT98	E	3	10	Polychaeta	3	1.98
13OCT98	F	1	3	Crustacea	1	0.03
13OCT98	F	1	3	Mollusca	1	0.18
13OCT98	F	1	3	Polychaeta	26	0.71
13OCT98	F	1	10	Mollusca	2	1
13OCT98	F	1	10	Rhynchocoela	1	0.34
13OCT98	F	1	10	Ophiuroidea	1	6.58
13OCT98	F	1	10	Polychaeta	12	4.62
13OCT98	F	2	3	Polychaeta	2	0.08
13OCT98	F	2	10	Polychaeta	12	15.56

13OCT98	F	3	3	Polychaeta	10	1.8
13OCT98	F	3	10	Polychaeta	9	7.89
06JAN99	A	1	3	Chironomid larvae	1	0.03
06JAN99	A	1	3	Mollusca	15	4.86
06JAN99	A	1	3	Polychaeta	2	0.09
06JAN99	A	1	10	Polychaeta	1	0.04
06JAN99	A	2	3	Mollusca	16	2.33
06JAN99	A	2	3	Polychaeta	2	0.05
06JAN99	A	2	10	Polychaeta	0	0
06JAN99	A	3	3	Mollusca	25	3.82
06JAN99	A	3	10	Rhynchocoela	1	0.17
06JAN99	A	3	10	Polychaeta	1	0.03
06JAN99	B	1	3	Mollusca	16	2.76
06JAN99	B	1	10	Rhynchocoela	1	0.87
06JAN99	B	1	10	Polychaeta	1	0.06
06JAN99	B	2	3	Mollusca	6	1.03
06JAN99	B	2	3	Rhynchocoela	2	0.18
06JAN99	B	2	3	Polychaeta	1	0.02
06JAN99	B	2	10	Rhynchocoela	2	0.71
06JAN99	B	2	10	Polychaeta	4	0.2
06JAN99	B	3	3	Mollusca	10	1.87
06JAN99	B	3	3	Polychaeta	8	0.44
06JAN99	B	3	10	Rhynchocoela	1	0.6
06JAN99	B	3	10	Polychaeta	2	0.29
06JAN99	C	1	3	Polychaeta	5	0.27
06JAN99	C	1	10	Polychaeta	0	0
06JAN99	C	2	3	Polychaeta	13	0.34
06JAN99	C	2	10	Polychaeta	2	0.14
06JAN99	C	3	3	Polychaeta	7	0.24
06JAN99	C	3	10	Polychaeta	1	0.06
06JAN99	D	1	3	Polychaeta	11	0.22
06JAN99	D	1	10	Polychaeta	0	0
06JAN99	D	2	3	Polychaeta	17	0.43
06JAN99	D	2	10	Polychaeta	0	0
06JAN99	D	3	3	Rhynchocoela	1	0.21
06JAN99	D	3	3	Polychaeta	8	0.37
06JAN99	D	3	10	Polychaeta	0	0
07APR99	A	1	3	Crustacea	2	10.44
07APR99	A	1	3	Chironomid larvae	1	0.04
07APR99	A	1	3	Mollusca	17	2.52
07APR99	A	1	3	Polychaeta	3	0.95
07APR99	A	1	10	Chironomid larvae	1	0.12
07APR99	A	1	10	Mollusca	4	0.56
07APR99	A	1	10	Polychaeta	1	0.1
07APR99	A	2	3	Chironomid larvae	1	0.02
07APR99	A	2	3	Mollusca	15	4.97
07APR99	A	2	3	Polychaeta	7	0.39
07APR99	A	2	10	Polychaeta	0	0
07APR99	A	3	3	Crustacea	1	0.01
07APR99	A	3	3	Mollusca	15	3.02
07APR99	A	3	3	Polychaeta	1	0.05

07APR99	A	3	10	Chironomid larvae	1	0.12
07APR99	A	3	10	Mollusca	1	0.17
07APR99	A	3	10	Polychaeta	1	0.04
07APR99	B	1	3	Mollusca	11	1.86
07APR99	B	1	3	Rhynchocoela	1	0.03
07APR99	B	1	3	Polychaeta	6	0.7
07APR99	B	1	10	Rhynchocoela	1	0.17
07APR99	B	2	3	Mollusca	3	0.69
07APR99	B	2	3	Polychaeta	2	0.18
07APR99	B	2	10	Polychaeta	1	0.1
07APR99	B	3	3	Mollusca	1	0.03
07APR99	B	3	3	Polychaeta	3	0.38
07APR99	B	3	10	Polychaeta	2	0.54
07APR99	C	1	3	Mollusca	3	0.65
07APR99	C	1	3	Polychaeta	13	1.41
07APR99	C	1	10	Rhynchocoela	1	0.08
07APR99	C	1	10	Polychaeta	6	0.57
07APR99	C	2	3	Mollusca	1	0.06
07APR99	C	2	3	Rhynchocoela	1	0.02
07APR99	C	2	3	Polychaeta	23	1.77
07APR99	C	2	10	Rhynchocoela	1	0.72
07APR99	C	2	10	Polychaeta	14	1.4
07APR99	C	3	3	Mollusca	2	0.54
07APR99	C	3	3	Polychaeta	12	0.86
07APR99	C	3	10	Polychaeta	13	1.53
07APR99	D	1	3	Polychaeta	22	1.28
07APR99	D	1	10	Polychaeta	1	19.03
07APR99	D	2	3	Crustacea	17	0.24
07APR99	D	2	3	Polychaeta	25	1.78
07APR99	D	2	10	Crustacea	3	0.07
07APR99	D	2	10	Polychaeta	3	0.49
07APR99	D	3	3	Polychaeta	20	1.65
07APR99	D	3	10	Polychaeta	6	11.7

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
06JUL98	A	1	3	Streblospio benedicti	5
06JUL98	A	1	3	Mediomastus ambiseta	10
06JUL98	A	1	10	Mediomastus ambiseta	29
06JUL98	A	2	3	Glycinde solitaria	1
06JUL98	A	2	3	Streblospio benedicti	5
06JUL98	A	2	3	Mulinia lateralis	1
06JUL98	A	2	3	Mediomastus ambiseta	9
06JUL98	A	2	10	Parandalia ocularis	1
06JUL98	A	2	10	Mediomastus ambiseta	22
06JUL98	A	3	3	Streblospio benedicti	5
06JUL98	A	3	3	Ampelisca abdita	1
06JUL98	A	3	3	Littoridina sphinctostoma	3
06JUL98	A	3	3	Mediomastus ambiseta	24
06JUL98	A	3	10	Mediomastus ambiseta	18
06JUL98	B	1	3	Streblospio benedicti	1
06JUL98	B	1	3	Mediomastus ambiseta	9
06JUL98	B	1	10	Glycinde solitaria	1
06JUL98	B	1	10	Mediomastus ambiseta	6
06JUL98	B	2	3	Mulinia lateralis	1
06JUL98	B	2	3	Mediomastus ambiseta	12
06JUL98	B	2	10	Mediomastus ambiseta	5
06JUL98	B	3	3	Streblospio benedicti	1
06JUL98	B	3	3	Mulinia lateralis	1
06JUL98	B	3	3	Mediomastus ambiseta	9
06JUL98	B	3	10	Mediomastus ambiseta	6
06JUL98	C	1	3	Rhynchocoela (unidentified)	1
06JUL98	C	1	3	Glycinde solitaria	1
06JUL98	C	1	3	Paraprionospio pinnata	1
06JUL98	C	1	3	Maldanidae (unidentified)	1
06JUL98	C	1	3	Mulinia lateralis	2
06JUL98	C	1	3	Tellina sp.	1
06JUL98	C	1	3	Phascolion strombi	1
06JUL98	C	1	3	Mysidopsis bahia	1
06JUL98	C	1	10	Rhynchocoela (unidentified)	1
06JUL98	C	1	10	Lumbrineris parvapedata	2
06JUL98	C	1	10	Cossura delta	5
06JUL98	C	1	10	Mediomastus ambiseta	6
06JUL98	C	2	3	Rhynchocoela (unidentified)	2
06JUL98	C	2	3	Lumbrineris parvapedata	1
06JUL98	C	2	3	Paraprionospio pinnata	3
06JUL98	C	2	3	Nuculana acuta	1

06JUL98	C	2	3	Monoculodes sp.	1
06JUL98	C	2	10	Paleanotus heteroseta	1
06JUL98	C	2	10	Ancistrosyllis jonesi	1
06JUL98	C	2	10	Ancistrosyllis papillosa	1
06JUL98	C	2	10	Sigambra bassi	3
06JUL98	C	2	10	Cossura delta	3
06JUL98	C	2	10	Mysella planulata	1
06JUL98	C	2	10	Asychis elongata	1
06JUL98	C	2	10	Mediomastus ambiseta	3
06JUL98	C	3	3	Glycinde solitaria	2
06JUL98	C	3	3	Paraprionospio pinnata	3
06JUL98	C	3	3	Scoloplos texana	1
06JUL98	C	3	3	Mulinia lateralis	2
06JUL98	C	3	3	Mediomastus ambiseta	3
06JUL98	C	3	10	Gyptis vittata	1
06JUL98	C	3	10	Lumbrineris parvapedata	1
06JUL98	C	3	10	Paraprionospio pinnata	1
06JUL98	C	3	10	Cossura delta	2
06JUL98	C	3	10	Mediomastus ambiseta	3
06JUL98	D	1	3	Ancistrosyllis jonesi	1
06JUL98	D	1	3	Paraprionospio pinnata	1
06JUL98	D	1	3	Minuspio cirrifera	1
06JUL98	D	1	3	Branchioasychis americana	1
06JUL98	D	1	3	Mediomastus ambiseta	2
06JUL98	D	1	10	Gyptis vittata	1
06JUL98	D	2	3	Rhynchocoela (unidentified)	1
06JUL98	D	2	3	Gyptis vittata	1
06JUL98	D	2	3	Minuspio cirrifera	1
06JUL98	D	2	3	Corbula contracta	1
06JUL98	D	2	3	Mediomastus ambiseta	2
06JUL98	D	2	10	Rhynchocoela (unidentified)	5
06JUL98	D	2	10	Oligochaetes (unidentified)	5
06JUL98	D	2	10	Ancistrosyllis jonesi	1
06JUL98	D	2	10	Lumbrineris parvapedata	1
06JUL98	D	2	10	Minuspio cirrifera	1
06JUL98	D	2	10	Cossura delta	1
06JUL98	D	2	10	Ophiuroidea (unidentified)	1
06JUL98	D	2	10	Apseudes sp. A	2
06JUL98	D	2	10	Periploma cf. orbiculare	1
06JUL98	D	3	3	Cossura delta	1
06JUL98	D	3	3	Ogyrides limicola	1
06JUL98	D	3	3	Phascolion strombi	1
06JUL98	D	3	3	Mediomastus ambiseta	1
06JUL98	D	3	10	Diopatra cuprea	1
06JUL98	D	3	10	Periploma margaritaceum	1
06JUL98	D	3	10	Pilargiidae (unidentified)	1
06JUL98	D	3	10	Ophiuroidea (unidentified)	1
06JUL98	E	1	3	Paraprionospio pinnata	1
06JUL98	E	1	3	Eulimostoma sp.	1
06JUL98	E	1	3	Mediomastus ambiseta	1
06JUL98	E	1	10	Sigambra tentaculata	1

06JUL98	E	1	10	Cossura delta	2
06JUL98	E	2	3	No species observed	0
06JUL98	E	2	10	Polydora caulleryi	1
06JUL98	E	2	10	Paraprionospio pinnata	1
06JUL98	E	2	10	Cossura delta	1
06JUL98	E	3	3	Paraprionospio pinnata	1
06JUL98	E	3	3	Mediomastus ambiseta	1
06JUL98	E	3	10	Polydora caulleryi	2
06JUL98	E	3	10	Minuspio cirrifera	1
06JUL98	E	3	10	Cossura delta	1
06JUL98	E	3	10	Ophiuroidea (unidentified)	1
06JUL98	F	1	3	Rhynchocoela (unidentified)	1
06JUL98	F	1	3	Paraprionospio pinnata	4
06JUL98	F	1	3	Edotea montosa	1
06JUL98	F	1	3	Mediomastus ambiseta	20
06JUL98	F	1	10	Rhynchocoela (unidentified)	1
06JUL98	F	1	10	Gyptis vittata	1
06JUL98	F	1	10	Mediomastus ambiseta	6
06JUL98	F	2	3	Rhynchocoela (unidentified)	1
06JUL98	F	2	3	Caecum johnsoni	1
06JUL98	F	2	3	Mediomastus ambiseta	11
06JUL98	F	2	10	Rhynchocoela (unidentified)	1
06JUL98	F	2	10	Paraprionospio pinnata	1
06JUL98	F	2	10	Cossura delta	1
06JUL98	F	2	10	Caecum johnsoni	1
06JUL98	F	2	10	Mediomastus ambiseta	6
06JUL98	F	3	3	Paraprionospio pinnata	1
06JUL98	F	3	3	Mediomastus ambiseta	12
06JUL98	F	3	10	Gyptis vittata	1
06JUL98	F	3	10	Mediomastus ambiseta	3
12OCT98	A	1	3	Streblospio benedicti	5
12OCT98	A	1	3	Mediomastus ambiseta	12
12OCT98	A	1	10	Mediomastus ambiseta	21
12OCT98	A	2	3	Streblospio benedicti	6
12OCT98	A	2	3	Mediomastus ambiseta	4
12OCT98	A	2	10	Rhynchocoela (unidentified)	1
12OCT98	A	2	10	Mediomastus ambiseta	14
12OCT98	A	3	3	Streblospio benedicti	9
12OCT98	A	3	3	Ostracoda (unidentified)	1
12OCT98	A	3	3	Mediomastus ambiseta	1
12OCT98	A	3	10	Streblospio benedicti	3
12OCT98	A	3	10	Mediomastus ambiseta	40
12OCT98	B	1	3	Streblospio benedicti	7
12OCT98	B	1	10	Streblospio benedicti	6
12OCT98	B	1	10	Mediomastus ambiseta	13
12OCT98	B	2	3	Streblospio benedicti	13
12OCT98	B	2	10	Rhynchocoela (unidentified)	1
12OCT98	B	2	10	Streblospio benedicti	3
12OCT98	B	2	10	Mediomastus ambiseta	14
12OCT98	B	3	3	Streblospio benedicti	17
12OCT98	B	3	3	Mediomastus ambiseta	6

12OCT98	B	3	10	Streblospio benedicti	4
12OCT98	B	3	10	Mediomastus ambiseta	3
12OCT98	C	1	3	Diopatra cuprea	1
12OCT98	C	1	3	Streblospio benedicti	3
12OCT98	C	1	3	Paraprionospio pinnata	1
12OCT98	C	1	3	Maldanidae (unidentified)	1
12OCT98	C	1	3	Nuculana acuta	1
12OCT98	C	1	3	Acteocina canaliculata	1
12OCT98	C	1	3	Mediomastus ambiseta	15
12OCT98	C	1	10	Paraprionospio pinnata	1
12OCT98	C	1	10	Spiochaetopterus costarum	1
12OCT98	C	1	10	Haploscoloplos fragilis	1
12OCT98	C	1	10	Cossura delta	2
12OCT98	C	1	10	Mediomastus ambiseta	6
12OCT98	C	2	3	Gyptis vittata	2
12OCT98	C	2	3	Streblospio benedicti	6
12OCT98	C	2	3	Maldanidae (unidentified)	1
12OCT98	C	2	3	Mediomastus ambiseta	5
12OCT98	C	2	10	Lumbrineris parvapedata	1
12OCT98	C	2	10	Paraprionospio pinnata	1
12OCT98	C	2	10	Tharyx setigera	1
12OCT98	C	2	10	Mediomastus ambiseta	6
12OCT98	C	3	3	Streblospio benedicti	17
12OCT98	C	3	3	Paraprionospio pinnata	1
12OCT98	C	3	3	Nuculana acuta	1
12OCT98	C	3	3	Mediomastus ambiseta	9
12OCT98	C	3	10	Rhynchocoela (unidentified)	1
12OCT98	C	3	10	Cossura delta	3
12OCT98	C	3	10	Mediomastus ambiseta	12
12OCT98	D	1	3	Streblospio benedicti	6
12OCT98	D	1	3	Cossura delta	4
12OCT98	D	1	3	Periploma cf. orbiculare	1
12OCT98	D	1	3	Mediomastus ambiseta	2
12OCT98	D	1	10	Rhynchocoela (unidentified)	2
12OCT98	D	1	10	Periploma margaritaceum	4
12OCT98	D	1	10	Mediomastus ambiseta	2
12OCT98	D	2	3	Streblospio benedicti	6
12OCT98	D	2	3	Cossura delta	1
12OCT98	D	2	3	Apseudes sp. A	12
12OCT98	D	2	3	Mediomastus ambiseta	1
12OCT98	D	2	3	Eudorella sp.	1
12OCT98	D	2	10	Oligochaetes (unidentified)	3
12OCT98	D	2	10	Sigambra tentaculata	1
12OCT98	D	2	10	Gyptis vittata	1
12OCT98	D	2	10	Minuspio cirrifera	6
12OCT98	D	2	10	Periploma margaritaceum	5
12OCT98	D	2	10	Ophiuroidea (unidentified)	1
12OCT98	D	2	10	Apseudes sp. A	2
12OCT98	D	2	10	Malmgreniella taylori	1
12OCT98	D	3	3	Rhynchocoela (unidentified)	2
12OCT98	D	3	3	Streblospio benedicti	5

12OCT98	D	3	3	Cossura delta	3
12OCT98	D	3	3	Apseudes sp. A	1
12OCT98	D	3	3	Mediomastus ambiseta	3
12OCT98	D	3	10	Rhynchocoela (unidentified)	1
12OCT98	D	3	10	Oligochaetes (unidentified)	2
12OCT98	D	3	10	Cossura delta	5
12OCT98	D	3	10	Periploma margaritaceum	10
12OCT98	D	3	10	Ophiuroidea (unidentified)	1
12OCT98	D	3	10	Mediomastus ambiseta	4
12OCT98	D	3	10	Malmgreniella taylori	1
12OCT98	E	1	3	Polydora caulleryi	8
12OCT98	E	1	3	Streblospio benedicti	7
12OCT98	E	1	3	Paraprionospio pinnata	1
12OCT98	E	1	3	Spiochaetopterus costarum	1
12OCT98	E	1	3	Cossura delta	3
12OCT98	E	1	3	Mediomastus ambiseta	1
12OCT98	E	1	10	Sigambra tentaculata	1
12OCT98	E	1	10	Gyptis vittata	1
12OCT98	E	1	10	Glycinde solitaria	1
12OCT98	E	1	10	Polydora caulleryi	60
12OCT98	E	1	10	Paraprionospio pinnata	3
12OCT98	E	1	10	Spiochaetopterus costarum	1
12OCT98	E	1	10	Cossura delta	1
12OCT98	E	1	10	Mediomastus ambiseta	7
12OCT98	E	1	10	Aricidea bryani	1
12OCT98	E	2	3	Polydora caulleryi	1
12OCT98	E	2	3	Streblospio benedicti	18
12OCT98	E	2	3	Paraprionospio pinnata	1
12OCT98	E	2	3	Mediomastus ambiseta	4
12OCT98	E	2	10	Paraprionospio pinnata	2
12OCT98	E	2	10	Cossura delta	3
12OCT98	E	2	10	Mediomastus ambiseta	2
12OCT98	E	2	10	Aricidea bryani	1
12OCT98	E	3	3	Rhynchocoela (unidentified)	1
12OCT98	E	3	3	Gyptis vittata	1
12OCT98	E	3	3	Polydora caulleryi	7
12OCT98	E	3	3	Streblospio benedicti	6
12OCT98	E	3	3	Paraprionospio pinnata	1
12OCT98	E	3	3	Scolelepis texana	1
12OCT98	E	3	3	Mulinia lateralis	2
12OCT98	E	3	3	Mediomastus ambiseta	3
12OCT98	E	3	3	Aricidea bryani	1
12OCT98	E	3	10	Sigambra tentaculata	1
12OCT98	E	3	10	Gyptis vittata	2
12OCT98	E	3	10	Polydora caulleryi	14
12OCT98	E	3	10	Paraprionospio pinnata	1
12OCT98	E	3	10	Cossura delta	1
12OCT98	E	3	10	Mediomastus ambiseta	14
12OCT98	E	3	10	Aricidea bryani	1
12OCT98	F	1	3	Glycinde solitaria	1
12OCT98	F	1	3	Streblospio benedicti	3

12OCT98	F	1	3	Paraprionospio pinnata	1
12OCT98	F	1	3	Turbellaria (unidentified)	1
12OCT98	F	1	3	Mediomastus ambiseta	4
12OCT98	F	1	10	Sigambra bassi	1
12OCT98	F	1	10	Mediomastus ambiseta	3
12OCT98	F	2	3	Streblospio benedicti	1
12OCT98	F	2	3	Mediomastus ambiseta	1
12OCT98	F	2	10	Mediomastus ambiseta	2
12OCT98	F	3	3	Streblospio benedicti	4
12OCT98	F	3	3	Mediomastus ambiseta	9
12OCT98	F	3	10	Mediomastus ambiseta	3
05JAN99	A	1	3	Rhynchocoela (unidentified)	1
05JAN99	A	1	3	Streblospio benedicti	3
05JAN99	A	1	3	Mediomastus ambiseta	16
05JAN99	A	1	10	No species observed	0
05JAN99	A	2	3	Streblospio benedicti	2
05JAN99	A	2	3	Hobsonia florida	1
05JAN99	A	2	3	Mediomastus ambiseta	11
05JAN99	A	2	10	No species observed	0
05JAN99	A	3	3	Streblospio benedicti	6
05JAN99	A	3	3	Mediomastus ambiseta	10
05JAN99	A	3	10	Mediomastus ambiseta	2
05JAN99	B	1	3	Rhynchocoela (unidentified)	1
05JAN99	B	1	3	Polinices duplicatus	1
05JAN99	B	1	3	Parandalia ocularis	1
05JAN99	B	1	3	Mediomastus ambiseta	2
05JAN99	B	1	10	No species observed	0
05JAN99	B	2	3	Streblospio benedicti	1
05JAN99	B	2	3	Parandalia ocularis	1
05JAN99	B	2	3	Mediomastus ambiseta	8
05JAN99	B	2	10	Rhynchocoela (unidentified)	1
05JAN99	B	3	3	Rhynchocoela (unidentified)	1
05JAN99	B	3	3	Mediomastus ambiseta	4
05JAN99	B	3	10	No species observed	0
05JAN99	C	1	3	Lumbrineris parvapedata	1
05JAN99	C	1	3	Streblospio benedicti	1
05JAN99	C	1	3	Spiochaetopterus costarum	1
05JAN99	C	1	3	Aligena texasiana	1
05JAN99	C	1	3	Mulinia lateralis	1
05JAN99	C	1	3	Parandalia ocularis	1
05JAN99	C	1	3	Mediomastus ambiseta	10
05JAN99	C	1	10	Rhynchocoela (unidentified)	2
05JAN99	C	1	10	Sigambra tentaculata	2
05JAN99	C	1	10	Paraonides lyra	1
05JAN99	C	1	10	Parandalia ocularis	1
05JAN99	C	1	10	Mediomastus ambiseta	6
05JAN99	C	2	3	Streblospio benedicti	8
05JAN99	C	2	3	Mulinia lateralis	2
05JAN99	C	2	3	Eulimostoma sp.	1
05JAN99	C	2	3	Mediomastus ambiseta	2
05JAN99	C	2	3	Euclymene sp. B	1

05JAN99	C	2	10	Sigambra bassi	1
05JAN99	C	2	10	Cossura delta	3
05JAN99	C	2	10	Mediomastus ambiseta	6
05JAN99	C	2	10	Euclymene sp. B	1
05JAN99	C	3	3	Rhynchocoela (unidentified)	1
05JAN99	C	3	3	Rhynchocoela (unidentified)	1
05JAN99	C	3	3	Mediomastus ambiseta	3
05JAN99	C	3	10	Rhynchocoela (unidentified)	1
05JAN99	C	3	10	Paraprionospio pinnata	1
05JAN99	C	3	10	Cossura delta	3
05JAN99	C	3	10	Mediomastus ambiseta	8
05JAN99	D	1	3	Oligochaetes (unidentified)	6
05JAN99	D	1	3	Gyptis vittata	1
05JAN99	D	1	3	Streblospio benedicti	3
05JAN99	D	1	3	Periploma margaritaceum	2
05JAN99	D	1	3	Phoronis architecta	1
05JAN99	D	1	10	Rhynchocoela (unidentified)	3
05JAN99	D	1	10	Oligochaetes (unidentified)	5
05JAN99	D	1	10	Cossura delta	2
05JAN99	D	1	10	Periploma margaritaceum	2
05JAN99	D	1	10	Ophiuroidea (unidentified)	1
05JAN99	D	1	10	Apseudes sp. A	2
05JAN99	D	1	10	Naineris sp. A	2
05JAN99	D	1	10	Mediomastus ambiseta	1
05JAN99	D	2	3	Oligochaetes (unidentified)	3
05JAN99	D	2	3	Sigambra tentaculata	1
05JAN99	D	2	3	Glycera americana	1
05JAN99	D	2	3	Glycinde solitaria	1
05JAN99	D	2	3	Streblospio benedicti	7
05JAN99	D	2	3	Paraprionospio pinnata	1
05JAN99	D	2	3	Cossura delta	1
05JAN99	D	2	3	Aligena texasiana	2
05JAN99	D	2	3	Periploma margaritaceum	2
05JAN99	D	2	3	Apseudes sp. A	2
05JAN99	D	2	10	Rhynchocoela (unidentified)	1
05JAN99	D	2	10	Oligochaetes (unidentified)	9
05JAN99	D	2	10	Sigambra tentaculata	2
05JAN99	D	2	10	Gyptis vittata	1
05JAN99	D	2	10	Minuspio cirrifera	1
05JAN99	D	2	10	Corbula contracta	1
05JAN99	D	2	10	Periploma margaritaceum	22
05JAN99	D	2	10	Ophiuroidea (unidentified)	1
05JAN99	D	2	10	Apseudes sp. A	4
05JAN99	D	2	10	Naineris sp. A	2
05JAN99	D	2	10	Mediomastus ambiseta	1
05JAN99	D	2	10	Malmgreniella taylori	1
05JAN99	D	3	3	Glycinde solitaria	1
05JAN99	D	3	3	Streblospio benedicti	5
05JAN99	D	3	3	Periploma margaritaceum	1
05JAN99	D	3	3	Mediomastus ambiseta	2
05JAN99	D	3	10	Streblospio benedicti	3

05JAN99	D	3	10	Minuspio cirrifera	2
05JAN99	D	3	10	Periploma margaritaceum	4
05JAN99	D	3	10	Ophiuroidea (unidentified)	1
05JAN99	D	3	10	Naineris sp. A	1
05JAN99	D	3	10	Mediomastus ambiseta	3
05JAN99	E	1	3	Sigambra tentaculata	1
05JAN99	E	1	3	Gyptis vittata	3
05JAN99	E	1	3	Polydora caulleryi	1
05JAN99	E	1	3	Streblospio benedicti	3
05JAN99	E	1	3	Cossura delta	2
05JAN99	E	1	3	Mediomastus ambiseta	1
05JAN99	E	1	10	Paraprionospio pinnata	2
05JAN99	E	1	10	Apoprionospio pygmaea	2
05JAN99	E	1	10	Cossura delta	2
05JAN99	E	1	10	Mediomastus ambiseta	1
05JAN99	E	2	3	Rhynchocoela (unidentified)	1
05JAN99	E	2	3	Glycinde solitaria	1
05JAN99	E	2	3	Polydora caulleryi	3
05JAN99	E	2	3	Streblospio benedicti	1
05JAN99	E	2	3	Cossura delta	1
05JAN99	E	2	3	Ampelisca abdita	1
05JAN99	E	2	10	Apoprionospio pygmaea	1
05JAN99	E	2	10	Spiochaetopterus costarum	1
05JAN99	E	2	10	Cossura delta	4
05JAN99	E	2	10	Mediomastus ambiseta	2
05JAN99	E	3	3	Rhynchocoela (unidentified)	1
05JAN99	E	3	3	Ancistrosyllis jonesi	1
05JAN99	E	3	3	Gyptis vittata	1
05JAN99	E	3	3	Glycinde solitaria	1
05JAN99	E	3	3	Polydora caulleryi	14
05JAN99	E	3	3	Streblospio benedicti	3
05JAN99	E	3	10	Rhynchocoela (unidentified)	1
05JAN99	E	3	10	Gyptis vittata	2
05JAN99	E	3	10	Polydora caulleryi	7
05JAN99	E	3	10	Paraprionospio pinnata	1
05JAN99	E	3	10	Apoprionospio pygmaea	1
05JAN99	E	3	10	Spiochaetopterus costarum	1
05JAN99	E	3	10	Mediomastus ambiseta	1
05JAN99	F	1	3	Polydora sp.	1
05JAN99	F	1	3	Streblospio benedicti	6
05JAN99	F	1	3	Mediomastus ambiseta	32
05JAN99	F	1	10	Mediomastus ambiseta	9
05JAN99	F	2	3	Streblospio benedicti	1
05JAN99	F	2	3	Mediomastus ambiseta	27
05JAN99	F	2	10	Mediomastus ambiseta	1
05JAN99	F	3	3	Streblospio benedicti	7
05JAN99	F	3	3	Ostracoda (unidentified)	1
05JAN99	F	3	3	Macoma mitchelli	1
05JAN99	F	3	3	Mediomastus ambiseta	22
05JAN99	F	3	10	Mediomastus ambiseta	3

06APR99	A	1	3	Rhynchocoela (unidentified)	2
06APR99	A	1	3	Streblospio benedicti	2
06APR99	A	1	3	Capitella capitata	1
06APR99	A	1	3	Ampelisca abdita	1
06APR99	A	1	3	Mediomastus ambiseta	2
06APR99	A	1	10	Mediomastus ambiseta	1
06APR99	A	2	3	Rhynchocoela (unidentified)	3
06APR99	A	2	3	Streblospio benedicti	5
06APR99	A	2	3	Mediomastus ambiseta	12
06APR99	A	2	10	Rhynchocoela (unidentified)	1
06APR99	A	2	10	Parandalia ocularis	3
06APR99	A	2	10	Mediomastus ambiseta	5
06APR99	A	3	3	Rhynchocoela (unidentified)	1
06APR99	A	3	3	Streblospio benedicti	6
06APR99	A	3	3	Littoridina sphinctostoma	1
06APR99	A	3	3	Mediomastus ambiseta	5
06APR99	B	1	3	Rhynchocoela (unidentified)	1
06APR99	B	1	3	Glycinde solitaria	1
06APR99	B	1	3	Mediomastus ambiseta	5
06APR99	B	1	10	Mediomastus ambiseta	1
06APR99	B	2	3	Streblospio benedicti	1
06APR99	B	2	3	Mulinia lateralis	1
06APR99	B	2	3	Ostracoda (unidentified)	1
06APR99	B	2	3	Mediomastus ambiseta	8
06APR99	B	2	10	Rhynchocoela (unidentified)	1
06APR99	B	2	10	Mediomastus ambiseta	7
06APR99	B	3	3	Streblospio benedicti	4
06APR99	B	3	3	Ostracoda (unidentified)	1
06APR99	B	3	3	Mediomastus ambiseta	7
06APR99	B	3	10	Glycinde solitaria	1
06APR99	B	3	10	Cossura delta	1
06APR99	B	3	10	Mediomastus ambiseta	2
06APR99	C	1	3	Mediomastus ambiseta	1
06APR99	C	1	10	Mediomastus ambiseta	1
06APR99	C	2	3	Mediomastus ambiseta	1
06APR99	C	2	10	Glycinde solitaria	1
06APR99	C	2	10	Paraprionospio pinnata	1
06APR99	C	2	10	Pilargiidae (unidentified)	1
06APR99	C	2	10	Mediomastus ambiseta	3
06APR99	C	3	3	Cyclaspis varians	1
06APR99	C	3	3	Mediomastus ambiseta	1
06APR99	C	3	10	Cossura delta	1
06APR99	C	3	10	Mediomastus ambiseta	2
06APR99	D	1	3	Ancistrosyllis jonesi	1
06APR99	D	1	3	Cossura delta	1
06APR99	D	1	3	Nuculana acuta	1
06APR99	D	1	3	Abra aequalis	1
06APR99	D	1	3	Corbula contracta	1
06APR99	D	1	3	Apseudes sp. A	2
06APR99	D	1	3	Mediomastus ambiseta	1
06APR99	D	1	10	Rhynchocoela (unidentified)	1

06APR99	D	1	10	Oligochaetes (unidentified)	4
06APR99	D	1	10	Ancistrosyllis jonesi	1
06APR99	D	1	10	Gyptis vittata	1
06APR99	D	1	10	Diopatra cuprea	1
06APR99	D	1	10	Minuspio cirrifera	4
06APR99	D	1	10	Paraonides lyra	1
06APR99	D	1	10	Lepton sp.	4
06APR99	D	1	10	Abra aequalis	1
06APR99	D	1	10	Corbula contracta	1
06APR99	D	1	10	Ophiuroidea (unidentified)	1
06APR99	D	1	10	Apseudes sp. A	2
06APR99	D	1	10	Naineris sp. A	1
06APR99	D	1	10	Mediomastus ambiseta	2
06APR99	D	2	3	Rhynchocoela (unidentified)	1
06APR99	D	2	3	Gyptis vittata	1
06APR99	D	2	3	Glycinde solitaria	1
06APR99	D	2	3	Paraprionospio pinnata	2
06APR99	D	2	3	Corbula contracta	1
06APR99	D	2	3	Schizocardium sp.	1
06APR99	D	2	3	Armandia maculata	1
06APR99	D	2	3	Apseudes sp. A	49
06APR99	D	2	3	Mediomastus ambiseta	2
06APR99	D	2	10	Rhynchocoela (unidentified)	2
06APR99	D	2	10	Oligochaetes (unidentified)	5
06APR99	D	2	10	Sigambra tentaculata	2
06APR99	D	2	10	Polydora caulleryi	3
06APR99	D	2	10	Cossura delta	2
06APR99	D	2	10	Lepton sp.	4
06APR99	D	2	10	Abra aequalis	1
06APR99	D	2	10	Corbula contracta	1
06APR99	D	2	10	Phoronis architecta	1
06APR99	D	2	10	Ophiuroidea (unidentified)	2
06APR99	D	2	10	Apseudes sp. A	32
06APR99	D	2	10	Mediomastus ambiseta	4
06APR99	D	3	3	Anthozoa (unidentified)	1
06APR99	D	3	3	Polydora caulleryi	1
06APR99	D	3	3	Paraprionospio pinnata	1
06APR99	D	3	3	Tharyx setigera	1
06APR99	D	3	3	Corbula contracta	3
06APR99	D	3	3	Schizocardium sp.	3
06APR99	D	3	3	Ophiuroidea (unidentified)	1
06APR99	D	3	3	Apseudes sp. A	24
06APR99	D	3	3	Mediomastus ambiseta	2
06APR99	D	3	3	Eudorella sp.	1
06APR99	D	3	10	Rhynchocoela (unidentified)	1
06APR99	D	3	10	Glycinde solitaria	1
06APR99	D	3	10	Lepton sp.	6
06APR99	D	3	10	Corbula contracta	1
06APR99	D	3	10	Ophiuroidea (unidentified)	1
06APR99	D	3	10	Apseudes sp. A	26
06APR99	D	3	10	Mediomastus ambiseta	1

06APR99	E	1	3	Gyptis vittata	1
06APR99	E	1	3	Spiochaetopterus costarum	1
06APR99	E	1	3	Melinna maculata	1
06APR99	E	1	3	Schizocardium sp.	3
06APR99	E	1	3	Mediomastus ambiseta	2
06APR99	E	1	10	Haploscoloplos fragilis	1
06APR99	E	1	10	Cossura delta	4
06APR99	E	1	10	Mediomastus ambiseta	2
06APR99	E	1	10	Aricidea bryani	1
06APR99	E	2	3	Spiochaetopterus costarum	1
06APR99	E	2	3	Haploscoloplos fragilis	1
06APR99	E	2	3	Ogyrides limicola	1
06APR99	E	2	3	Schizocardium sp.	3
06APR99	E	2	3	Nereidae (unidentified)	1
06APR99	E	2	3	Turbellaria (unidentified)	1
06APR99	E	2	3	Apseudes sp. A	1
06APR99	E	2	3	Mediomastus ambiseta	2
06APR99	E	2	10	Gyptis vittata	1
06APR99	E	2	10	Paraprionospio pinnata	2
06APR99	E	2	10	Haploscoloplos fragilis	1
06APR99	E	2	10	Cossura delta	3
06APR99	E	2	10	Schizocardium sp.	1
06APR99	E	2	10	Ophiuroidea (unidentified)	1
06APR99	E	2	10	Mediomastus ambiseta	3
06APR99	E	2	10	Malmgreniella taylori	1
06APR99	E	2	10	Aricidea bryani	1
06APR99	E	3	3	Rhynchocoela (unidentified)	1
06APR99	E	3	3	Oligochaetes (unidentified)	1
06APR99	E	3	3	Spiochaetopterus costarum	1
06APR99	E	3	3	Haploscoloplos fragilis	1
06APR99	E	3	3	Cossura delta	1
06APR99	E	3	3	Phoronis architecta	1
06APR99	E	3	3	Schizocardium sp.	6
06APR99	E	3	3	Eulimostoma sp.	1
06APR99	E	3	3	Mediomastus ambiseta	3
06APR99	E	3	10	Glycinde solitaria	1
06APR99	E	3	10	Polydora caulleryi	1
06APR99	E	3	10	Paraprionospio pinnata	1
06APR99	E	3	10	Cossura delta	3
06APR99	E	3	10	Schizocardium sp.	1
06APR99	E	3	10	Nuculana concentrica	1
06APR99	E	3	10	Turbellaria (unidentified)	1
06APR99	E	3	10	Caecum johnsoni	1
06APR99	E	3	10	Mediomastus ambiseta	2
06APR99	E	3	10	Aricidea bryani	1
06APR99	F	1	3	Streblospio benedicti	2
06APR99	F	1	3	Ampelisca abdita	7
06APR99	F	1	3	Mediomastus ambiseta	30
06APR99	F	1	10	Cossura delta	1
06APR99	F	1	10	Caecum johnsoni	1
06APR99	F	1	10	Mediomastus ambiseta	4

06APR99	F	2	3	Streblospio benedicti	6
06APR99	F	2	3	Haploscoloplos fragilis	1
06APR99	F	2	3	Ostracoda (unidentified)	2
06APR99	F	2	3	Ampelisca abdita	8
06APR99	F	2	3	Mediomastus ambiseta	22
06APR99	F	2	10	Mediomastus ambiseta	25
06APR99	F	3	3	Rhynchocoela (unidentified)	1
06APR99	F	3	3	Streblospio benedicti	7
06APR99	F	3	3	Ostracoda (unidentified)	1
06APR99	F	3	3	Ampelisca abdita	1
06APR99	F	3	3	Eulimostoma sp.	1
06APR99	F	3	3	Mediomastus ambiseta	18
06APR99	F	3	10	Rhynchocoela (unidentified)	1
06APR99	F	3	10	Mediomastus ambiseta	22

Guadalupe Estuary

Date	Station	Replicate	Section	Species	n
07JUL98	A	1	3	Streblospio benedicti	10
07JUL98	A	1	3	Mulinia lateralis	3
07JUL98	A	1	3	Rangia cuneata	5
07JUL98	A	1	3	Callianassa sp.	1
07JUL98	A	1	3	Littoridina sphinctostoma	38
07JUL98	A	1	10	Littoridina sphinctostoma	1
07JUL98	A	1	10	Parandalia ocularis	2
07JUL98	A	1	10	Mediomastus ambiseta	1
07JUL98	A	2	3	Polydora sp.	1
07JUL98	A	2	3	Streblospio benedicti	4
07JUL98	A	2	3	Mulinia lateralis	7
07JUL98	A	2	3	Monoculodes sp.	1
07JUL98	A	2	3	Chironomid larvae	1
07JUL98	A	2	3	Mysidopsis almyra	1
07JUL98	A	2	3	Rangia cuneata	10
07JUL98	A	2	3	Littoridina sphinctostoma	44
07JUL98	A	2	10	Streblospio benedicti	1
07JUL98	A	3	3	Streblospio benedicti	6
07JUL98	A	3	3	Mulinia lateralis	9
07JUL98	A	3	3	Monoculodes sp.	1
07JUL98	A	3	3	Rangia cuneata	4
07JUL98	A	3	3	Callianassa sp.	2
07JUL98	A	3	3	Littoridina sphinctostoma	14
07JUL98	A	3	10	Littoridina sphinctostoma	1
07JUL98	B	1	3	Rhynchocoela (unidentified)	1
07JUL98	B	1	3	Streblospio benedicti	4
07JUL98	B	1	3	Mysidopsis almyra	1
07JUL98	B	1	3	Littoridina sphinctostoma	9
07JUL98	B	1	3	Mediomastus ambiseta	25
07JUL98	B	1	10	No species observed	0
07JUL98	B	2	3	Streblospio benedicti	2

07JUL98	B	2	3	Littoridina sphinctostoma	6
07JUL98	B	2	3	Mediomastus ambiseta	15
07JUL98	B	2	10	Mediomastus ambiseta	2
07JUL98	B	3	3	Streblospio benedicti	10
07JUL98	B	3	3	Littoridina sphinctostoma	17
07JUL98	B	3	3	Mediomastus ambiseta	5
07JUL98	B	3	10	Mediomastus ambiseta	20
07JUL98	C	1	3	Streblospio benedicti	2
07JUL98	C	1	3	Maldanidae (unidentified)	1
07JUL98	C	1	3	Mulinia lateralis	1
07JUL98	C	1	3	Cyclaspis varians	1
07JUL98	C	1	3	Littoridina sphinctostoma	2
07JUL98	C	1	3	Mediomastus ambiseta	23
07JUL98	C	1	10	Caecum johnsoni	1
07JUL98	C	1	10	Mediomastus ambiseta	11
07JUL98	C	2	3	Streblospio benedicti	2
07JUL98	C	2	3	Mulinia lateralis	1
07JUL98	C	2	3	Littoridina sphinctostoma	3
07JUL98	C	2	3	Mediomastus ambiseta	16
07JUL98	C	2	10	Mediomastus ambiseta	3
07JUL98	C	3	3	Glycinde solitaria	1
07JUL98	C	3	3	Streblospio benedicti	4
07JUL98	C	3	3	Haploscoloplos fragilis	1
07JUL98	C	3	3	Cyclaspis varians	2
07JUL98	C	3	3	Littoridina sphinctostoma	5
07JUL98	C	3	3	Mediomastus ambiseta	34
07JUL98	C	3	10	Mediomastus ambiseta	11
07JUL98	D	1	3	Mulinia lateralis	1
07JUL98	D	1	3	Monoculodes sp.	1
07JUL98	D	1	3	Parandalia ocularis	1
07JUL98	D	1	3	Mediomastus ambiseta	13
07JUL98	D	1	10	Glycinde solitaria	1
07JUL98	D	1	10	Parandalia ocularis	1
07JUL98	D	1	10	Mediomastus ambiseta	3
07JUL98	D	2	3	Streblospio benedicti	2
07JUL98	D	2	3	Cyclaspis varians	1
07JUL98	D	2	3	Nereidae (unidentified)	1
07JUL98	D	2	3	Parandalia ocularis	1
07JUL98	D	2	3	Mediomastus ambiseta	14
07JUL98	D	2	10	Parandalia ocularis	4
07JUL98	D	2	10	Mediomastus ambiseta	1
07JUL98	D	3	3	Streblospio benedicti	1
07JUL98	D	3	3	Parandalia ocularis	1
07JUL98	D	3	3	Mediomastus ambiseta	11
07JUL98	D	3	10	Rhynchocoela (unidentified)	1
07JUL98	D	3	10	Haploscoloplos fragilis	1
07JUL98	D	3	10	Parandalia ocularis	1
07JUL98	D	3	10	Mediomastus ambiseta	3
13OCT98	A	1	3	Streblospio benedicti	7
13OCT98	A	1	3	Rangia cuneata	1
13OCT98	A	1	3	Callianassa sp.	1

13OCT98	A	1	3	Littoridina sphinctostoma	7
13OCT98	A	1	10	Parandalia ocularis	2
13OCT98	A	2	3	Rhynchocoela (unidentified)	1
13OCT98	A	2	3	Streblospio benedicti	10
13OCT98	A	2	3	Rangia cuneata	1
13OCT98	A	2	3	Littoridina sphinctostoma	5
13OCT98	A	2	3	Mediomastus ambiseta	6
13OCT98	A	2	10	Rhynchocoela (unidentified)	1
13OCT98	A	2	10	Parandalia ocularis	1
13OCT98	A	2	10	Mediomastus ambiseta	2
13OCT98	A	3	3	Rhynchocoela (unidentified)	1
13OCT98	A	3	3	Streblospio benedicti	10
13OCT98	A	3	3	Littoridina sphinctostoma	7
13OCT98	A	3	3	Mediomastus ambiseta	7
13OCT98	A	3	10	No species observed	0
13OCT98	B	1	3	Streblospio benedicti	8
13OCT98	B	1	3	Mediomastus ambiseta	11
13OCT98	B	1	10	Mediomastus ambiseta	13
13OCT98	B	2	3	Streblospio benedicti	17
13OCT98	B	2	3	Littoridina sphinctostoma	5
13OCT98	B	2	3	Mediomastus ambiseta	8
13OCT98	B	2	10	Mediomastus ambiseta	5
13OCT98	B	3	3	Streblospio benedicti	9
13OCT98	B	3	3	Mulinia lateralis	1
13OCT98	B	3	3	Littoridina sphinctostoma	2
13OCT98	B	3	3	Mediomastus ambiseta	3
13OCT98	B	3	10	Mediomastus ambiseta	12
13OCT98	C	1	3	Leucon sp.	1
13OCT98	C	1	3	Macoma mitchelli	1
13OCT98	C	1	3	Rictaxis punctostriatus	1
13OCT98	C	1	3	Mediomastus ambiseta	20
13OCT98	C	1	10	Rhynchocoela (unidentified)	1
13OCT98	C	1	10	Paraprionospio pinnata	1
13OCT98	C	1	10	Haploscoloplos fragilis	1
13OCT98	C	1	10	Mediomastus ambiseta	7
13OCT98	C	2	3	Gyptis vittata	1
13OCT98	C	2	3	Mediomastus ambiseta	22
13OCT98	C	2	10	Parandalia ocularis	2
13OCT98	C	2	10	Mediomastus ambiseta	16
13OCT98	C	3	3	Glycinde solitaria	1
13OCT98	C	3	3	Streblospio benedicti	2
13OCT98	C	3	3	Eulimostoma sp.	1
13OCT98	C	3	3	Mediomastus ambiseta	25
13OCT98	C	3	10	Rhynchocoela (unidentified)	1
13OCT98	C	3	10	Mediomastus ambiseta	4
13OCT98	D	1	3	Streblospio benedicti	1
13OCT98	D	1	3	Capitella capitata	1
13OCT98	D	1	3	Hemicyclops sp.	1
13OCT98	D	1	3	Mediomastus ambiseta	6
13OCT98	D	1	10	Hemicyclops sp.	3
13OCT98	D	2	3	Streblospio benedicti	1

13OCT98	D	2	3	Mulinia lateralis	1
13OCT98	D	2	3	Mediomastus ambiseta	6
13OCT98	D	2	10	Paraprionospio pinnata	1
13OCT98	D	2	10	Mediomastus ambiseta	1
13OCT98	D	3	3	Rhynchocoela (unidentified)	1
13OCT98	D	3	3	Streblospio benedicti	3
13OCT98	D	3	3	Cyclaspis varians	1
13OCT98	D	3	3	Nudibranchia (unidentified)	1
13OCT98	D	3	3	Parandalia ocularis	1
13OCT98	D	3	3	Mediomastus ambiseta	9
13OCT98	D	3	10	Spiochaetopterus costarum	2
13OCT98	D	3	10	Hemicyclops sp.	2
13OCT98	D	3	10	Mediomastus ambiseta	2
13OCT98	E	1	3	Rhynchocoela (unidentified)	1
13OCT98	E	1	3	Glycinde solitaria	1
13OCT98	E	1	3	Streblospio benedicti	2
13OCT98	E	1	3	Paraprionospio pinnata	2
13OCT98	E	1	3	Spiochaetopterus costarum	4
13OCT98	E	1	3	Mediomastus ambiseta	3
13OCT98	E	1	10	Rhynchocoela (unidentified)	1
13OCT98	E	1	10	Glycinde solitaria	1
13OCT98	E	1	10	Spiochaetopterus costarum	2
13OCT98	E	1	10	Parandalia ocularis	1
13OCT98	E	2	3	Rhynchocoela (unidentified)	1
13OCT98	E	2	3	Glycinde solitaria	1
13OCT98	E	2	3	Paraprionospio pinnata	1
13OCT98	E	2	3	Spiochaetopterus costarum	3
13OCT98	E	2	3	Mediomastus ambiseta	5
13OCT98	E	2	10	Spiochaetopterus costarum	4
13OCT98	E	2	10	Mediomastus ambiseta	1
13OCT98	E	3	3	Streblospio benedicti	1
13OCT98	E	3	3	Paraprionospio pinnata	1
13OCT98	E	3	3	Spiochaetopterus costarum	1
13OCT98	E	3	10	Spiochaetopterus costarum	2
13OCT98	E	3	10	Cossura delta	1
13OCT98	F	1	3	Streblospio benedicti	6
13OCT98	F	1	3	Periploma margaritaceum	1
13OCT98	F	1	3	Grandidierella bonnieroides	1
13OCT98	F	1	3	Mediomastus ambiseta	20
13OCT98	F	1	10	Rhynchocoela (unidentified)	1
13OCT98	F	1	10	Cossura delta	1
13OCT98	F	1	10	Aligena texasiana	2
13OCT98	F	1	10	Ophiuroidea (unidentified)	1
13OCT98	F	1	10	Mediomastus ambiseta	7
13OCT98	F	1	10	Euclymene sp. B	3
13OCT98	F	1	10	Malmgreniella taylori	1
13OCT98	F	2	3	Streblospio benedicti	2
13OCT98	F	2	10	Gyptis vittata	1
13OCT98	F	2	10	Cossura delta	1
13OCT98	F	2	10	Mediomastus ambiseta	7
13OCT98	F	2	10	Euclymene sp. B	3

13OCT98	F	3	3	Streblospio benedicti	3
13OCT98	F	3	3	Mediomastus ambiseta	7
13OCT98	F	3	10	Paraprionospio pinnata	1
13OCT98	F	3	10	Mediomastus ambiseta	6
13OCT98	F	3	10	Euclymene sp. B	2
06JAN99	A	1	3	Mulinia lateralis	1
06JAN99	A	1	3	Chironomid larvae	1
06JAN99	A	1	3	Rangia cuneata	1
06JAN99	A	1	3	Littoridina sphinctostoma	13
06JAN99	A	1	3	Mediomastus ambiseta	2
06JAN99	A	1	10	Mediomastus ambiseta	1
06JAN99	A	2	3	Littoridina sphinctostoma	16
06JAN99	A	2	3	Mediomastus ambiseta	2
06JAN99	A	2	10	No species observed	0
06JAN99	A	3	3	Littoridina sphinctostoma	25
06JAN99	A	3	10	Rhynchocoela (unidentified)	1
06JAN99	A	3	10	Mediomastus ambiseta	1
06JAN99	B	1	3	Littoridina sphinctostoma	16
06JAN99	B	1	10	Rhynchocoela (unidentified)	1
06JAN99	B	1	10	Mediomastus ambiseta	1
06JAN99	B	2	3	Rhynchocoela (unidentified)	2
06JAN99	B	2	3	Littoridina sphinctostoma	6
06JAN99	B	2	3	Mediomastus ambiseta	1
06JAN99	B	2	10	Rhynchocoela (unidentified)	2
06JAN99	B	2	10	Oligochaetes (unidentified)	1
06JAN99	B	2	10	Mediomastus ambiseta	3
06JAN99	B	3	3	Littoridina sphinctostoma	10
06JAN99	B	3	3	Mediomastus ambiseta	8
06JAN99	B	3	10	Rhynchocoela (unidentified)	1
06JAN99	B	3	10	Capitella capitata	2
06JAN99	C	1	3	Mediomastus ambiseta	5
06JAN99	C	1	10	No species observed	0
06JAN99	C	2	3	Mediomastus ambiseta	13
06JAN99	C	2	10	Mediomastus ambiseta	2
06JAN99	C	3	3	Mediomastus ambiseta	7
06JAN99	C	3	10	Mediomastus ambiseta	1
06JAN99	D	1	3	Streblospio benedicti	1
06JAN99	D	1	3	Mediomastus ambiseta	10
06JAN99	D	1	10	No species observed	0
06JAN99	D	2	3	Streblospio benedicti	1
06JAN99	D	2	3	Mediomastus ambiseta	16
06JAN99	D	2	10	No species observed	0
06JAN99	D	3	3	Rhynchocoela (unidentified)	1
06JAN99	D	3	3	Streblospio benedicti	1
06JAN99	D	3	3	Parandalia ocularis	1
06JAN99	D	3	3	Mediomastus ambiseta	6
06JAN99	D	3	10	No species observed	0
07APR99	A	1	3	Chironomid larvae	1
07APR99	A	1	3	Mysidopsis almyra	1
07APR99	A	1	3	Rangia cuneata	7
07APR99	A	1	3	Callianassa sp.	1

07APR99	A	1	3	Littoridina sphinctostoma	10
07APR99	A	1	3	Parandalia ocularis	1
07APR99	A	1	3	Mediomastus ambiseta	2
07APR99	A	1	10	Chironomid larvae	1
07APR99	A	1	10	Littoridina sphinctostoma	4
07APR99	A	1	10	Mediomastus ambiseta	1
07APR99	A	2	3	Mulinia lateralis	2
07APR99	A	2	3	Chironomid larvae	1
07APR99	A	2	3	Rangia cuneata	10
07APR99	A	2	3	Littoridina sphinctostoma	3
07APR99	A	2	3	Mediomastus ambiseta	7
07APR99	A	2	10	No species observed	0
07APR99	A	3	3	Mulinia lateralis	1
07APR99	A	3	3	Mysidopsis almyra	1
07APR99	A	3	3	Rangia cuneata	5
07APR99	A	3	3	Littoridina sphinctostoma	9
07APR99	A	3	3	Mediomastus ambiseta	1
07APR99	A	3	10	Chironomid larvae	1
07APR99	A	3	10	Littoridina sphinctostoma	1
07APR99	A	3	10	Mediomastus ambiseta	1
07APR99	B	1	3	Rhynchocoela (unidentified)	1
07APR99	B	1	3	Mulinia lateralis	2
07APR99	B	1	3	Littoridina sphinctostoma	9
07APR99	B	1	3	Mediomastus ambiseta	6
07APR99	B	1	10	Rhynchocoela (unidentified)	1
07APR99	B	2	3	Mulinia lateralis	1
07APR99	B	2	3	Littoridina sphinctostoma	2
07APR99	B	2	3	Mediomastus ambiseta	2
07APR99	B	2	10	Mediomastus ambiseta	1
07APR99	B	3	3	Streblospio benedicti	2
07APR99	B	3	3	Mulinia lateralis	1
07APR99	B	3	3	Mediomastus ambiseta	1
07APR99	B	3	10	Mediomastus ambiseta	2
07APR99	C	1	3	Streblospio benedicti	2
07APR99	C	1	3	Mulinia lateralis	3
07APR99	C	1	3	Mediomastus ambiseta	11
07APR99	C	1	10	Rhynchocoela (unidentified)	1
07APR99	C	1	10	Mediomastus ambiseta	6
07APR99	C	2	3	Rhynchocoela (unidentified)	1
07APR99	C	2	3	Streblospio benedicti	13
07APR99	C	2	3	Mulinia lateralis	1
07APR99	C	2	3	Mediomastus ambiseta	10
07APR99	C	2	10	Rhynchocoela (unidentified)	1
07APR99	C	2	10	Mediomastus ambiseta	14
07APR99	C	3	3	Streblospio benedicti	4
07APR99	C	3	3	Mulinia lateralis	2
07APR99	C	3	3	Mediomastus ambiseta	8
07APR99	C	3	10	Capitella capitata	1
07APR99	C	3	10	Mediomastus ambiseta	12
07APR99	D	1	3	Neanthes succinea	1
07APR99	D	1	3	Streblospio benedicti	6

07APR99	D	1	3	Mediomastus ambiseta	15
07APR99	D	1	10	Diopatra cuprea	1
07APR99	D	2	3	Glycinde solitaria	1
07APR99	D	2	3	Streblospio benedicti	5
07APR99	D	2	3	Hemicyclops sp.	17
07APR99	D	2	3	Mediomastus ambiseta	19
07APR99	D	2	10	Glycinde solitaria	1
07APR99	D	2	10	Capitella capitata	1
07APR99	D	2	10	Hemicyclops sp.	3
07APR99	D	2	10	Mediomastus ambiseta	1
07APR99	D	3	3	Streblospio benedicti	3
07APR99	D	3	3	Capitella capitata	1
07APR99	D	3	3	Mediomastus ambiseta	16
07APR99	D	3	10	Parandalia ocularis	1
07APR99	D	3	10	Mediomastus ambiseta	5

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

Bay	Date	Station	Replicate	Section	Porosity	%N	$\delta^{15}N$	%C	$\delta^{13}C$
LM	17-May-99	6	1	1	0.8074	0.29	3.85	2.86	-16.38
LM	17-May-99	6	1	3	0.7043	0.27	3.54	2.85	-15.70
LM	17-May-99	6	1	6	0.6503	0.20	5.06	2.20	-15.53
LM	17-May-99	6	1	11	0.6643	0.18	4.98	2.10	-14.71
LM	17-May-99	6	1	16	0.6880	0.22	3.82	3.12	-12.78
LM	17-May-99	6	1	20	0.6789	0.20	3.95	2.91	-12.53
LM	17-May-99	6	1	40	0.6157	0.27	2.88	6.12	-6.84
LM	17-May-99	6	1	60	0.6950	0.21	3.60	3.24	-12.12
LM	17-May-99	6	1	80	0.6476	0.23	3.46	5.11	-7.42
LM	17-May-99	6	1	100	0.6945	0.19	4.04	2.96	-12.07
LM	17-May-99	6	2	1	0.7422	0.31	3.94	3.13	-14.77
LM	17-May-99	6	2	3	0.5989	0.23	3.83	2.67	-13.14
LM	17-May-99	6	2	6	0.6425	0.16	4.75	2.10	-12.21
LM	17-May-99	6	2	11	0.6983	0.20	4.28	2.30	-14.66
LM	17-May-99	6	2	16	0.6866	0.21	3.82	2.81	-12.91
LM	17-May-99	6	2	20	0.7188	0.20	3.99	2.47	-13.42
LM	17-May-99	6	2	40	0.7004	0.33	2.62	5.23	-9.39
LM	17-May-99	6	2	60	0.7002	0.24	3.38	3.32	-12.18
LM	17-May-99	6	2	80	0.6517	0.20	3.41	6.78	-7.64
LM	17-May-99	6	2	100	0.7035	0.20	4.00	3.09	-11.35
LM	17-May-99	24	1	1	0.7724	0.24	5.91	1.94	-18.48
LM	17-May-99	24	1	3	0.7391	0.20	5.94	2.07	-15.43
LM	17-May-99	24	1	6	0.6792	0.15	6.67	2.02	-12.92
LM	17-May-99	24	1	11	0.7015	0.14	6.56	1.46	-16.22
LM	17-May-99	24	1	16	0.7405	0.13	5.32	1.34	-19.12
LM	17-May-99	24	1	20	0.7300	0.14	5.13	1.39	-17.84
LM	17-May-99	24	1	40	0.7289	0.12	5.34	1.70	-12.87
LM	17-May-99	24	1	60	0.6665	0.23	3.12	4.14	-9.31
LM	17-May-99	24	1	80	0.6851	0.13	4.43	2.67	-9.16
LM	17-May-99	24	1	100	0.6731	0.16	3.89	3.05	-9.95
LM	17-May-99	24	2	1	0.7533	0.24	5.50	2.04	-17.59
LM	17-May-99	24	2	3	0.7566	0.21	5.57	1.83	-18.79
LM	17-May-99	24	2	6	0.6722	0.16	6.70	2.00	-13.34
LM	17-May-99	24	2	11	0.6958	0.13	6.68	1.41	-16.27
LM	17-May-99	24	2	16	0.7262	0.13	5.76	1.31	-18.65
LM	17-May-99	24	2	20	0.7369	0.14	5.16	1.44	-18.23
LM	17-May-99	24	2	40	0.6685	0.17	4.22	2.48	-12.65

LM	17-May-99	24	2	60	0.6959	0.19	4.58	2.90	-11.55
LM	17-May-99	24	2	80	0.6606	0.17	3.56	3.81	-7.43
LM	17-May-99	24	2	100	0.6721	0.17	3.88	2.93	-10.58
LM	26-May-99	135G	1	1	0.4406	0.09	2.71	1.06	-12.06
LM	26-May-99	135G	1	3	0.3764	0.14	2.56	1.84	-11.26
LM	26-May-99	135G	1	6	0.2744	0.08	2.69	1.08	-11.15
LM	26-May-99	135G	1	11	0.2187	0.02	2.52	0.90	2.25
LM	26-May-99	135G	1	16	0.2252	0.04	2.84	4.03	0.10
LM	26-May-99	135G	1	20	0.2511	0.01	2.89	1.17	0.56
LM	26-May-99	135G	1	40	0.2091	0.00	0.00	0.34	-0.06
LM	26-May-99	135G	1	60	0.1964	0.00	0.00	0.27	-0.43
LM	26-May-99	135G	1	80	0.2663	0.02	3.51	1.32	-1.65
LM	26-May-99	135G	1	100	0.2244	0.02	2.98	0.81	-2.86
LM	26-May-99	135G	2	1	0.3573	0.07	2.60	1.01	-9.88
LM	26-May-99	135G	2	3	0.3573	0.10	2.71	1.38	-10.54
LM	26-May-99	135G	2	6	0.2404	0.04	3.11	0.79	-6.66
LM	26-May-99	135G	2	11	0.2043	0.01	3.62	0.77	-0.91
LM	26-May-99	135G	2	16	0.2209	0.02	3.09	3.33	1.89
LM	26-May-99	135G	2	20	0.2077	0.01	3.00	2.02	1.35
LM	26-May-99	135G	2	40	0.2044	0.00	3.37	0.38	0.68
LM	26-May-99	135G	2	60	0.1994	0.00	3.93	0.52	1.39
LM	26-May-99	135G	2	80	0.1837	0.01	2.70	1.73	2.03
LM	26-May-99	135G	2	100	0.2983	.	.	.	.
LM	17-May-99	189G	1	1	0.6535	0.59	2.64	6.99	-12.81
LM	17-May-99	189G	1	3	0.4731	0.15	2.61	1.81	-12.46
LM	17-May-99	189G	1	6	0.4574	0.19	2.99	2.87	-10.29
LM	17-May-99	189G	1	11	0.4092	0.07	3.46	1.12	-9.67
LM	17-May-99	189G	1	16	0.4105	0.12	4.20	2.10	-8.64
LM	17-May-99	189G	1	20	0.2602	0.04	3.97	1.12	-3.79
LM	17-May-99	189G	1	40	0.2250	0.02	4.82	0.39	-18.00
LM	17-May-99	189G	1	60	0.2117	0.02	11.84	0.31	-18.36
LM	17-May-99	189G	1	80	0.1918	0.01	6.82	0.13	-18.17
LM	17-May-99	189G	1	100	0.1927	0.01	4.91	0.10	-16.30
LM	17-May-99	189G	2	1	0.7881	0.76	2.77	8.13	-14.75
LM	17-May-99	189G	2	3	0.5630	0.17	2.45	1.98	-13.53
LM	17-May-99	189G	2	6	0.3685	0.09	3.27	1.52	-9.01
LM	17-May-99	189G	2	11	0.2899	0.04	3.93	0.82	-6.90
LM	17-May-99	189G	2	16	0.3094	0.05	4.21	1.15	-6.41
LM	17-May-99	189G	2	20	0.2250	0.03	3.66	0.86	-3.05
LM	17-May-99	189G	2	40	0.2423	0.01	4.77	0.43	-7.86
LM	17-May-99	189G	2	60	0.2302	0.02	5.11	0.84	-5.52
LM	17-May-99	189G	2	80	0.2111	0.01	4.79	0.53	-4.49
LM	17-May-99	189G	2	100	0.1990	0.01	4.30	0.22	-8.95

Average Vertical Distribution of Elemental Content (%) among Stations

Nitrogen and Carbon in % dry weight of sediment, nitrogen and carbon isotope values.

Station	N (%)	$\delta^{15}N$	C (%)	$\delta^{13}C$
135G	0.0358	2.6753	1.3026	-3.0111
189G	0.1205	4.3760	1.6710	-10.4480
24	0.1675	5.1960	2.1965	-14.3190
6	0.2270	3.8600	3.3685	-12.3875

DISCUSSION

Conditions in Current Sampling Year

Following an El Niño event in 1997, 1998 was a dry year. Consequently, salinities were very high during summer 1998 (Figs. 2 and 3). Tropical Storm France brushed by the south Texas coast during September 10 - 12, 1998 bringing rain and lowering salinities from July to October. However, during October 17 - 18, 1998 between 18 and 31 inches of rain fell. The ensuing flood may have been one of the largest in the Guadalupe River. Bill West, general manager of the Guadalupe-Blanco River Authority was quoted in the Corpus Christi Caller Times as saying "it was a flood larger that one we had ever seen in this part of the world before." We had sampled October 12 - 13 just prior to the flood. Prior to the flood, salinities influenced by Frances were still relatively high in the Guadalupe Estuary ranging from 2 psu at the most river-influenced station (A) to 18 psu at the most Gulf-influenced station (D). In January 1999, three months after the flood, salinity was still zero at station A and only 8 psu at station D, indicating effects of the flood lasted for several months. By April 1999, six months later, salinities were back to pre-flood levels. Effects of Frances were felt in the Lavaca-Colorado Estuary, but no trace of the October flood was evident by January 1999. The lowest salinities in the Lavaca-Colorado Estuary were in July 1999, following an unusually wet summer period.

There was a complete salinity gradient from fresh (near zero) to sea water strength (near 30) in the Lavaca-Colorado Estuary only during July 1999 (Fig. 2). The rest of the year, it was evidently dry, and salinities were relatively high. Station F (near the mouth of the Colorado River) was like Station A (near the mouth of the Lavaca River) only during January 1999. Salinities at Station F were similar to salinities near Station C (where Lavaca Bay meets Matagorda Bay) in July and October 1998, but didn't return to those levels until July 1999. Salinities fluctuated throughout the year at all stations, but generally dropped during the study period because the year started out dry and ended wet.

Upper San Antonio Bay (Stations A and B) were similar from July 1998 through January 1999, but different in April and July 1999 (Fig. 3). Salinities were always higher than Lower San Antonio Bay (Stations C and D). Salinities at Station A (near the mouth of the Guadalupe River) were high (9 psu) in July 1998, but dropped throughout the year. In contrast, from January through April 1999, salinities rose substantially at all stations. Generally, salinity is higher at station D (which is nearest Matagorda Bay) than C (which is nearest Aransas Bay). But in a dry period the opposite is true because south Texas estuaries can be hypersaline.

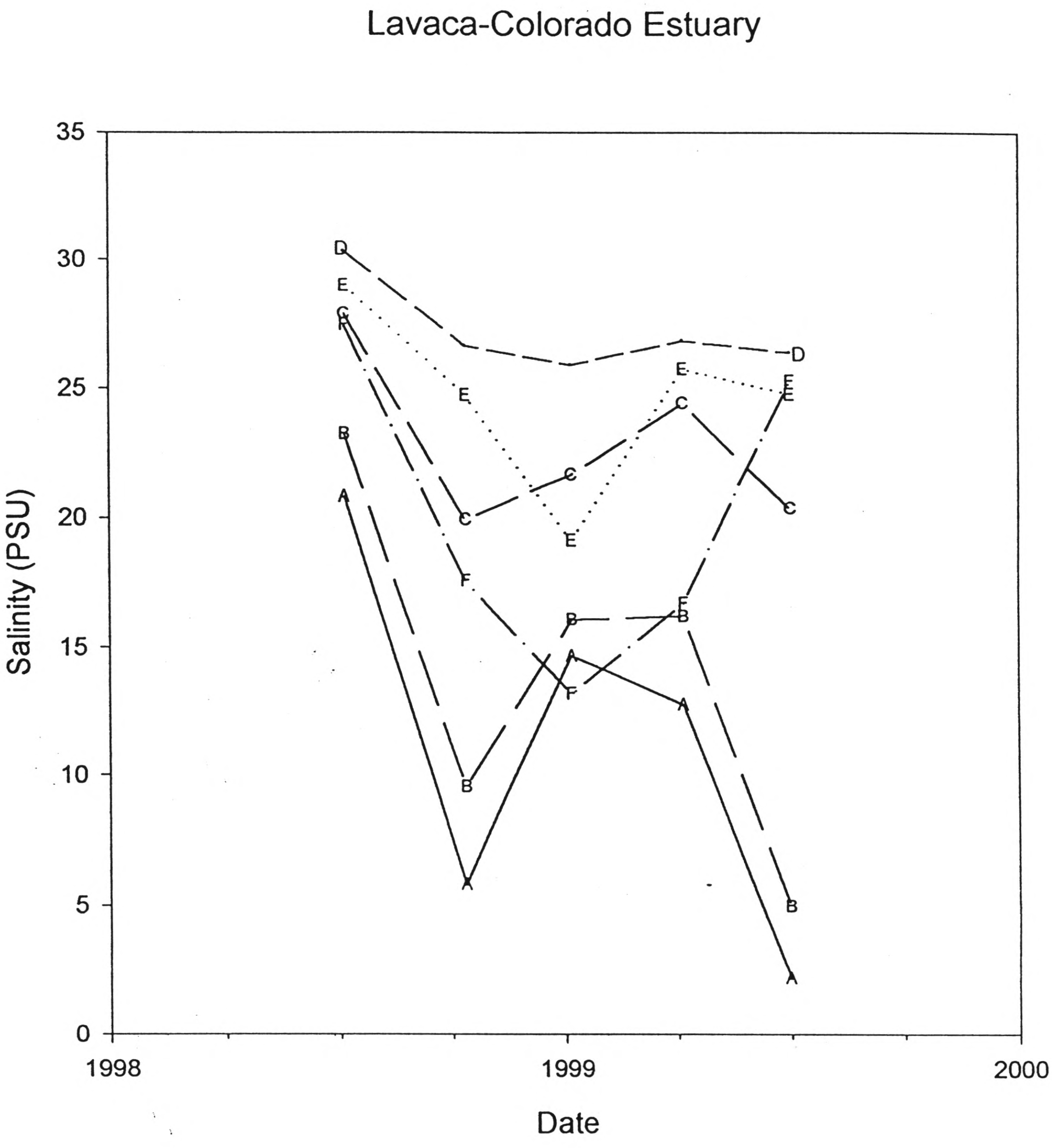

Figure 2. Salinity change at stations in Lavaca-Colorado Estuary during the sampling period.

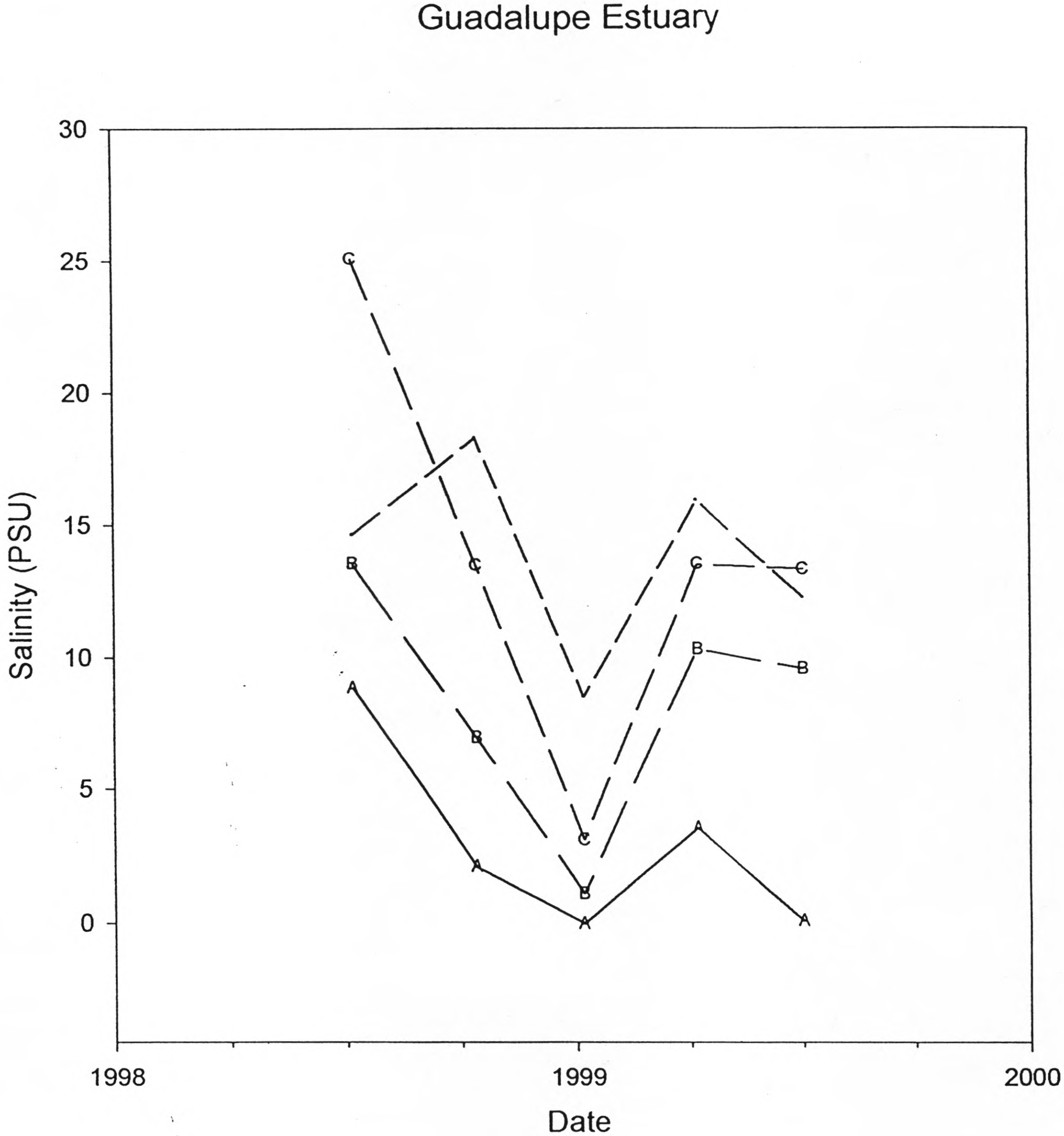

Figure 3. Salinity change at stations in Guadalupe Estuary during the sampling period.

Benthic Response in Current Sampling Year

The biomass (Fig. 4) and abundance (Fig. 5) remained relatively constant over the year in the Lavaca-Colorado Estuary. The biomass 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 all year, but abundance was highest only in April 1999. A bloom of the polychaete *Polydora caulleryi* was responsible for very high densities at station E in October 1998. Unlike past years, stations A and F did not exhibit similar responses to inflow over the year.

The response to the October flood in 1998 is evident in the biomass (Fig. 6) and abundance (Fig. 7) changes in the Guadalupe Estuary. The lowest biomass and abundance was recorded in January 1999 following the flood. However, as seen in the past, both biomass and abundance bloomed (in April 1999) following the initial response as salinities increased. The overall influence of inflow is demonstrated by the trend in abundance and biomass among the stations. Stations A and B had higher biomass than stations C and D from July 1998 through January 1999. The trend is especially strong during the high salinity period of July 1998.

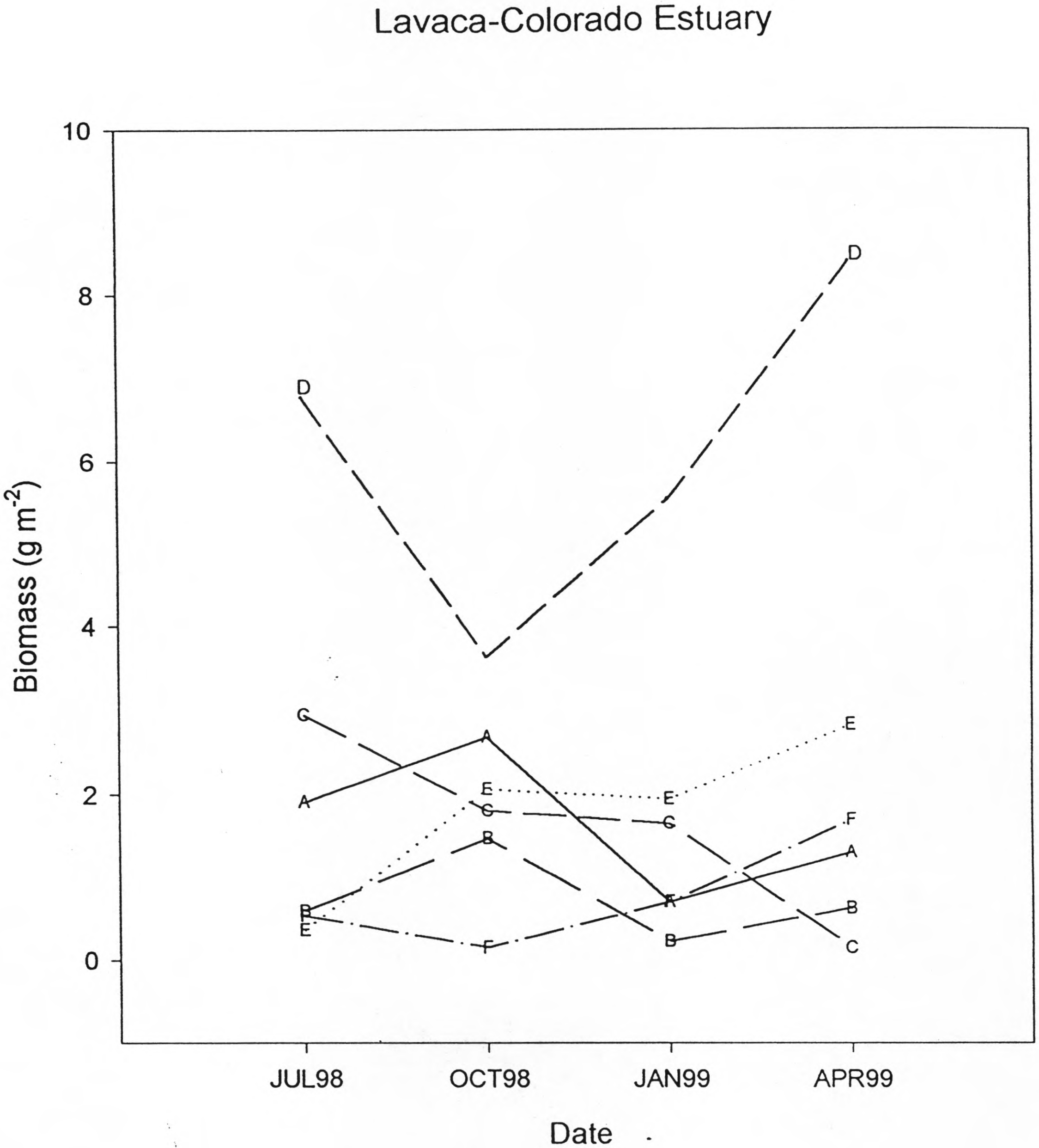

Figure 4. Macrofauna biomass change at stations in Lavaca-Colorado Estuary during the sampling period.

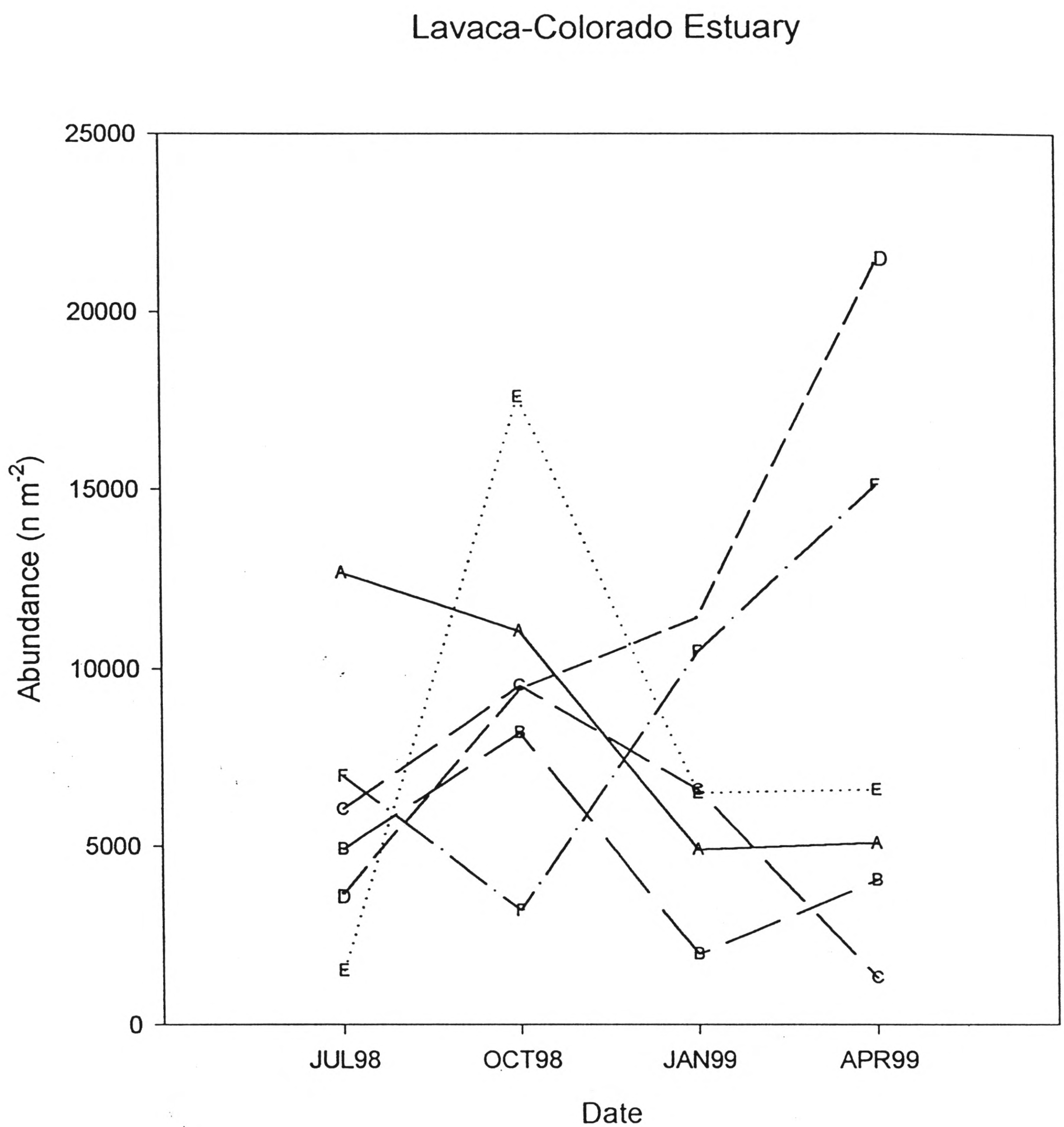

Figure 5. Macrofauna abundance change at stations in Lavaca-Colorado Estuary during the sampling period.

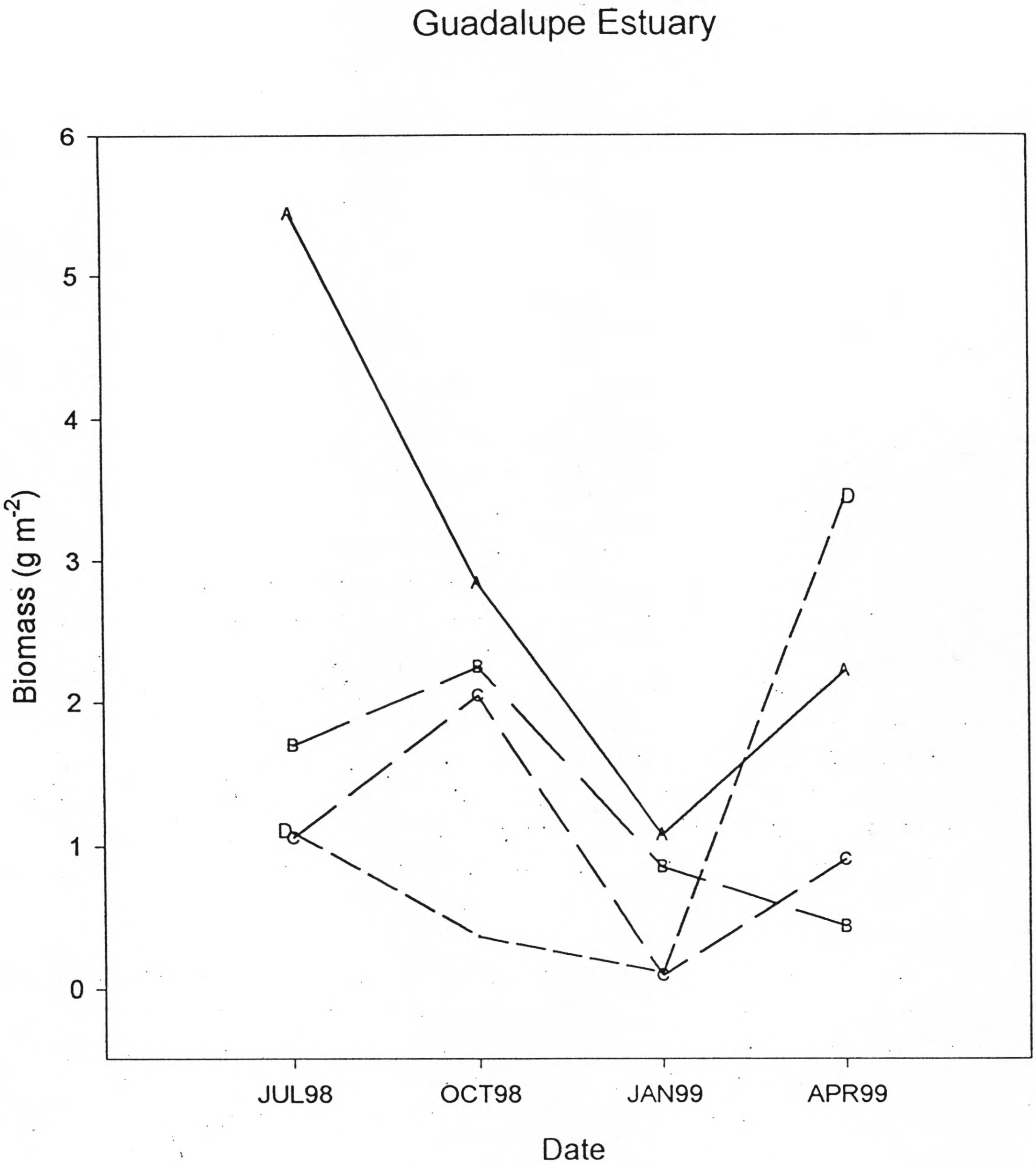

Figure 6. Macrofauna biomass change at stations in Guadalupe Estuary during the sampling period.

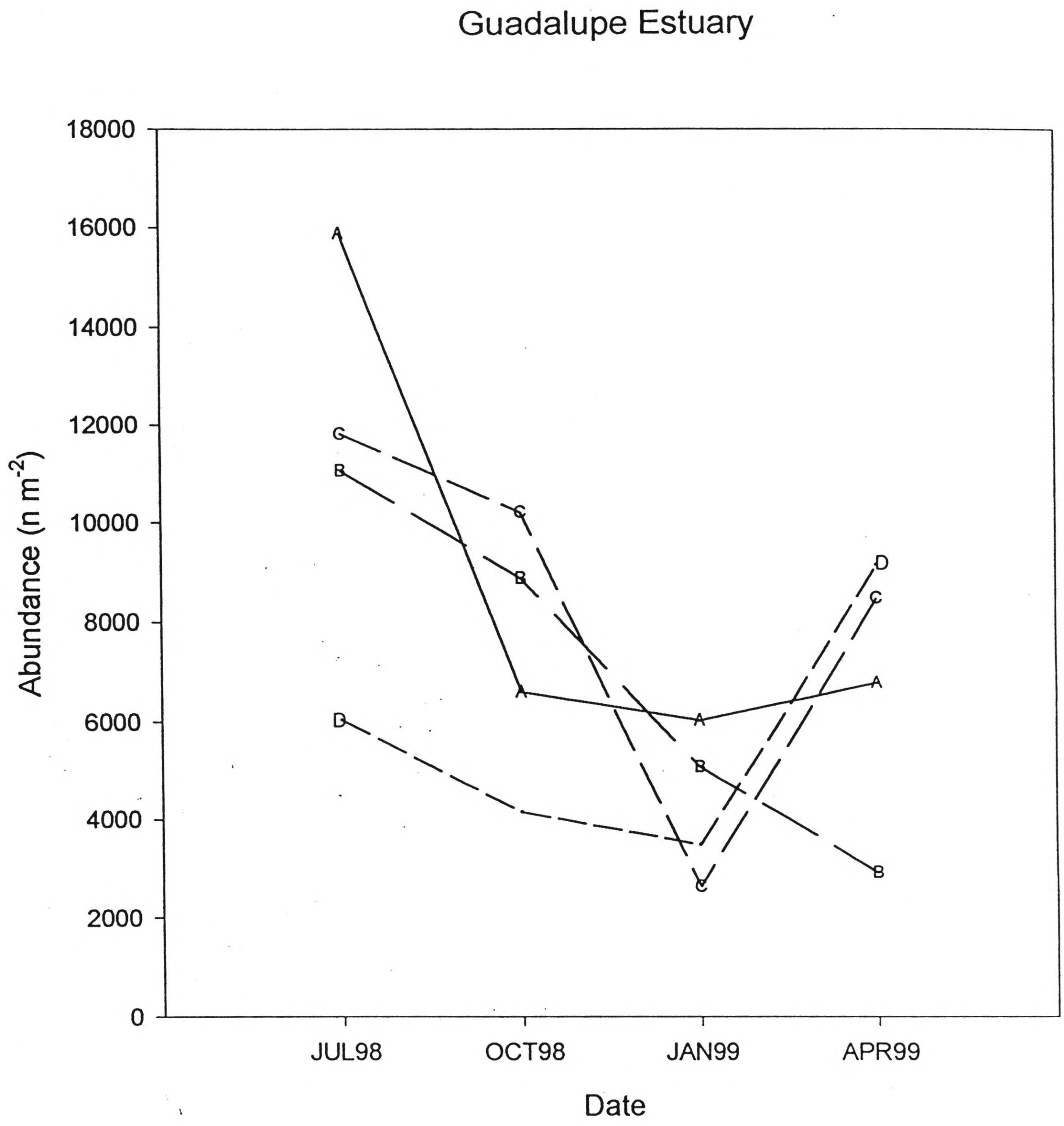

Figure 7. Macrofauna abundance change at stations in Guadalupe Estuary during the sampling period.

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 estuarine-wide salinities (average 20.4 ± 6.4 psu from 1988-1999; Figs. 8 and 9) than the Guadalupe (average 13.5 ± 8.6 psu from 1987 - 1999; Figs. 10 and 11), which is smaller and has restricted exchange. This indicates 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. At any given time salinities are lower in the Guadalupe than Lavaca-Colorado Estuary. This is true estuarine-wide and at stations A and B (nearest the river inflow source) 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 indicates 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 biomass in the Lavaca-Colorado from 1988-1999 among all stations was 4.6 ±3.8 $g \cdot m^{-2}$ (Fig. 8) and average abundance was 11,200 ±6,800 individuals$\cdot m^{-2}$ (Fig. 9). The average biomass among all times and stations in the Guadalupe from 1987 - 1999 was 6.0 ±5.0 $g \cdot m^{-2}$ and average abundance was 19,600 ±14,900 individuals$\cdot m^{-2}$ (Fig. 10). 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 long-term time series of salinity indicates 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 - 1987, 1992 - 1993, and 1997 -1998. 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. The intervening dry periods are also different in the two estuaries. There have been two major dry periods with high salinities between El Niños: 1988 - 1992 and 1994 - 1997. We are currently in the third dry period, which began in 1998. The main difference between the two estuaries is that the smaller Guadalupe Estuary responds to flood with episodic periods of low salinity (Fig. 12).

Whereas the effects of El Niño are seen in both estuaries, storms have more localized effects. The October 1998 is a good example. The long-term trend from mid-1997 through 1999 was a dry period with increasing salinities (Fig. 12). However, the precipitation that caused the October 1998 flood occurred primarily in the Guadalupe watershed. Therefore, salinities in the Guadalupe Estuary were low through January 1999, whereas salinities in the Lavaca-Colorado Estuary increased.

Our study of the Lavaca-Colorado and Guadalupe Estuaries demonstrates the biological effects of this El Niño driven cycle. Flood conditions introduce nutrient rich waters into the estuary which result in lower salinity (Figs. 13 - 14). This happened in the winter/spring of 1987, 1992 and 1997 in both estuaries. During those El Niño periods the lowest salinities and highest nutrient values were recorded. 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), which lasts about six months. 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 macrofauna biomass and densities. This was seen from 1989 to 1990, 1993 to 1995, and from 1997 through the present. Pulsed flood events, particularly in dry years, mitigates these patterns.

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 to ten 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. To date, we have captured three wet-period cycles in the Guadalupe, and two in the Lavaca-Colorado, and two dry-period cycles in both estuaries.

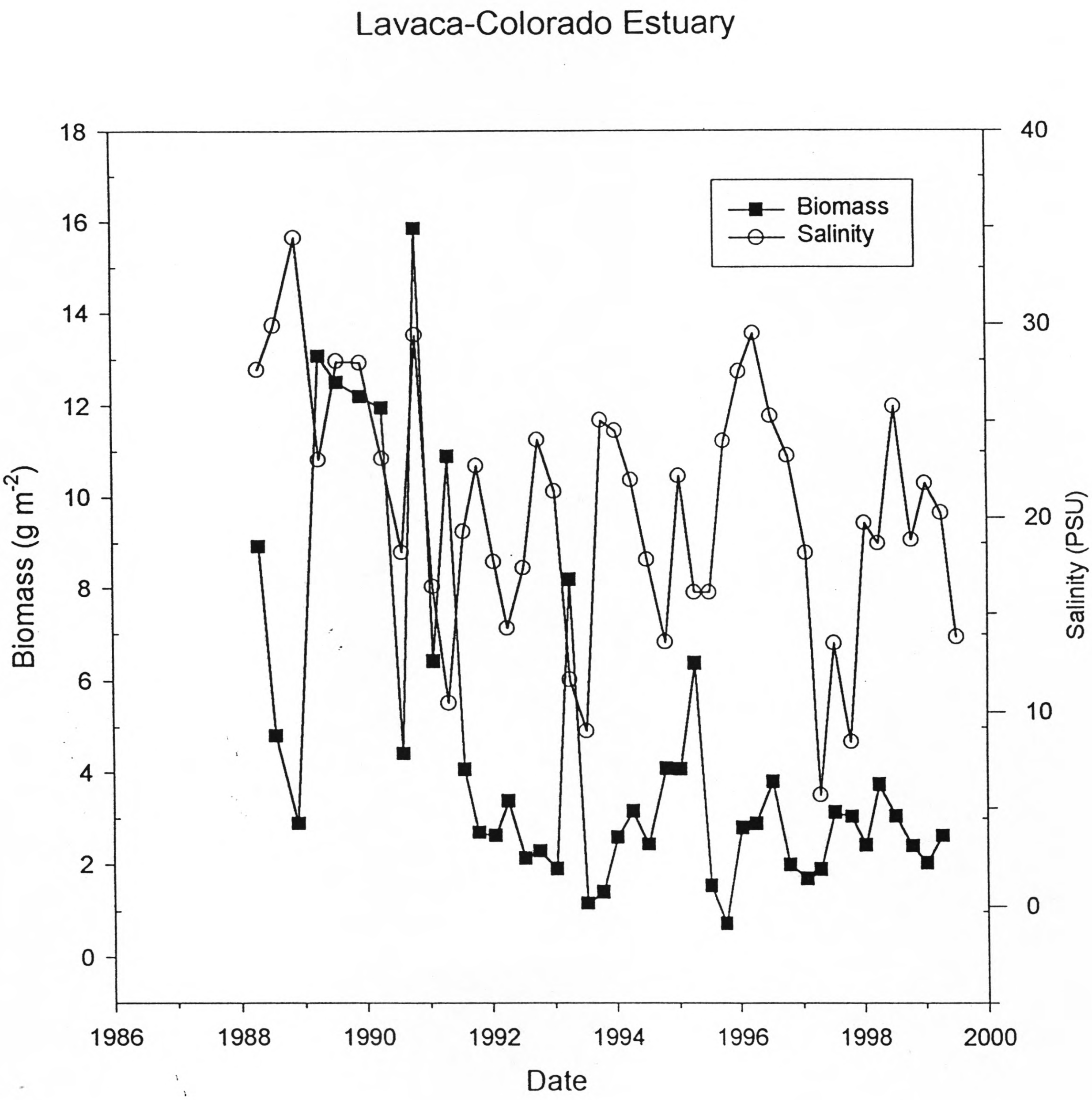

Figure 8. Long-term macrofauna biomass and salinity change in Lavaca-Colorado Estuary. Estuarine-wide average for stations A - D.

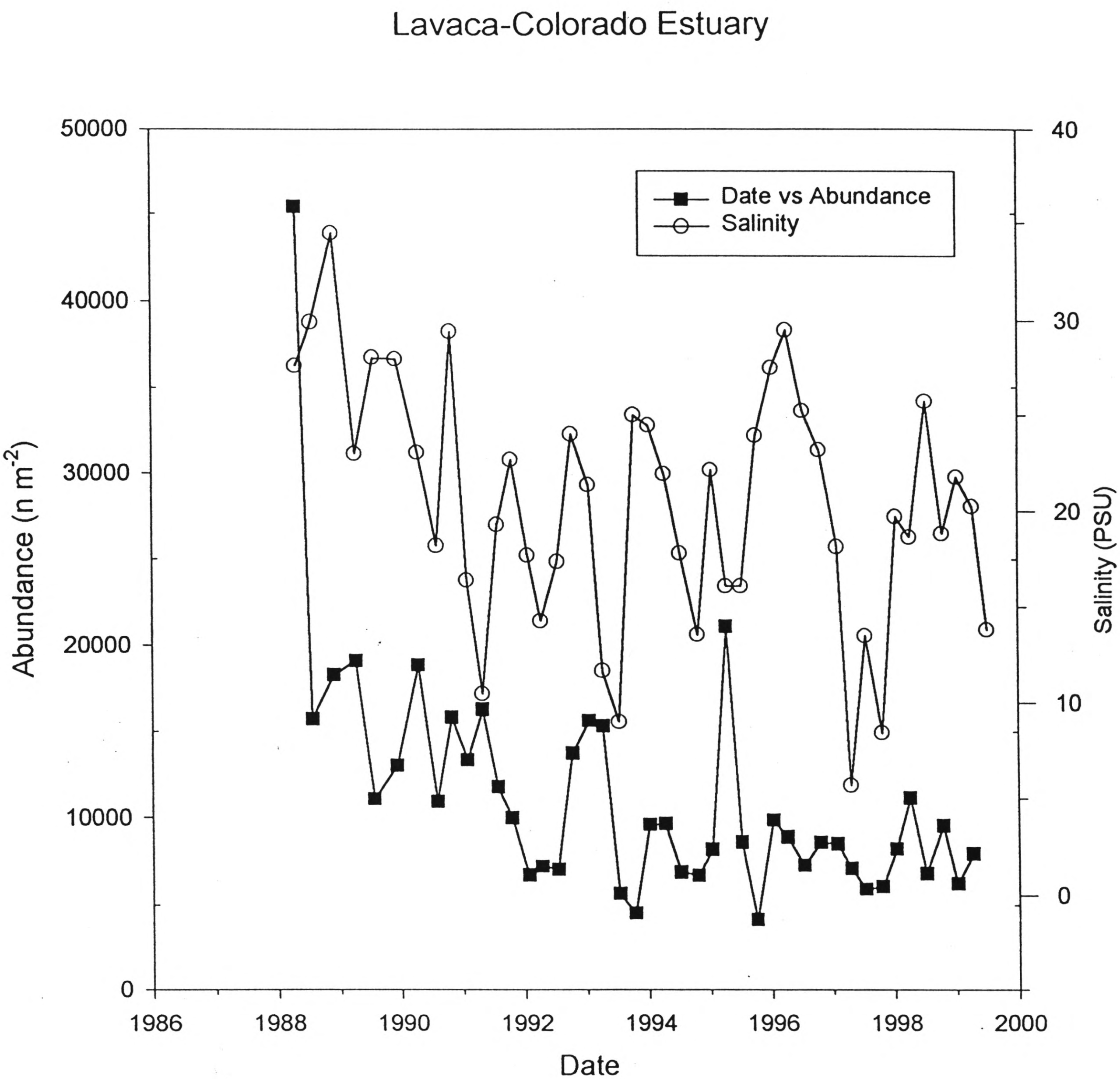

Figure 9. Long-term macrofauna abundance and salinity change in Lavaca-Colorado Estuary. Estuarine-wide average for stations A - D.

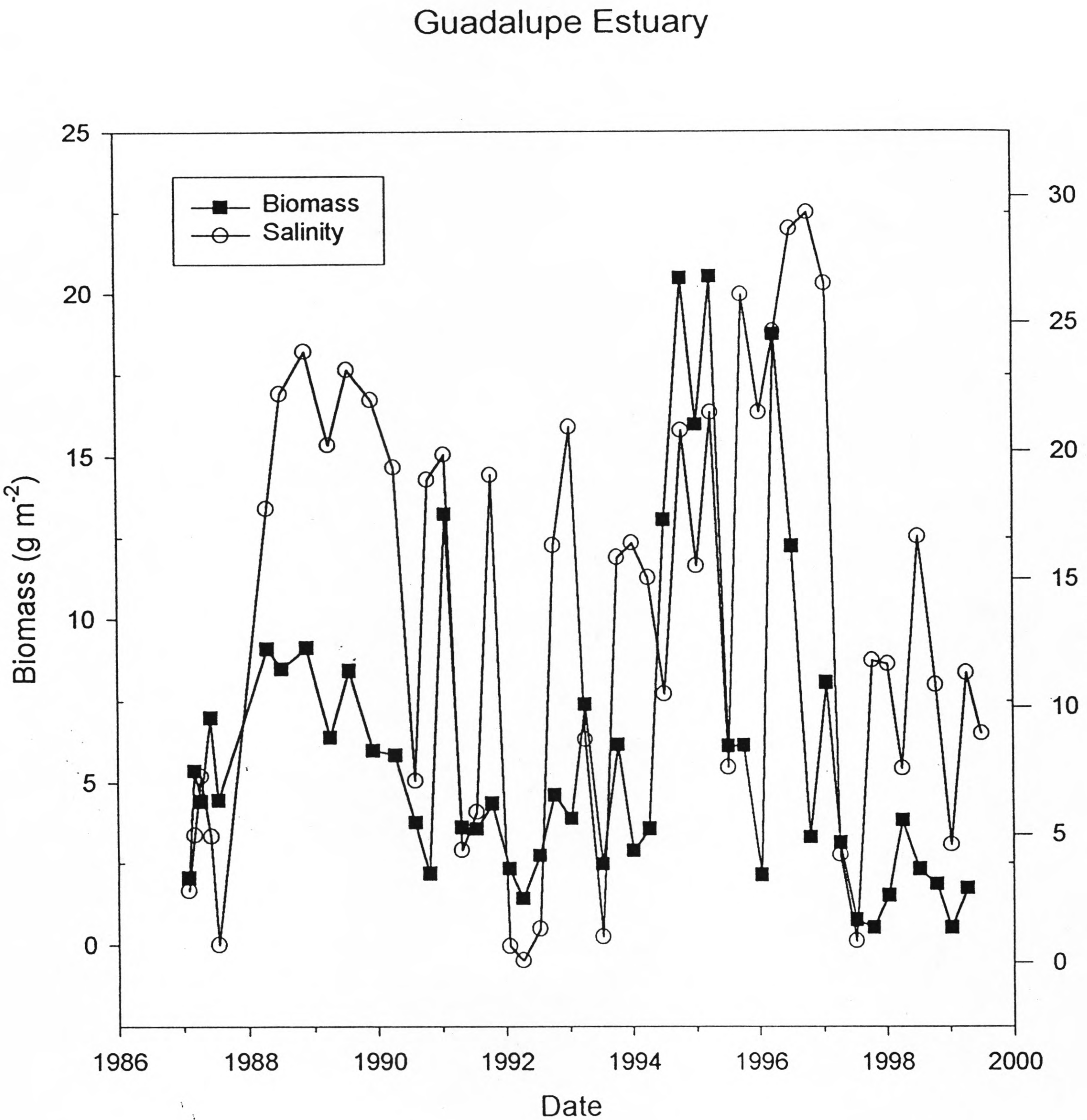

Figure 10. Long-term macrofauna biomass and salinity change in Guadalupe Estuary. Estuarine-wide average for stations A - D.

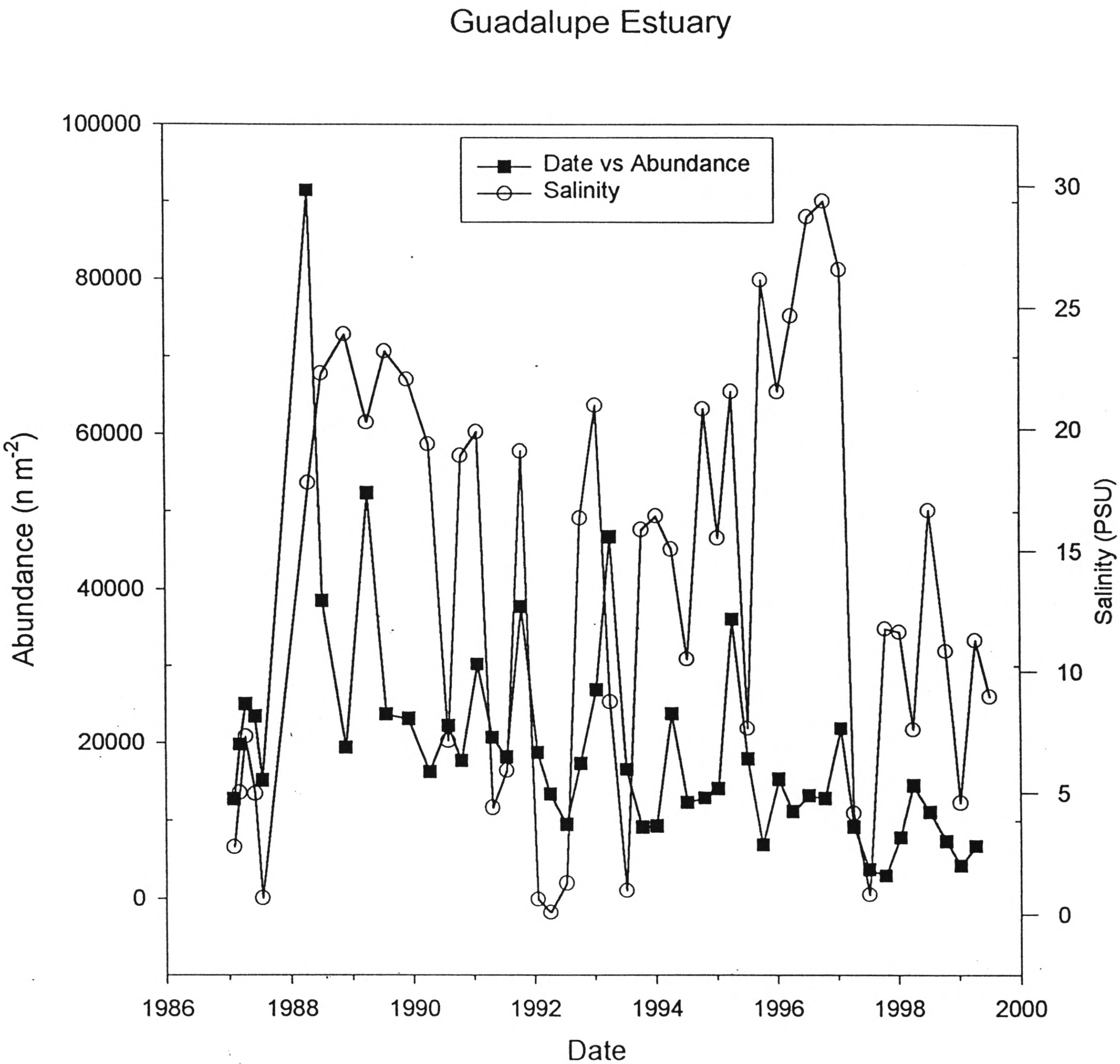

Figure 11. Long-term macrofauna abundance and salinity change in Guadalupe Estuary. Estuarine-wide average for stations A - D.

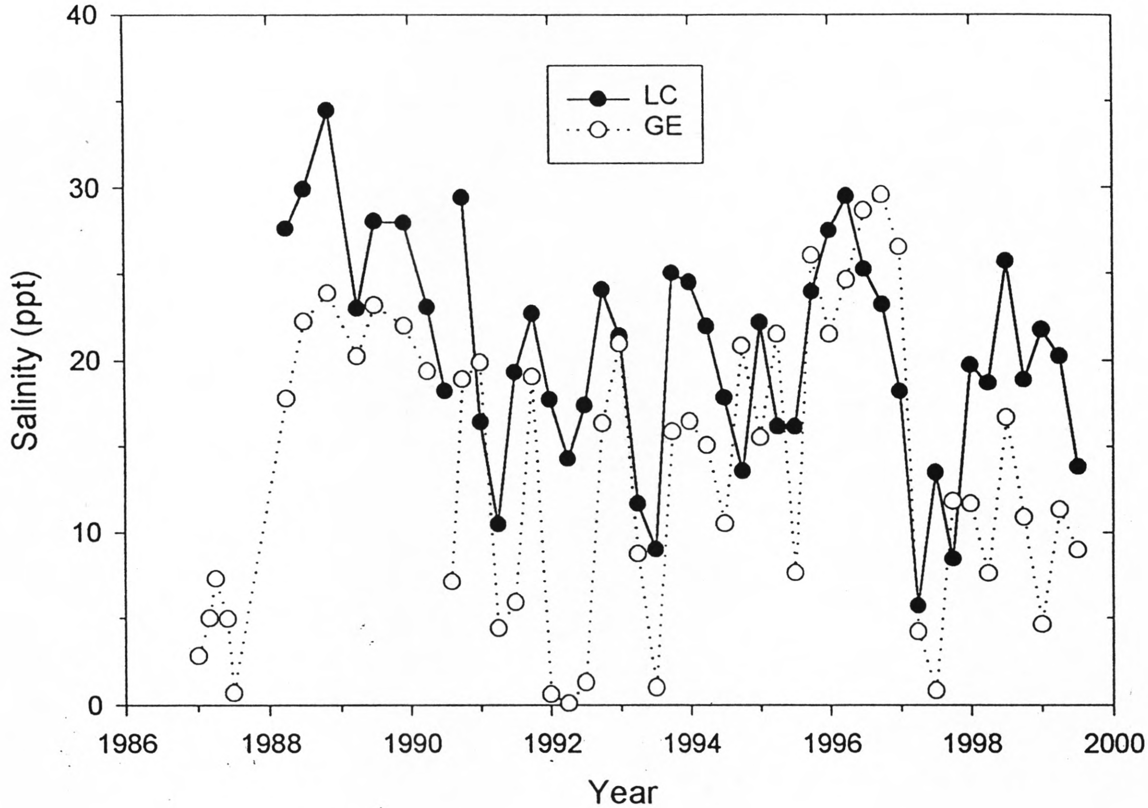

Figure 12. Long-term salinity change in the Lavaca-Colorado and Guadalupe Estuaries. Estuarine-wide average for stations A - D.

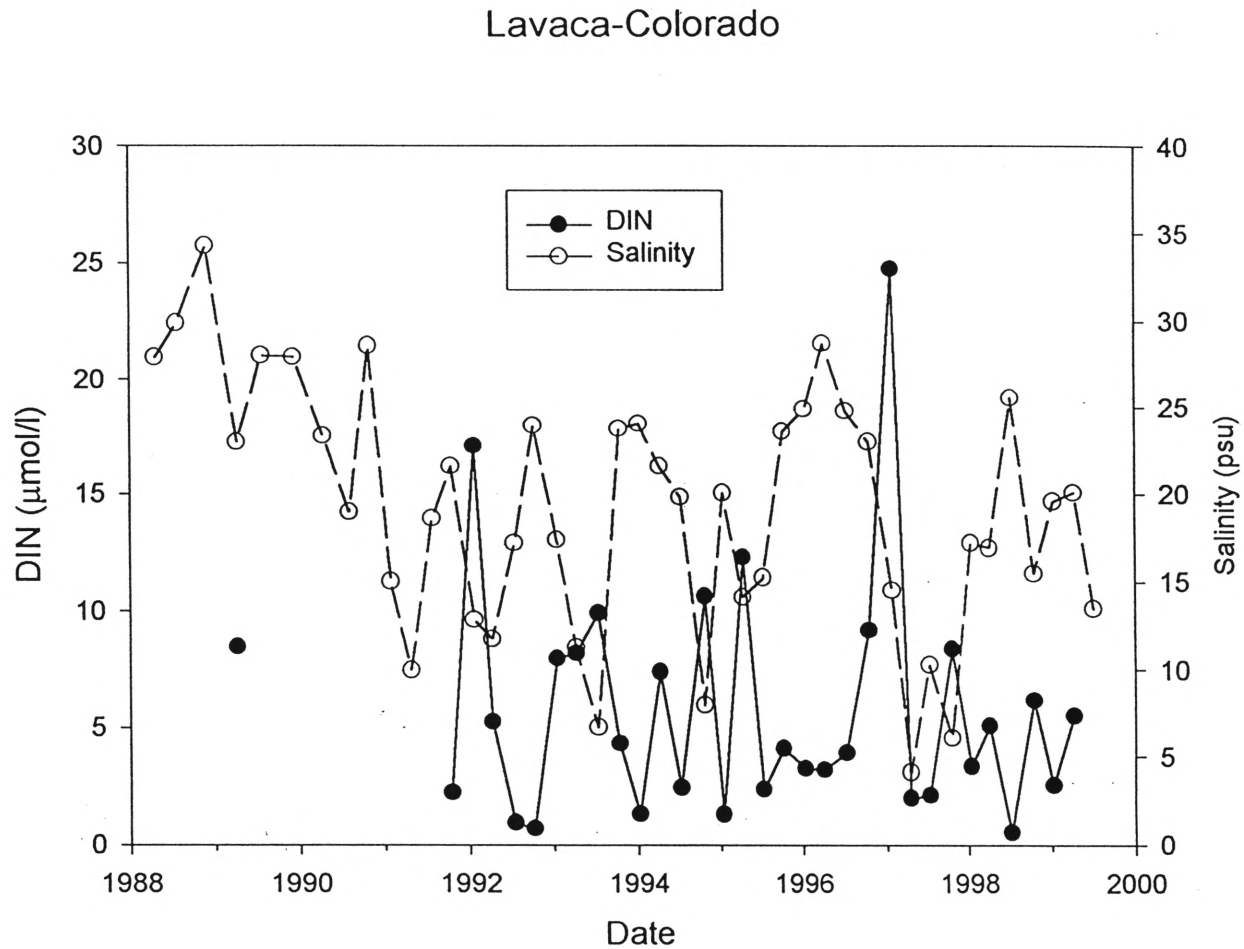

Figure 13. Long-term salinity change and dissolved inorganic nitrogen (DIN) change in the Lavaca-Colorado Estuary. Quarterly estuarine-wide average for stations A - D.

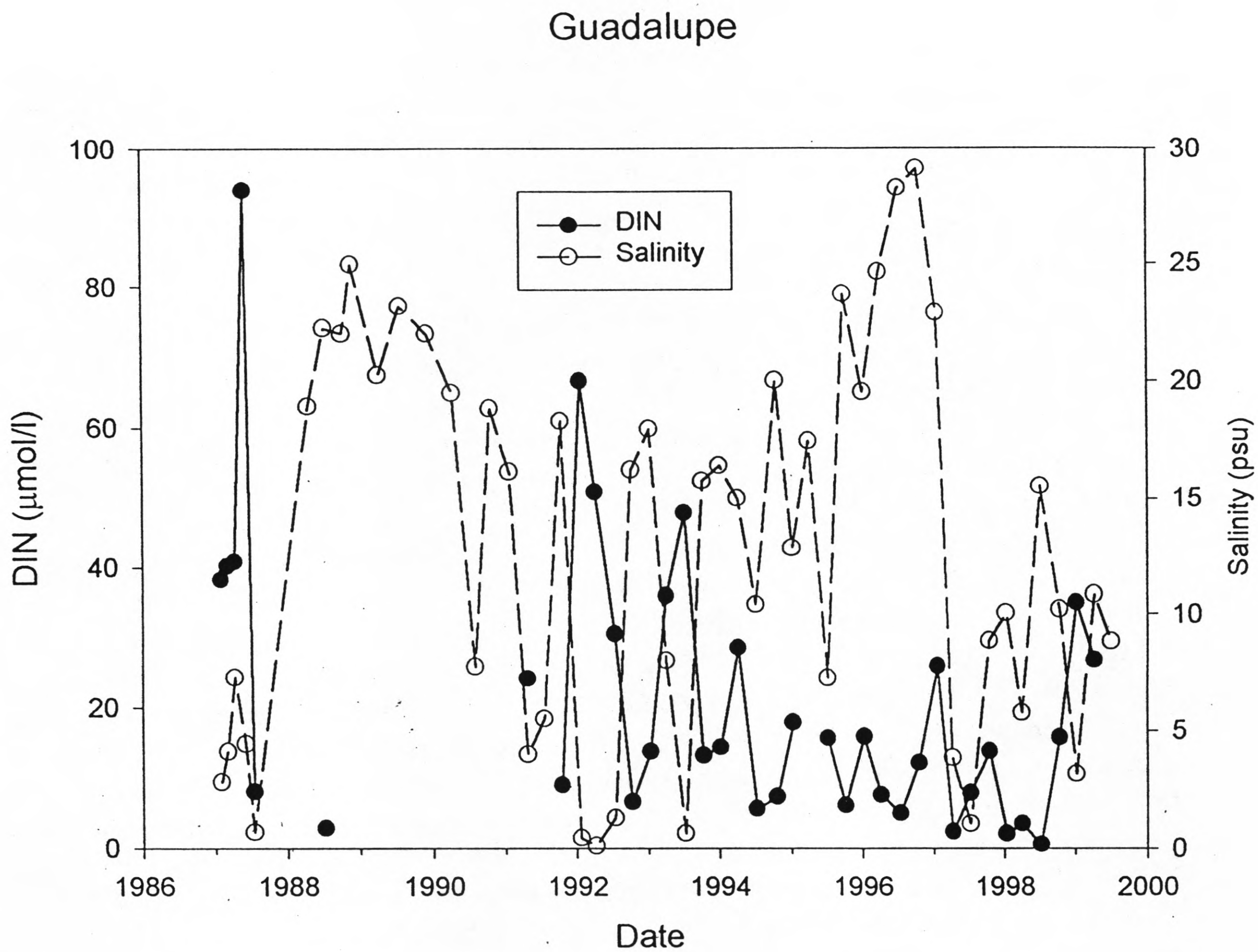

Figure 14. Long-term salinity change and dissolved inorganic nitrogen (DIN) change in the Guadalupe Estuary. Quarterly estuarine-wide average for stations A - D.

Nitrogen Losses

A great deal of nitrogen enters bays via river inflow (Figs. 13 - 14). If this nitrogen 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 Baffin Bay - Upper Laguna Madre has little river influence, except for intermittent creeks fed from the tertiary bays. The effect of even that intermittent flow is evident in that both nitrogen (Figure 15) and carbon (Figure 16) appear to have higher concentrations in sediments in Baffin Bay (stations 6 and 24) than in Laguna Madre, which is away from the inflow sources (stations 135 and 189).

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. On average, there is a strong decrease in carbon and nitrogen values in the top 20 cm of sediment, and then values are relatively constant to 100 cm depth (Fig. 17). Thus, the labile zone appears to be limited to between 0 and 20 cm in Upper Laguna Madre (Fig. 17) 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 sediment 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 (Montagna, 1998). Upper Laguna Madre is nitrogen rich. The surface sediment varies from 0.3 % to 0.01 at the surface (Fig. 17). The refractory zone is only 20 cm deep. The values here confirm earlier finding that Upper Laguna Madre has a much higher nitrogen content (0.2 at the surface and 0.15 at depth) than found in Lower Laguna Madre or other Texas estuaries (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 or there are unaccounted for sources..

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.

This year, we used a new mass spectrometer that also measures isotopic values as well as elemental content values. Laguna Madre had lower nitrogen ($\delta^{15}N$) (Fig. 18) and higher carbon ($\delta^{13}C$) isotope values (Fig. 19) than Baffin Bay in the top 20 cm of sediment. The differences indicate the importance of seagrass productivity in producing depositional particulates in Laguna Madre relative to phytoplankton productivity in Baffin Bay. On average, the vertical profile of nitrogen values varied only 1 ‰ indicating no change through the sediment (Fig. 20). On average, the vertical profile of carbon values varied 7 ‰, decreasing mostly in the top 20 cm of sediment. The change in carbon values verifies that the biogenic labile zone, which is dominated by fresh plant detritus, is limited to the top 20 cm.

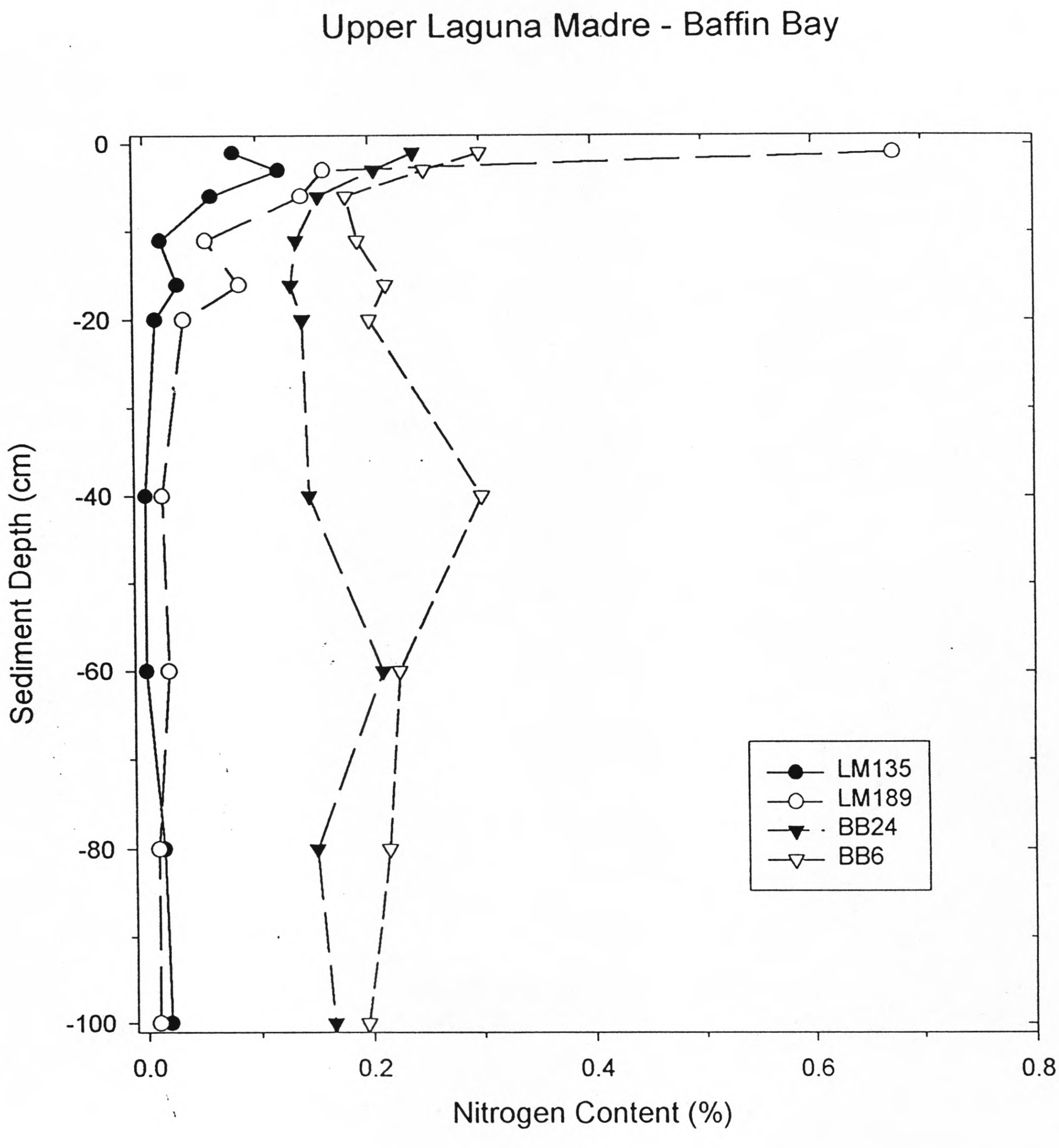

Figure 15. Nitrogen content of Upper Laguna Madre - Baffin Bay sediments.

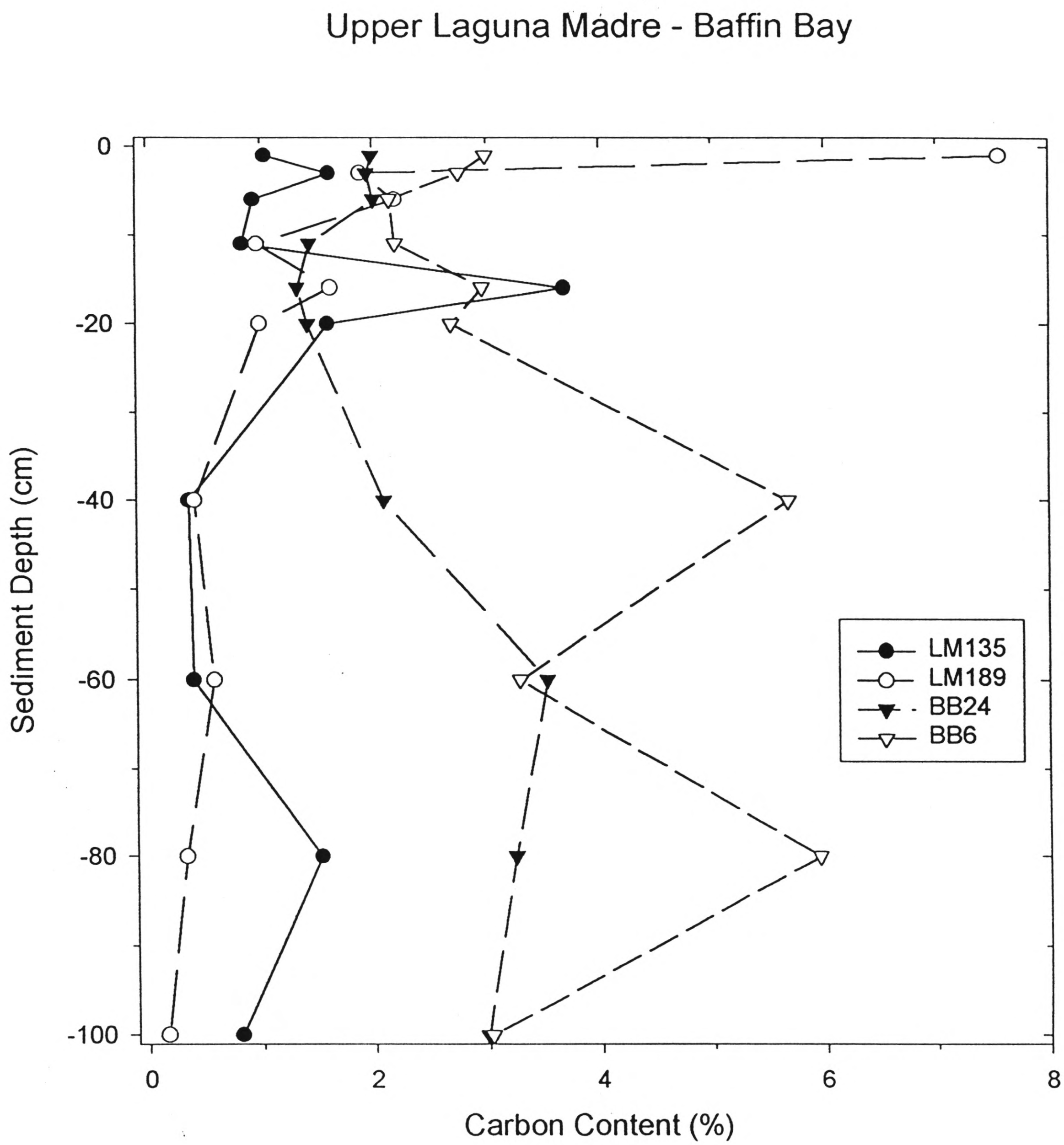

Figure 16. Carbon content of Upper Laguna Madre - Baffin Bay sediments.

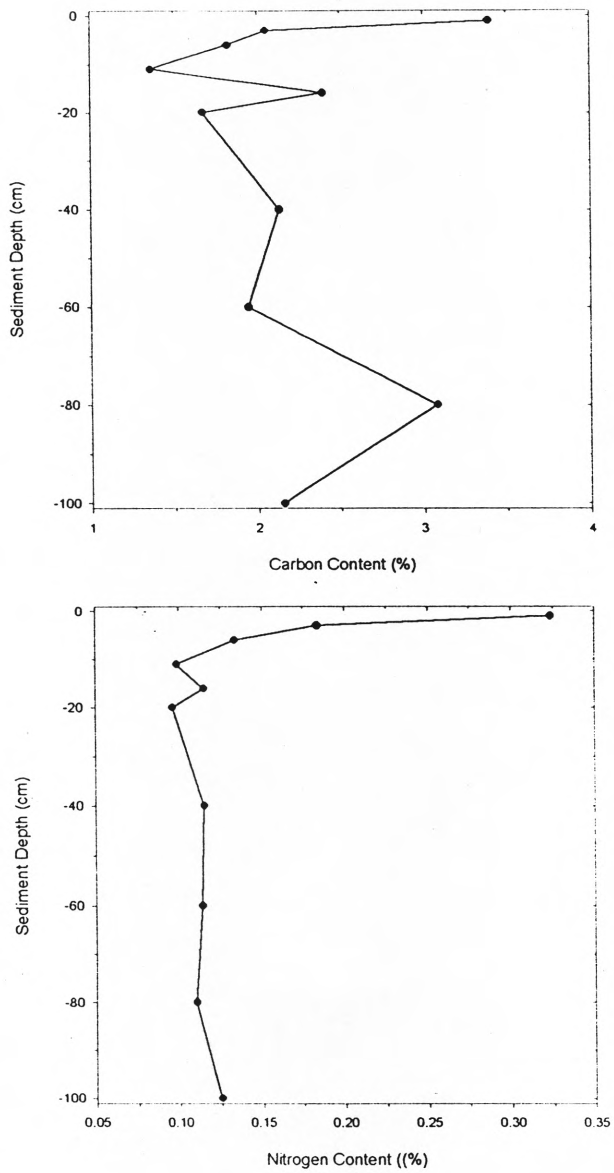

Figure 17. Average nitrogen and carbon content in Upper Laguna Madre - Baffin Bay sediments.

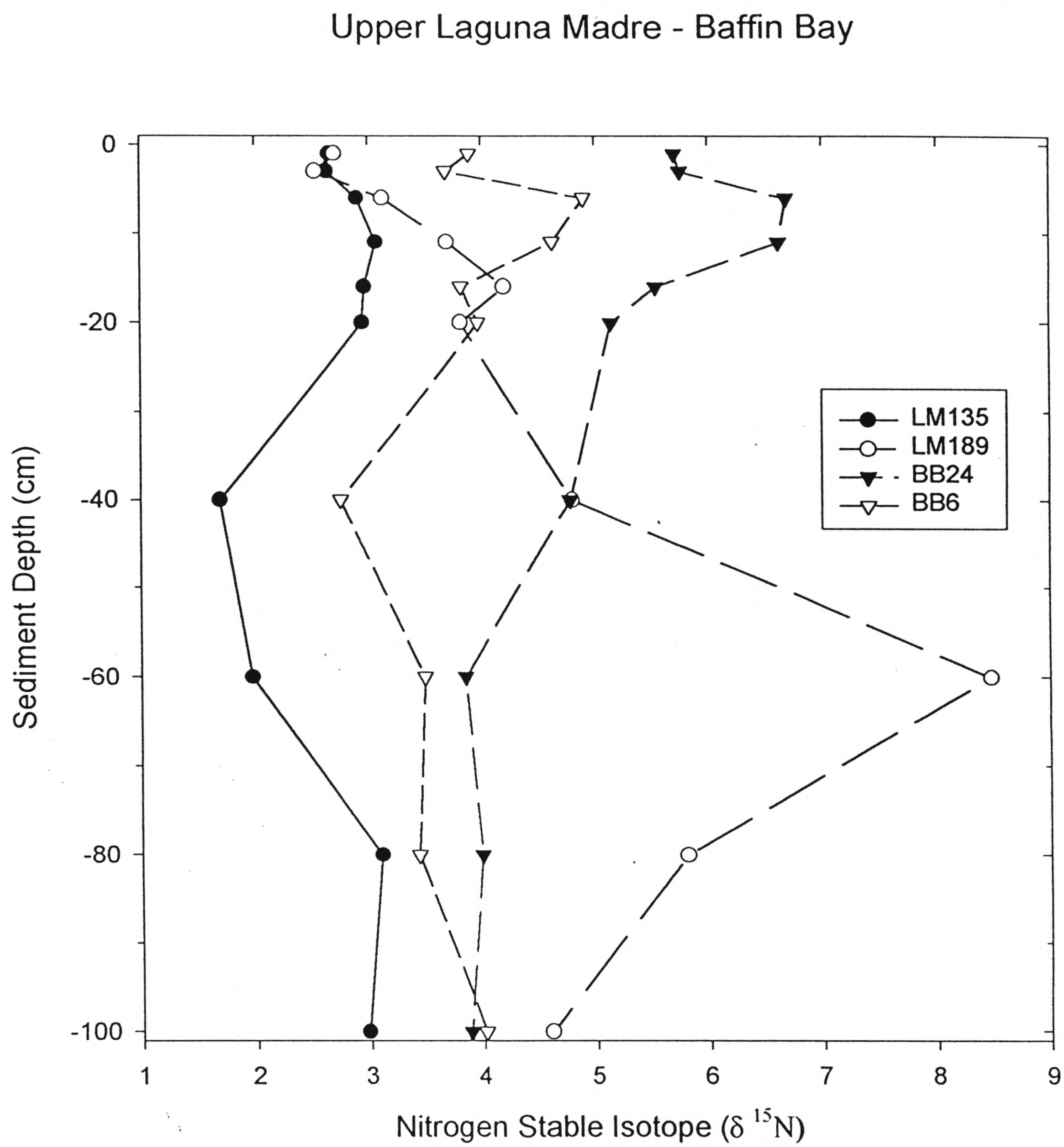

Figure 18. Profile of nitrogen (δ ^{15}N) isotope values in Upper Laguna Madre - Baffin Bay sediments.

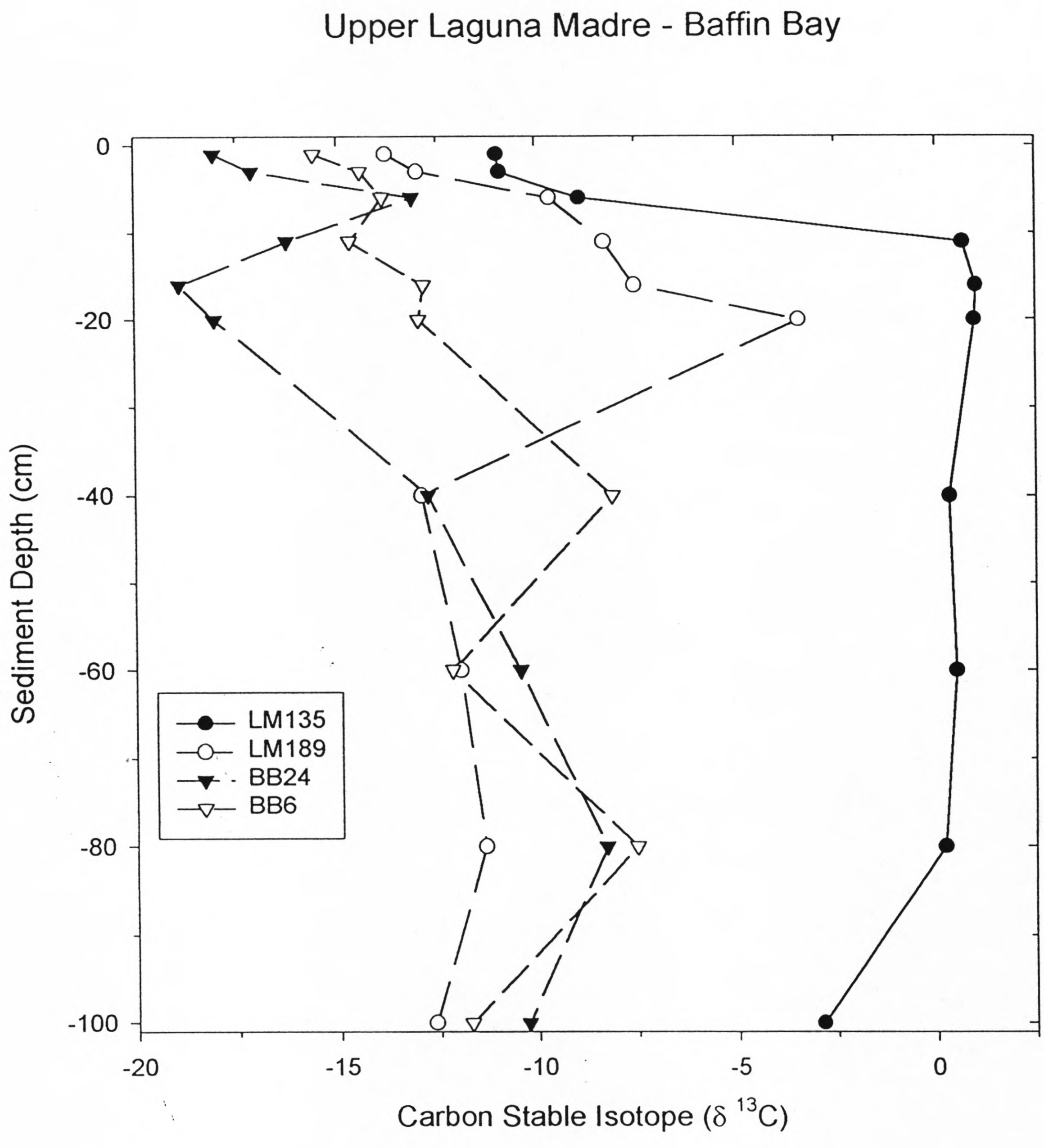

Figure 19. Profile of carbon ($\delta\ ^{13}C$) isotope values in Upper Laguna Madre - Baffin Bay sediments.

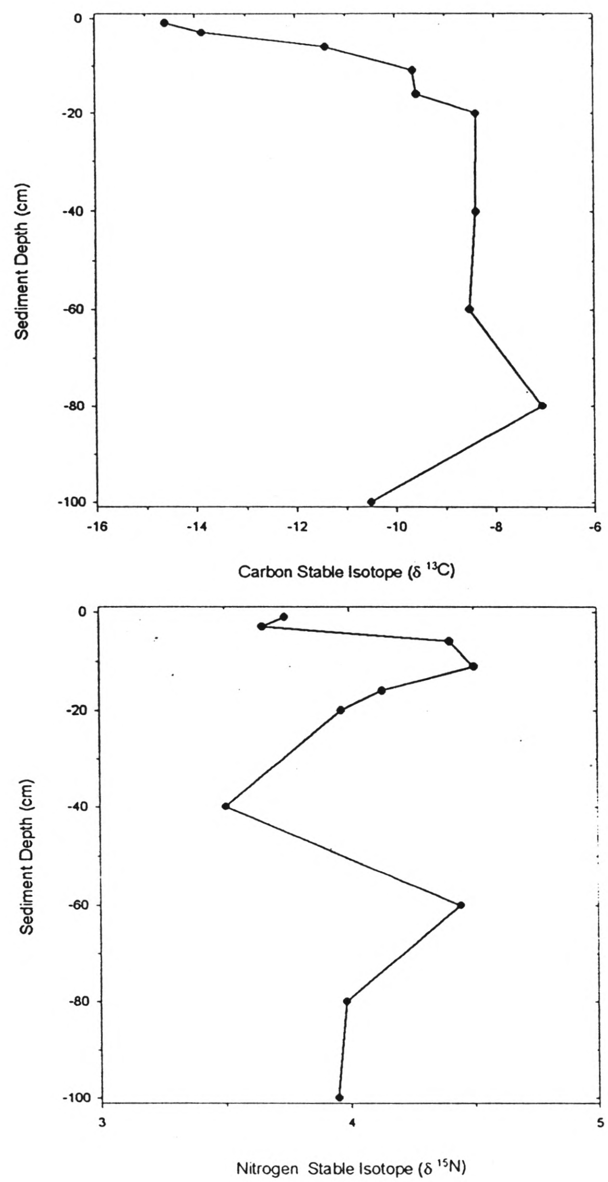

Figure 20. Average of nitrogen ($\delta\ ^{15}N$)and carbon ($\delta\ ^{13}C$)isotope values in Upper Laguna Madre - Baffin Bay sediments.

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. Higher inflow introduces higher values of dissolved inorganic nitrogen, which in turn stimulates primary production. The higher primary production, which is ephemeral and changes on very short time scales (days to weeks) drives benthic production, which changes over longer times scales (three to six months). Typically, nitrogen (which is derived from inflow and processed by estuarine organisms) is lost within the top 20 cm of sediment. Inflow also drives benthic community succession, due to different salinity tolerances of fresh, brackish, estuarine, and marine species. Due to the species changes and time scales of effects, the signal of inflow effects is easiest to measure and monitor using benthos as indicators. It is also apparent that long-term changes may be related to global climate cycles, e.g., El Niño events in the western Pacific Ocean. This study has benefitted by a statistical quirk (or trend) in climate data. There have been 11 El Niños in this century, three occurred in the first half and 8 have occurred in the second half. This short study (only 12 years) has captured three events. Because the long-term global cycles can vary from three to 20 years in length, long-term monitoring data will be required to develop reliable quantitative estimates of productivity versus inflow. Because the last few decades have been unusually wet, estimates based on the current study are likely to be over-estimates of the long-term average.

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TEXAS WATER DEVELOPMENT BOARD

September 29, 1999

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750 Channel View Drive
Port Aransas, TX 78373-5015

RE: Draft Final Report for Project 99-483-267: "Effect of Freshwater Inflow on Macrobenthos Productivity and Nutrient Losses in Texas Estuaries"

Dear Dr. Montagna:

I received and reviewed the draft final report "Effect of Freshwater Inflow on Macrobenthos Productivity and Nutrient Losses in Texas Estuaries." Attached are photocopies of several pages with minor typographic errors that I noticed in the draft. I have a few other comments that are all very minor.

Page 44, line 5, ". . . but abundance was highest only in July 1998." Looking at Figure 4 it appears to me that phrase above should say ". . . only in April 1999." I noticed that the indicator "D" was missing in figures 4, 5, 6, and 7. In figures 5 and 6 it is challenging to follow a few of the station patterns through time since dashed lines intersect without the "D" indicators.

Page 44, line 12, ". . . (in April 1998)." The year should be 1999 instead of 1998.

Page 44, line 14, "Stations A and B had higher abundance and biomass than stations C and D." While the pattern described above is true for biomass for three of the four sample periods, it only appears to be true for one of the sample periods for macrofaunal abundance (Figure 7). It looks like it would be hard to generalize on a pattern for the abundance case.

Page 58, lines 35-36, "Laguna Madre had lower nitrogen ($\delta\,^{15}N$) and carbon ($\delta\,^{13}C$) isotope values than Baffin Bay." In Figure 18, the nitrogen isotope ratios at depths below 40 cm for LM189 complicate the generalization that Laguna Madre has lower isotope ratios than Baffin Bay. I would agree with the generalization for depths less than 40 cm. For carbon isotopes at depths less than 40 cm, Figure 19 shows Laguna Madre samples with higher ratios than Baffin Bay. For greater depths, carbon isotope ratios for Laguna Madre ranged from values greater than Baffin Bay to values about the same as Baffin Bay. Note that figures 18, 19, and 20 do not appear to be referenced in the text.

That takes care of my comments; revision of the report should be easy.

Best regards,

[redacted]

William L. Longley, Ph.D.
Assistant Division Director, HEMon Division