IS SALINITY VARIABILITY A BENTHIC DISTURBANCE?

A Thesis

by

AMANDA D. VAN DIGGELEN

Submitted to the Office of Graduate and Professional Studies of Texas A&M University
and the Graduate Faculty of The Texas A&M University – Corpus Christi
in partial fulfillment of the requirements for the joint degree of

MASTER OF SCIENCE

Chair of Committee,	Paul Montagna
Committee Members,	Kim Withers
	Jennifer Pollack
Head of Department,	Joe Fox

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Abstract

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Estuaries are subjected to variable salinity regimes governed by variable freshwater inflow and tidal regimes. Estuaries are less saline near the river (source of fresh water); salinities increase towards the inlet of the adjacent sea or ocean. Freshwater inflow is a driver to the functioning of estuaries, and average salinity is usually measured to identify the effects of inflow. However, salinity variability could act as a disturbance by producing unstable habitats. The purpose of this research was to determine if salinity variance is an indicator of benthic disturbance, and therefore a driver of community stability. The macrofauna communities of the five most southern estuaries on the Texas coastline were analyzed using a long-term data set. The estuaries lie in a climatic gradient and have different long-term salinity dynamics, thus salinity variance within and between estuaries can be compared. Benthic diversity, evenness, and richness (i.e., total number of species) were calculated and compared to salinity average and salinity variance to determine the efficacy of each diversity measure for determining community changes within and between estuarine systems. Salinity variance, rather than salinity average, was found to be more correlated to benthic diversity for each estuarine system. Freshwater inflow acts as a benthic disturbance both within and between estuaries. As salinity variance decreased (i.e. reduced freshwater inflow) diversity levels of benthic communities increased, while areas with more freshwater inflow displayed lower levels of benthic diversity. These findings advance a general theory of diversity maintenance. When communities are not influenced by persistent stressors, such as salinity variance, multiple stages of succession may occur with more species available to occupy the resulting open niches, thereby increasing diversity.

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Introduction

Ecologists frequently assert that stability can be directly correlated to relative diversity within a given community. This idea stems from seminal papers that form the foundation of modern ecology. For example, Watt (1964, p. 1434) stressed that "a rich flora and fauna, as in tropical rain forests, tends to be very stable because of a multiplicity of ecological checks and balances…" and MacArthur (1955, p. 535) claimed, "stability increases as the number of links increase". The diversity-stability relationship is proposed as a potential safeguard that keeps communities from collapsing in times of stress and change (Doak et al. 1998, Ives et al. 2000, Ives and Hughes 2002).

Diversity within a community can be defined in two distinct ways: genetic diversity and species diversity. Genetic diversity increases the likelihood for a species to persist when experiencing extreme stressors, and is especially crucial with small, potentially bottlenecked populations (Roman and Darling 2007). Genetic diversity provides greater potential for uncommon genes to become dominant within a changing environment and allow the species to cope and adjust with a persistent disturbance. Conversely, species diversity can be a measure of the likelihood of a particular organism being present within an ecosystem (Roman and Darling 2007). While effects of stressors in terms of maintaining specific ecosystem processes may be diminished in a more diverse ecosystem, disturbance and stress are fundamental processes encountered by all organisms.

Disturbances are defined by the nature of their properties such as frequency (i.e., predictability), timing, size (i.e., magnitude), and duration (i.e., length of time) (Lake 2000). Disturbance is a process that has shaped communities into what they are today.

During a disturbance, organisms can be killed or displaced, consumable resources can be exhausted, and essential habitat may be lost (Tilman 1999). Temporal patterns of disturbances can be either a pulse event or a press event. Pulses are characterized as short-term events that have a sudden on-set such as hurricanes, floods or oil spills (Lake 2000). Conversely, press events are disturbances that are chronic, and may ultimately level off and become a constant force in the environment (Lake 2000). Examples of press events are global warming, droughts, or fishing pressures. Marine environments are subject to both press disturbances and pulse disturbances, so there is a growing need to ascertain the implications these events have on community dynamics and how systems can overcome or outlast the stress.

The stability and health of a community can be studied based on its inherent ability to either resist or recover from a disturbance. There is a rich literature on the link between stability of an ecosystem and diversity (Doak et al. 1998, Tilman 1999, Ives et al. 2000, McCann 2000, Ives and Carpenter 2007, Thébault and Loreau 2005). Differing concepts of stability can apply, depending on the dynamics and disturbances that are exhibited within a system. If a system is stable because it is resistant to disturbance, then it may be able to bend without breaking. Specifically, resistance is a measure of a system's tipping point, or the amount of pressure or stress that it can withstand before succumbing to a given pressure (Whitford et al.1999). A system will be more resistant when it is more diverse because there are more species to offset the stress. Conversely, a resilient system is able to bounce back following a disturbance. Measurements of recovery time and what exclusively can be recovered within a system form the basis of resilience metrics (Whitford et al.1999). Unlike resistance, a highly resilient community typically has low species diversity, which allows it to return to pre-disturbance conditions in a shorter time (Thompson et al. 2009). A system's ability to both resist and recover are contributing factors to ecosystem health and stability. Stability however, can have many definitions and the specific definition can give rise to different stability-diversity relationships (McCann 2000). Here we define community stability as low salinity variance, determined by freshwater input.

Freshwater inflows are an ideal way to study abiotic fluxes in an estuary because the effects of flow are multifaceted (Pollack et al. 2009, Montagna et al. 2013). Because inflow arrives in pulses, it can be viewed as a disturbance or stress. Typically, the mean salinity is calculated to represent environmental quality levels in freshwater inflow studies (McIvor et al. 1994, Montagna et al. 2002, Alber 2002, Montagna et al. 2008). But the variability of salinity as expressed as the variance of salinity could be an indicator of a disturbance that is presented by freshwater inflow pulses. By using salinity as an indicator, we can identify habitats that are specific to certain salinity zones. Thus, across habitats, both within estuaries (i.e., distinct stations) and between estuaries, the variability in salinity can provide a direct link to the stability of the salinity zone habitat.

The primary purpose this study was to determine if freshwater inflow variability is a disturbance that affects benthic community stability and diversity within estuaries. Thus, the primary null hypothesis is that salinity variance is not related to benthic community structure and diversity. The secondary purpose of this study is to determine if community stability, as defined by salinity variance, is influenced by press disturbance events (climatic freshwater gradient) or pulse disturbance events (floods). The approach used here is to examine the relationship between diversity and stability through the use of long-term data on estuarine benthos, freshwater inflow, and salinity across multiple spatial scales.

Methods

Study Sites

Texas has seven major estuaries along its coastline, but this study analyzed the five most southern estuaries: Laguna Madre Estuary (LM), Nueces Estuary (NC), Mission-Aransas Estuary (MA), Guadalupe Estuary (GE), and Lavaca-Colorado Estuary (LC) (Fig. 1). While each estuary is distinct, they share similar geomorphological structural traits. The estuaries form at the mouth of a river, where freshwater from a river flows into a secondary bay. Navigating towards the Gulf of Mexico, secondary bays are connected to primary bays that are open to the ocean and tides, so this environment has more marine influence. Thus, within each estuary there is a gradient of lower salinity secondary bays, and higher salinity primary bays. However, Laguna Madre is a reverse estuary and is therefore subjected to hydrographic influences unseen in the other estuaries. This estuary is classified as a hypersaline lagoon, governed by greater evaporation rates than freshwater runoff into the system (Kjerfve and Magill 1989). Contrary to a typical estuary, reverse estuaries have higher salinities associated with the secondary bay, while the more marine influenced primary bay has lower salinity. It is an uncommon system, but an excellent “test” estuary to determine the efficacy of hydrographic disturbance indicators. When present in the analysis, Laguna Madre may act as an outlier, influencing both the average and variance of a variable’s distribution (Hendra and Staum 2010). Although each estuary shares common structural attributes with the others, these sites offer a good spatial comparison because salinity within each bay varies due to differences in freshwater inflow (Montagna et al. 2011a).

Variation in salinity among estuaries is driven by differing freshwater inflow and climatic regimes (Montagna and Kalke 1995, Montagna et al. 2007, Montagna et al. 2011a, Montagna et al. 2011b). Generally, rainfall is sparsest in the southwestern region, and increases towards the northeast. The southwestern region of Texas is also subjected to variable rainfall on an annual basis, thereby producing a series wet and dry years over time (Fig. 2). The amount of freshwater inflow entering an estuary is subsequently driven by this climatic regime, and the southwestern estuaries receive markedly lower inflow levels compared to their northeastern counterparts (Table 1).

Sampling

Due to the structural similarities of Texas estuaries, Montagna and Kalke (1992, 1995) established 4-6 stations (A-F) within each estuary, where each sampling station varies in distance from the source of freshwater. To maintain a balanced experimental design only 4 stations, A-D, were used in this research. Stations (A-D) were assigned along a salinity gradient, with stations A and B closest to the freshwater inflow and stations C-D are closest to the Gulf of Mexico (Fig. 1). By having stations A and B within a region subjected to freshwater influence, and stations C and D in a region under stronger marine influence, the problem of pseudoreplication addressed by Hurlbert (1984), is mitigated (Montagna and Kalke 1995) (Fig. 1). For Laguna Madre, stations were renamed into the same letter format where: station 6 represents A, station 24 represents B, station 189G (seagrass bottom) represents C, and station 189S (sand bottom) represents D (Table 2).

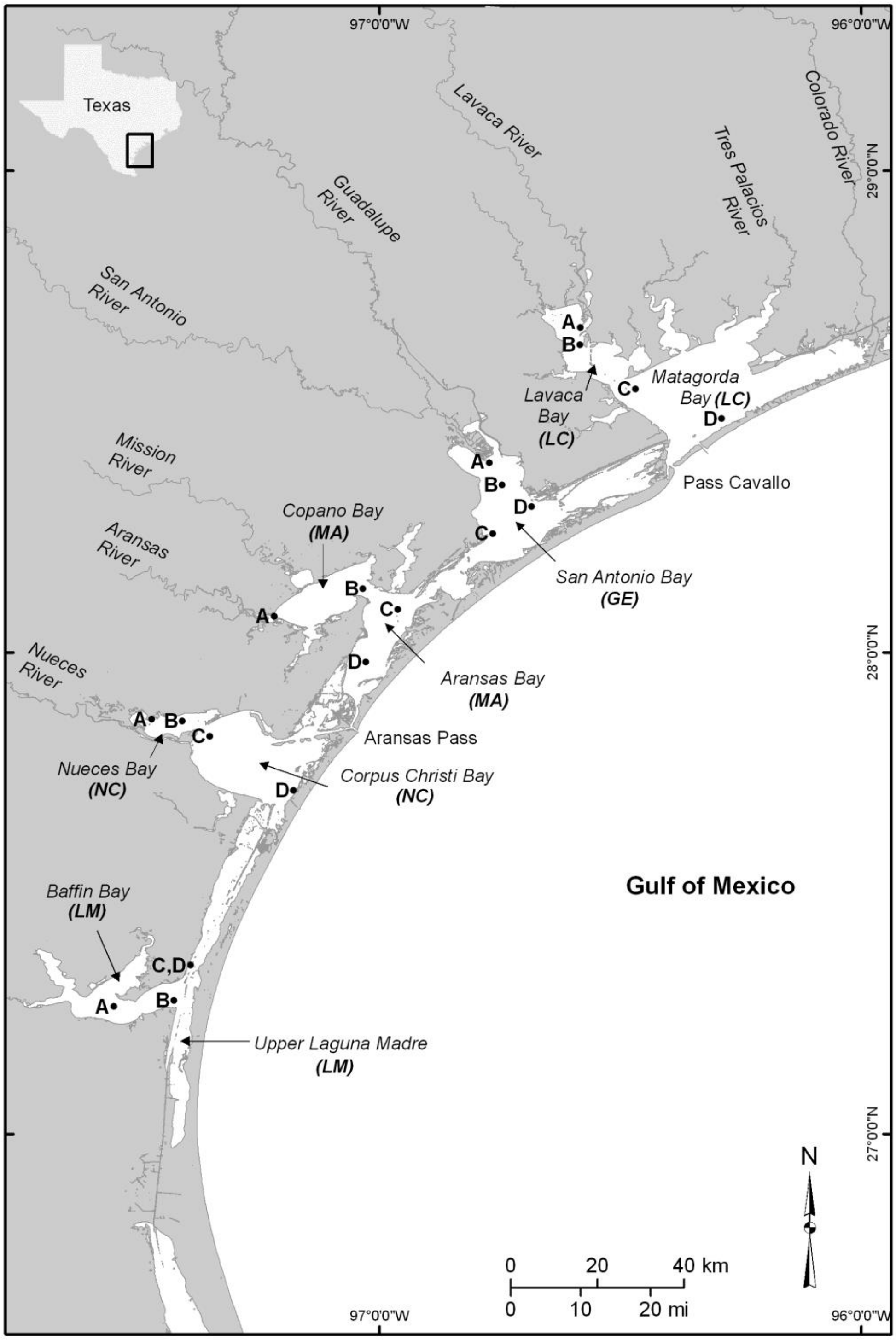

Fig. 1 Map of study sites along Texas coast with station locations within each site. Estuaries identified within parentheses underneath associated primary and secondary bays: Laguna Madre Estuary (LM), Nueces Estuary (NC), Mission-Aransas Estuary (MA), Guadalupe Estuary (GE), and Lavaca-Colorado Estuary (LC). Station coordinates located in Appendix 1.

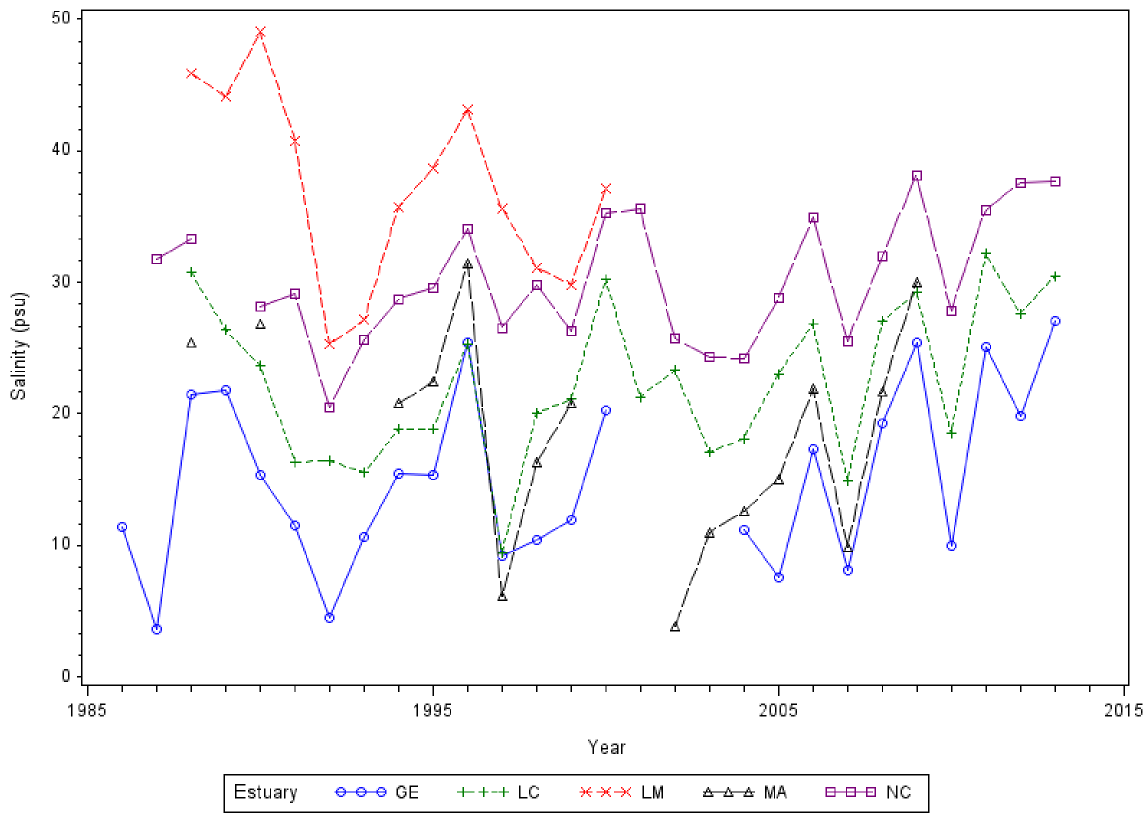

Fig. 2 Average estuary-wide salinity by year over the course of the present study. Estuary abbreviations same as Fig. 1.

Table 1 Texas coastline estuarine gradients. Estuaries are listed from north to south; area at mean low tide (Diener 1975), average annual rainfall (1951-1980, Larkin and Bomar 1983), and average annual freshwater inflow balance (1941-1999, Texas Water Development Board http://www.twdb.state.tx.us/data/bays_estuaries/bays_estuary_toc.htm), average estuary-wide salinity (Orlando et al. 1993). Original table outlined in Montagna et al.2007.

Estuary	Area (km^2)	Rainfall (cm yr^{-1})	Inflow (10^6 m^3 yr^{-1})	Salinity (ppt)
Lavaca-Colorado	1,158	102	3,801	18
Guadalupe	551	91	2,664	16
Mission-Aransas	453	81	265	15
Nueces	433	76	298	23
Laguna Madre	1,139	69	-893	36

At each of the stations, samples for the benthic fauna were collected quarterly each year in the months of January, April, July, and October. Kalke and Montagna (1991) established this sampling regime, and numerous studies (Montagna and Kalke 1992, Montagna 2000, Palmer et al. 2011, Kim and Montagna 2012) have demonstrated the efficacy of quarterly sampling for capturing temporal benthic dynamics in Texas estuaries.

To sample benthic macrofauna, 3 replicate sediment cores are taken within a 2 meter radius at each station within an estuary. Macrofauna are collected with a 6.7 cm diameter coring tube (35.4 cm^2 area) attached to a long pole, to reach the bay floor from a boat. As the core is pulled onto the boat, the bottom is capped off before leaving the water so the sample is not lost. Following collection the cores are split into two depths for sampling (0-3 cm and 3-10 cm). Benthic macrofauna from the cores are preserved in the field using 5% buffered formalin. When returned to the lab these cores are sieved on 0.5 mm mesh screens. Biota are then sorted, counted, and identified to the lowest taxonomic level for abundance measures (species distribution data for Lavaca-Coloardo and Guadalupe estuaries are found in Appendix 2, species distribution data for Mission-Aransas, Nueces, and Laguna Madre estuaries are found in Appendix 3). Following laboratory separations, relative measures of species richness (S), Shannon-Weiner Diversity (H′), and Pielou's Evenness Index (J′) were calculated for each date/station combination. Shannon-Weiner's Diversity index was chosen due to its familiarity and frequency of appearance in the ecological literature. Richness (i.e., total species number) and evenness were included to provide a different perspective of benthic community structure within and among the estuaries. Both species richness (S) and evenness (J′)

describe the two general aspects that contribute to diversity. Richness is simply the total number of species present, while evenness calculations illuminate how abundance is distributed among the total number of individuals within a community (Heip et al. 1998).

Hydrographic data were collected concurrently starting with the initial sampling period in 1987, and measurements include: salinity, pH, dissolved oxygen, temperature, conductivity, oxidation-reduction potential, and depth (Monatgna and Kalke 1992, 1995). Measurements were collected both at depth (0.1 m above bay bottom) and at the surface using a sonde. The initial instrument was a Hydrolab 4000 later replaced by a YSI 6920. For this study, the only hydrographic parameter of interest is salinity, which is reported in practical salinity units (psu). Both hydrographic and macrofauna data from each station, within the 5 estuaries of interest, are available dating back to 1988.

Statistical Analysis

Statistical analyses were performed with SAS software version 9.3 (SAS Institute Inc. 2013). PROC UNIVARIATE was used to analyze the distribution and normality of the diversity data. There was no need to adjust for normality so the raw data were used in the subsequent analyses. A 2-way partially hierarchical Analysis of Variance (ANOVA) was run using PROC GLM. This ANOVA was used to test for differences in the three dependent variables S, H´, and J´ among dates, estuaries, and stations nested within estuaries, and the interaction. Tukey's Standardized Range Test was run in tangent with the ANOVA as a post-hoc analysis in order to determine the relationship between location and the diversity indices. Following PROC GLM, scatterplots were created using PROC SGSCATTER to show the relationship of both salinity average and salinity variance on the three variables of interest. Two scatterplots were created to show the

Table 2 Location of sampling stations and time periods. Stations in parentheses renamed for the current study. Station coordinates located in Appendix 1.

Estuary	Bay Type	Bay Name	Stations	Sampling Period
Lavaca-Colorado	Secondary Primary	Lavaca Bay Matagorda Bay	A, B C, D	1988-2009
Guadalupe	Secondary	Upper San Antonio Bay	A, B	1987-2000, 2004-2013
	Primary	Lower San Antonio Bay	C, D	
Mission-Aransas	Secondary Primary	Copano Bay Aransas Bay	A, B C, D	1988, 1990, 1994-1999, 2002, 2003
Nueces	Secondary Primary	Nueces Bay Corpus Christi Bay	A, B C, D	1987-2002, 2012
Laguna Madre	Secondary Primary	Baffin Bay Laguna Madre	6(A), 24(B) 189G(C), 189S(D)	1988-2000

differences between the measures when the Laguna Madre Estuary was present and removed. Laguna Madre is a reverse estuary and potentially an anomalous system, so it was imperative to determine if it had a significant effect on the outcome. Finally, PROC CORR was used in order to determine the strength and significance of each relationship between both salinity measures and the three dependent variables in the generated scatterplots.

After determining the relationship's strength and significance for each diversity and salinity measure, non-metric multi-dimensional scaling (MDS) was used to analyze macrofaunal community structure. The MDS plot was created using a Bray-Curtis similarity matrix among estuaries and stations using Primer software (Clarke and Gorley 2006). The data were root transformed before calculating the Bray-Curtis similarity. A root transform reduces the weight of dominant species, thereby allowing less common species to impact the similarity calculation (Clarke and Warwick 2001). Cluster analysis and salinity vectors were subsequently used to illustrate the relationship between macrofaunal community composition and the response to salinity. Finally a SIMPER analysis was done following the cluster analysis also using Primer software (Clarke and Gorley 2006). Samples were disaggregated from their multivariate structure in order to identify which species primarily drive the sample groupings in the cluster analysis (Clarke and Warwick 2001). By calculating average dissimilarity between all samples for two groups, and then breaking this dissimilarity down into contributions of each species to the dissimilarity (Clarke and Warwick 2001) we were able to find good discriminating species. A good discriminating species is determined by how significantly it contributes to the dissimilarity between two groups (Clarke and Warwick 2001); here groupings were established between estuaries and between stations.

Results

The 2-way ANOVA produced no significant interaction between the factors, dates and estuaries, for the three diversity measures (Table 3). However, the factor estuary does have a significant relationship with each of the diversity measures independent of the factor date (Table 3). Taking this independent influence of estuary, salinity regimes can be measured solely on location, without examining influences potentially imposed at the time of collection.

Salinity Measures

There is a strong inverse relationship between salinity variance and diversity measures: S, H´, and J´ (Fig. 3). As salinity variance increases within an estuary the diversity of the system decreases. Concurrently, species richness and community evenness also decrease. More marine influenced stations (C and D) tend to have lower variance and higher diversity than the freshwater influenced stations (A and B). With the exception of stations C and D for LC, there is an additional diversity gradient with highest diversity in southwestern estuaries and decreasing diversity toward northeastern estuaries. Each relationship between salinity variance and diversity was significant for the Pearson-Correlation test (all p-values < 0.05).

There is no linear relationship between average salinity and the dependent variable J´ (Fig. 3f), and the Pearson correlation test found no significant relationship between average salinity and J´ ($p > 0.05$). However, average salinity shows a slight positive linear relationship for both S and H´ (Fig. 3d, e). The Pearson correlation test found a significant relationship for S with a p-value < 0.05, while the relationship between average salinity and H´ was insignificant ($p > 0.05$).

Salinity Measures without Laguna Madre

Coinciding with the first analysis, which includes LM, as salinity variance increases the dependent variables decrease (Figs. 4a, b, c). Again, marine-influenced stations are less variable and diversity is higher. The same climatic distribution is observed with higher diversity in southwestern estuaries compared to their northeastern counterparts (with the exception of stations C and D in LC). Even with the removal of LM the salinity variance relationship with all 3 diversity measures remains significant when determining the Pearson-correlation values (p-values < 0.05). In the absence of LM there is a positive correlation generated between estuarine salinity averages and the dependent variables: S, H´, and J´ (Figs. 4d, e, f). Diversity at marine-influenced stations (C and D) is higher, corresponding to higher average salinity. There is also a climatic gradient that is manifest in the higher average salinity in the southwest that decreases to

Table 3 Probabilities of 2-way ANOVA testing for differences on the three dependent variables S, H´, and J´ among dates, estuaries, and the interaction. Abbreviations: S=species richness, H´=Shannon-Weiner Diversity, and J´=Pielou's Evenness Index.

Factor	S	H´	J´
Dates	<0.0001	0.1327	0.0003
Estuaries	<0.0001	<0.0001	<0.0001
Dates*Estuaries	0.9999	0.9993	0.4516

the northeast (excluding stations C and D in LC). While the Pearson correlation analysis affirmed this linear relationship with corresponding significant values for average salinity and both S and H´, J´ still remains statistically insignificant.

Macrofaunal Community Structure

The Multidimensional scaling (MDS) Cluster Analysis split macrofaunal communities into three distinct groups (Fig. 5a). Within each of the three groups, there is at least a 40% similarity among stations. MDS Group 1 contained the two stations within the upper Laguna Madre's proper. Within MDS Group 1 the macrofaunal communities of stations C and D of Laguna Madre were at least 60% similar to one another. MDS Group 2 contained Baffin, Copano, Aransas, upper San Antonio, lower San Antonio, Lavaca, and Nueces bays. Within MDS Group 2, stations A and B of Laguna Madre were at least 60% similar in their macrofanual community composition. Within MDS Group 2, stations A and B of Mission Aransas Estuary were at least 50% similar to one another in their marcofaunal community structure while stations C and D of Mission Aransas Estuary were at least 60% similar to one another. Within MDS Group 2, there was at least a 50% similarity between all stations within the Guadalupe Estuary, stations A and B of the Lavaca-Colorado Estuary, and station A of the Nueces-Corpus Estuary. Within MDS Group 2, of the four stations found within the Guadalupe Estuary, stations A and B were at least a 60% similar to one another and stations C and D were 60% similar to one

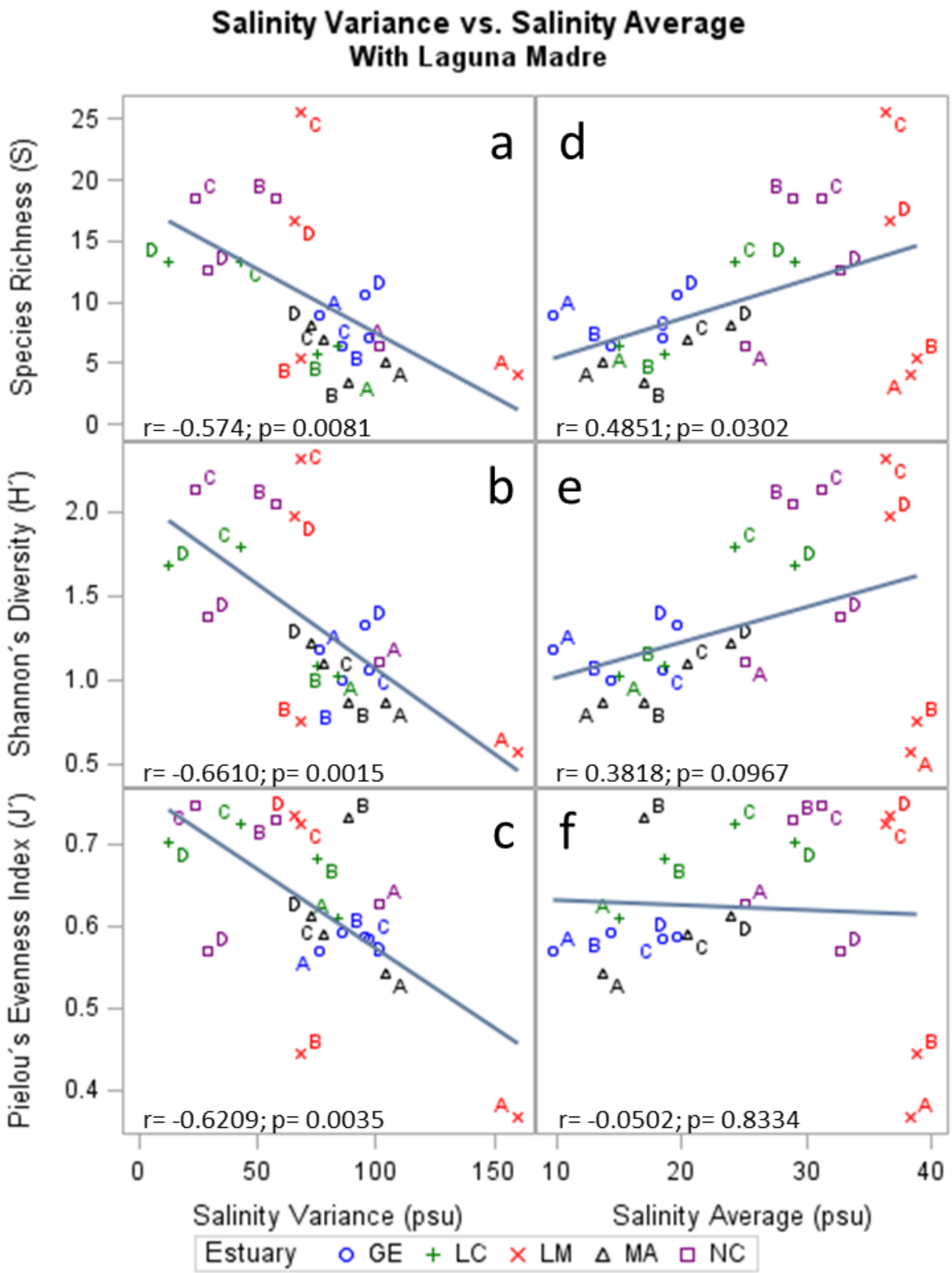

Fig. 3 Relationship between salinity measures and dependent variables with Laguna Madre Estuary. Estuary abbreviations same as Fig. 1, r=Pearson correlation coefficient, p=p-value.

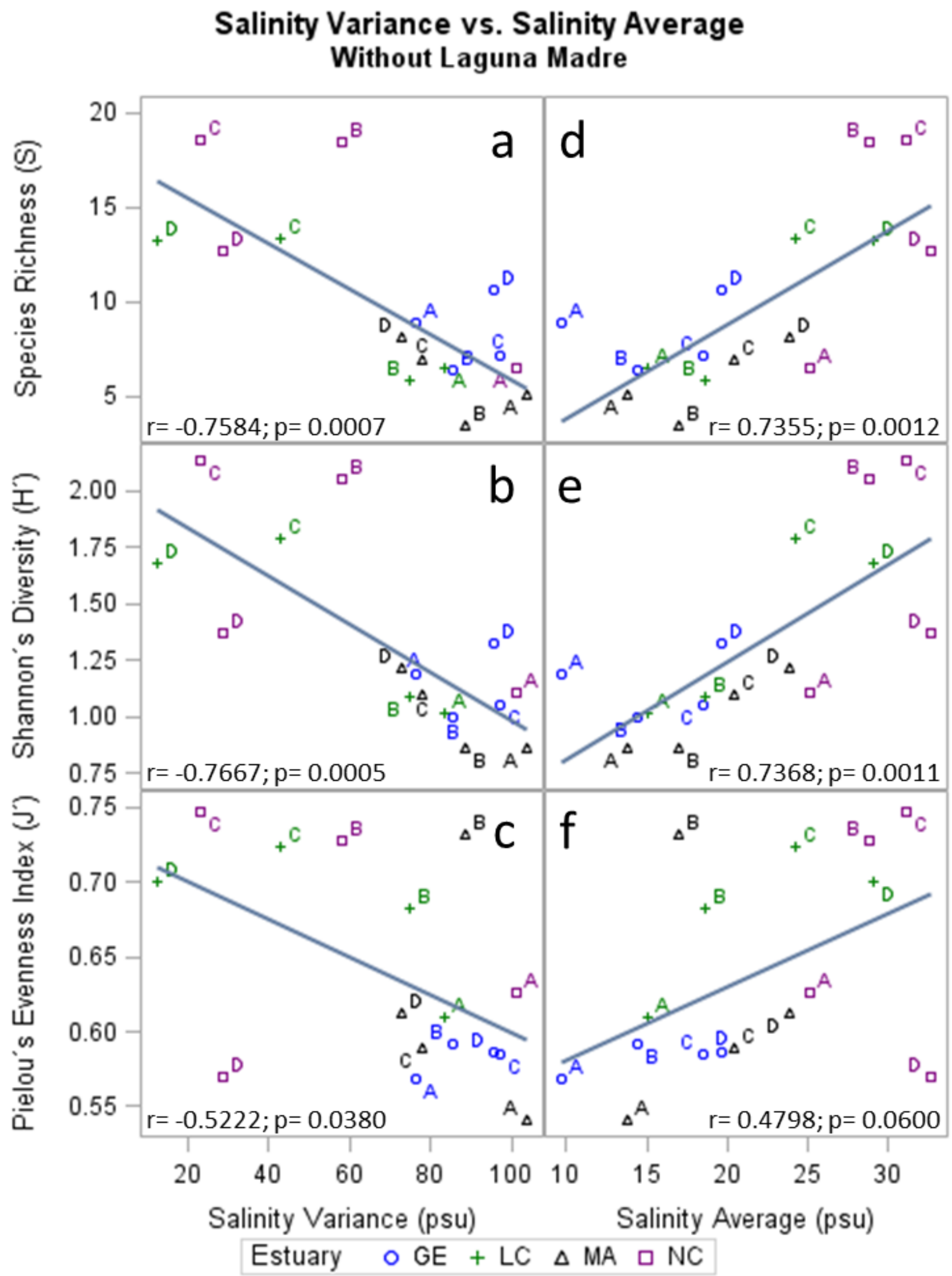

Fig. 4 Relationship between salinity measures and dependent variables without Laguna Madre Estuary. Estuary abbreviations same as Fig. 1, r=Pearson correlation coefficient, p=p-value.

another for their macrofaunal community structures. Within MDS Group 2, stations A and B of the Lavaca-Colorado Estuary and station A of the Nueces-Corpus Estuary had at least a 60% similarity in their macrofaunal community structure. MDS Group 3 contained Nueces, Corpus Christi, and Matagorda bays. All stations within MDS Group 3 share at least a 50% similarity in macrofaunal community structure. Within MDS Group 3, stations C and D of the Nueces-Corpus Estuary and station C of the Lavaca-Colorado Estuary have at least a 60% similarity in their macrofaunal community structure. Figure 5b displays MDS ordination of changing salinities along the 5 estuaries and 4 stations in relation to benthic community assemblages. The line denotes salinity trajectory by linking values sequentially among site locations from lowest salinity (GE-A, 10 psu) to highest salinity (LM-A, 39 psu).

The Simper analysis revealed particularly influential species between samples. While each estuary had a unique set of dominant organisms, *Mediomastus ambiseta* and *Streblospio benedicti* were consistently two of the top three dominant organisms found throughout all estuaries (Table 4). Other dominant species included *Apseudes* sp. A for LC, *Texadina sphinctostoma* for GE, *Paraprionopio pinnata* for MA (not a top overall dominant species), *Polydora caulleryi* for NC, and unidentified species of Oligochaeta for LM. Coinciding with estuaries, comparisons of station locations revealed that both *M. ambiseta* and *S. benedicti* were again two of the top three dominant organisms (Table 5). Unidentified species of Oligochaeta, was the third dominant species for the primary bays, and *Texadina sphinctostoma* and *Mulinia lateralis* rounded out the top three dominants for stations A and B respectively. These dominant species comprised over 75% of the abundance over the course of the study.

While estuaries share common dominant species, all of the comparisons done through the Simper analysis revealed a unique combination of discriminating species with the top 3 discriminating species between two estuaries consistently varied (Table 6). The average dissimilarity values reveal how different two estuaries are with the lowest overall dissimilarity value seen between LC and NC at 45.68 and the greatest overall dissimilarity value between LM and MA at 67.19. Laguna Madre is the most dissimilar estuary with all dissimilarity values over 60. There is no relationship between the dissimilarity values and geographic location of each estuary.

Similarly, the comparisons between stations reveal a distinct grouping of the top 3 discriminating species, with only a few of the dominant species presented as a strong discriminating species (Table 7). Unlike the comparisons between estuaries, stations demonstrate a spatial relationship, where dissimilarity values are lower the closer two stations are to one another. Stations A and B are most similar with a dissimilarity value of 35.15. This comparison is followed closely by stations C and D, which have a dissimilarity value of 36.8. Stations A and D are the most dissimilar at 60.58. The remaining "intermediate" combinations are comprised of groupings associated with either station B or C.

Finally, a post-hoc test using Tukey's Standardized Range Test was used to determine how similar the estuaries were to one another for the three diversity measures (Table 8). For species richness (S) NC was significantly different from all other estuaries, LC and LM were not significantly different from one another but were significantly different from the remaining three estuaries, and GE and MA were not significantly different from one another, but were significantly different from LC, LM, and NC. For Shannon-Weiner diversity (H´) NC was significantly different from all other estuaries, and LC and LM were not significantly different from one another. While LC was significantly different from MA, GE, and NC for H´, LM was not significantly different from MA and GE. For Pielou's Evenness Index (J´) estuaries NC, LC, and MA were not significantly different from one another but were significantly different from GE and LM. GE and LM were not significantly different in the evenness of their species abundances.

Discussion

Average salinity is one of the most common ancillary measures used in ecological research efforts to monitor benthic disturbance (McIvor et al. 1994, Montagna et al. 2002, Alber 2002). However, the primary purpose of this study was to determine if salinity variance could be used as an indicator of benthic disturbance. The results from this long-term analysis show that salinity variance may be better than average salinity at capturing the same disturbance. When compared against one another, salinity variance was able to capture the same community diversity trends, with or without the anomalous Laguna Madre System (Fig. 3a, b, c, and Fig. 4a, b, c). However, salinity average showed a significant correlation between salinity levels and diversity trends only in the absence of Laguna Madre. While average salinity can be used to measure diversity of benthic communities, salinity variance may be a better indicator of diversity, and therefore stability, due to its ability to capture significant trends across different estuarine systems.

Disturbance regimes are well known for having a significant impact on biodiversity within a given community (Connell 1978, Huston 1994). Therefore, a

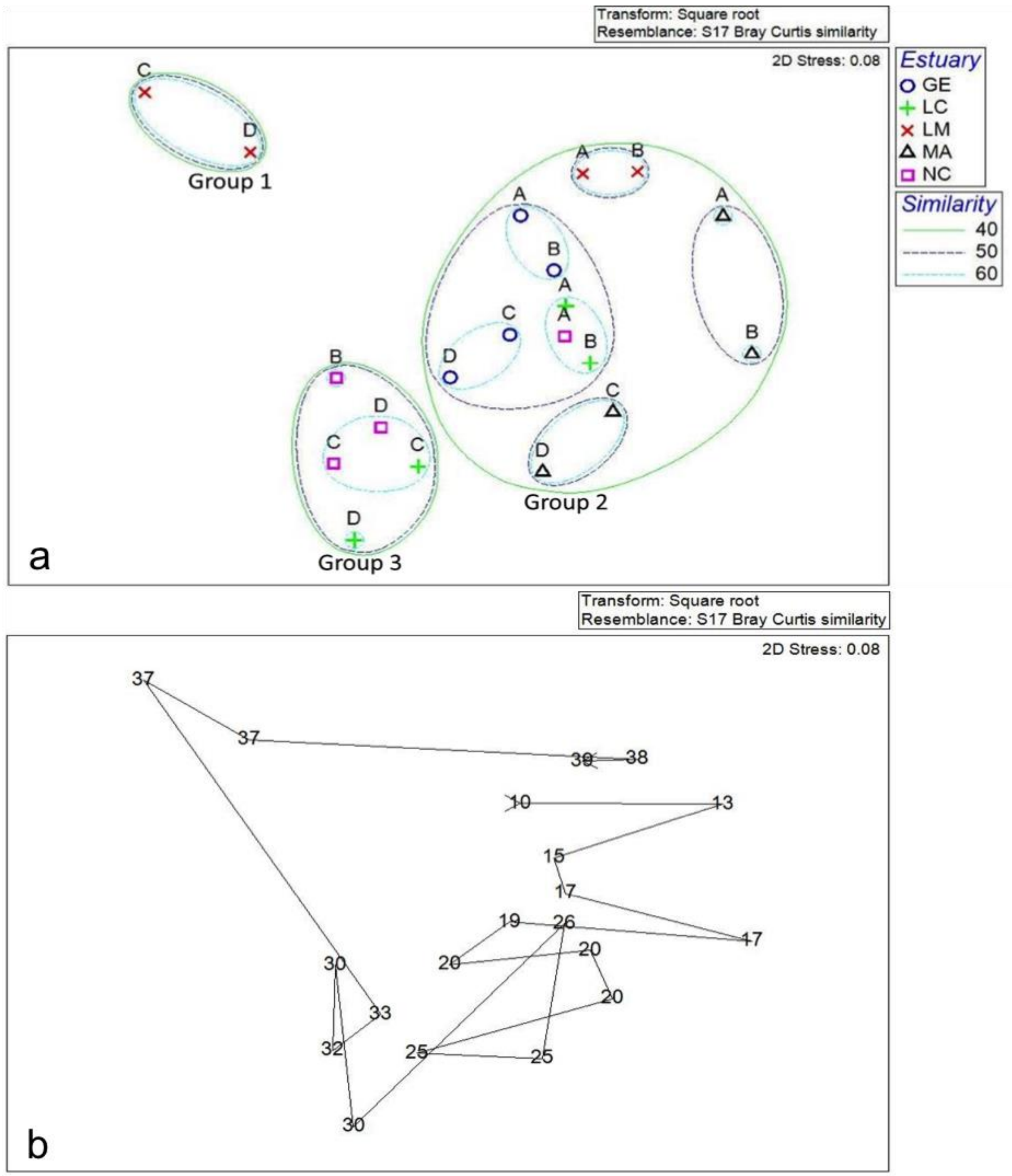

Fig. 5 Multidimensional scaling (MDS) plot and cluster analysis of macrofauna community similarity. A With stations as labels and B with overall average salinity as label and salinity trajectory (i.e. seriation from lowest to highest salinity). Estuary abbreviations same as Fig. 1.

Table 4 Dominant species in each estuary (>1% overall contribution) with remaining species (<1% overall contribution) combined. Abundance (n/m^2) of dominant species provided in parentheses, and an asterisk indicates top 3 species within an estuary. Overall species abundances and rankings located in Appendix 4.

Rank	Taxa	Overall	Lavaca-Colorado	Guadalupe	Mission-Aransas	Nueces	Laguna Madre
1	*Mediomastus ambiseta*	27.1%	41.6%	41.1%	38.6%	29.4%	4.7%
		(10,671)	(11,895*)	(18,391*)	(7,995*)	(12,207*)	(2,865*)
2	*Streblospio benedicti*	19.4%	6.3%	21.4%	36.8%	11.2%	23.9%
		(7,639)	(1,807*)	(9,579*)	(7,623*)	(4,648*)	(14,537*)
3	Oligochaeta (unidentified)	5.7%	3.4%	0.9%	0.9%	1.1%	15.1%
		(2,243)	(980)	(407)	(189)	(468)	(9,173*)
4	*Mulinia lateralis*	4.4%	3.0%	8.2%	0.7%	5.8%	2.8%
		(1,745)	(848)	(3,649)	(142)	(2,403)	(1,683)
5	*Polydora caulleryi*	3.0%	2.9%	0.6%	0.7%	11.3%	0.0%
		(1,189)	(840)	(265)	(142)	(4,697*)	(0)
6	*Texadina sphinctostoma*	2.9%	0.1%	12.4%	0.4%	0.0%	0.0%
		(1,128)	(16)	(5,548*)	(77)	(0)	(0)
7	*Ampelisca abdita*	2.3%	1.1%	1.2%	2.4%	1.0%	4.5%
		(904)	(319)	(528)	(502)	(402)	(2,766)
8	*Prionospio heterobranchia*	2.3%	0.0%	0.0%	0.0%	0.0%	7.4%
		(902)	(0)	(0)	(0)	(0)	(4,512)
9	*Syllis cornuta*	1.9%	0.0%	0.0%	0.0%	0.1%	6.0%
		(747)	(1)	(1)	(0)	(54)	(3,678)
10	*Tharyx setigera*	1.7%	0.9%	0.0%	0.1%	7.5%	0.0%
		(676)	(245)	(15)	(12)	(3,108)	(0)
11	Nemertea (unidentified)	1.6%	2.4%	1.2%	1.8%	1.5%	1.6%
		(638)	(699)	(553)	(366)	(611)	(959)
12	*Apseudes* species. A	1.4%	9.7%	0.0%	0.0%	0.0%	0.0%
		(557)	(2,786*)	(0)	(0)	(0)	(0)
13	*Exogone* species.	1.2%	0.0%	0.0%	0.0%	0.0%	4.0%
		(491)	(0)	(2)	(0)	(13)	(2,442)
14	*Capitella capitata*	1.2%	0.2%	0.9%	0.5%	0.2%	2.8%
		(467)	(70)	(381)	(112)	(67)	(1,706)
	Remaining species percent	23.7%	28.4%	12.1%	17.2%	31.0%	27.2%
	Total percent	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	Remaining species count	375	226	185	75	265	161
	Total species count	389	238	197	85	276	171

Table 5 Dominant species at each station (>1% overall contribution) with remaining species (<1% overall contribution) combined. Abundance (n/m^2) of dominant species provided in parentheses, and an asterisk indicates top 3 species at a station. Overall species abundances and rankings located in Appendix 4.

Rank	Taxa	Overall	Station A	Station B	Station C	Station D
1	*Mediomastu ambiseta*	27.1% (10,671)	31.1% (10,138*)	29.5% (10,575*)	21.7% (10,222*)	28.2% (11,748*)
2	*Streblospio benedicti*	19.4% (7,639)	32.7% (10,639*)	33.4% (11,977*)	8.2% (3,869*)	9.8% (4,070*)
3	Oligochaeta (unidentified)	5.7% (2,243)	0.7% (215)	0.4% (147)	10.3% (4,875*)	9.0% (3,735*)
4	*Mulinia lateralis*	4.4% (1,745)	8.1% (2,651)	7.5% (2,675*)	2.3% (1,084)	1.4% (570)
5	*Polydora caulleryi*	3.0% (1,189)	0.0% (3)	2.5% (907)	1.1% (503)	8.0% (3,342)
6	*Texadina sphinctostoma*	2.9% (1,128)	10.3% (3,347*)	2.2% (801)	0.6% (288)	0.2% (77)
7	*Ampelisca abdita*	2.3% (904)	5.9% (1,912)	4.2% (1,494)	0.2% (111)	0.2% (97)
8	*Prionospio heterobranchia*	2.3% (902)	0.0% (14)	0.0% (0)	5.7% (2,684)	2.2% (912)
9	*Syllis cornuta*	1.9% (747)	0.0% (4)	0.1% (30)	4.6% (2,152)	1.9% (800)
10	*Tharyx setigera*	1.7% (676)	0.0% (8)	2.3% (834)	2.3% (1,085)	1.9% (777)
11	Nemertea (unidentified)	1.6% (638)	0.8% (253)	0.9% (339)	2.6% (1,214)	1.8% (743)
12	*Apseudes* species. A	1.4% (557)	0.0% (0)	0.0% (0)	0.0% (1)	5.4% (2,228)
13	*Exogone* species.	1.2% (491)	0.1% (18)	0.0% (6)	3.7% (1,763)	0.4% (178)
14	*Capitella capitata*	1.2% (467)	1.0% (332)	0.5% (162)	1.0% (494)	2.1% (880)
	Remaining species percent	23.7%	9.4%	16.5%	35.7%	27.5%
	Total percent	100.0%	100.0%	100.0%	100.0%	100.0%
	Remaining species count	375	149	207	286	291
	Total species count	389	162	219	300	305

Table 6 Average dissimilairty values and the top 3 associated discriminating species between estuaries.

Estuary	Lavaca-Colorado	Guadalupe	Mission-Aransas	Nueces
Guadalupe	47.28 *Cyclaspis varians* *Axiothella mucosa* *Pyramidella crenulata*			
Mission-Aransas	49.74 *Sphaerosyllis* species. A *Streblospio benedicti* *Mysidopsis bahia*	51.89 *Neanthes succinea* *Rictaxis punctostriatus* *Tellina texana*		
Nueces	45.68 *Ogyrides limicola* *Oxyurostylis salinoi* *Drilonereis magna*	53.80 Maldanidae (unidentified) *Mysidopsis* species. *Acteocina canaliculata*	59.34 *Corophium ascherusicum* *Lumbrineris parvapedata* Oligochaeta (unidentified)	
Laguna Madre	65.09 *Listriella barnardi* Gastropoda (unidentified) *Sigambra bassi*	62.17 *Polydora socialis* *Anaitides erythrophyllus* Nudibranchia (unidentified)	67.19 Pycnogonida (unidentified) *Grandidierella bonnieroides* *Anaitides erythrophyllus*	65.40 *Oxyurostylis salinoi* *Glycinde solitaria* *Mediomastus ambiseta*

Table 7 Average dissimilairty values and the top 3 associated discriminating species between stations.

Station	A	B	C
B	35.15 *Capitella capitata* *Ampelisca abdita* *Mediomastus ambiseta*		
C	57.34 *Turbonilla* species. *Ampelisca abdita* *Branchioasychis americana*	48.88 *Mulinia lateralis* *Tellina* species *Mitrella lunata*	
D	60.58 *Mulinia lateralis* *Turbonilla* species. *Axiothella mucosa*	56.04 *Mulinia lateralis* Nereididae (unidentified) *Listriella barnardi*	36.80 *Axiothella mucosa* *Haploscoloplos fragilis* *Branchioasychis americana*

Table 8 Tukey's Studentized Range (HSD) Test for the three dependent variables S, H´, and J´ for estuary. Means with the same letter are not significantly different. Abbreviations: S=species richness, H´=Shannon-Weiner Diversity, and J´=Pielou's Evenness Index.

Estuary	S		H´		J´	
	Average Value	Tukey Grouping	Average Value	Tukey Grouping	Average Value	Tukey Grouping
Lavaca-Colorado	13.619	B	1.561	B	0.645	A
Guadalupe	10.140	C	1.232	C	0.569	B
Mission-Aransas	8.646	C	1.261	C	0.639	A
Nueces	18.876	A	1.858	A	0.669	A
Laguna Madre	14.356	B	1.414	BC	0.546	B

secondary pursuit of this research was to determine the impact of freshwater related disturbance events to benthic communities. In order to evaluate two types of disturbance events, pulse and press, the two distinct salinity gradients established in this study must be considered when interpreting the results. One of these gradients is within an individual estuary, while the second gradient is between estuaries. Within an estuary, there were two distinctions made: 1) a freshwater influenced region, defined by stations A and B, located within a secondary bay nearest the source of freshwater input, and 2) a marine influenced region defined by stations C and D, located within a primary bay closer to the Gulf of Mexico. The second gradient is a natural climatic gradient imposed on the estuaries. Southwestern estuaries are situated in a more arid region, and have less freshwater input than their northeastern counterparts (Table 1). As estuaries transition northward, they receive more freshwater input naturally due to this climatic gradient. Additionally, the annual amount of freshwater input each estuary receives is also highly variable with an oscillation between wet and dry years (Fig. 2).

The acute behavior associated with pulse disturbances can be analyzed using the first gradient, which looks at benthic communities within individual estuaries. In this scenario a pulse of freshwater inflow simulates short-term flooding events. Under this disturbance condition the station closest to the point source of inflow (Station A) is the most susceptible to the disturbance, with relative impacts dissipating away from the river outflow (Station D least susceptible). As shown by salinity variance in Fig. 3b, every station A within an individual estuary has lower diversity than D stations within the same estuary. This behavior is also apparent in species richness (Fig. 3a) and evenness (Fig. 3c). In conjunction with these diversity measures are the individual species present within each estuary. One notable species is *Mulinia lateralis,* which is a dominant species for stations A and B (Table 5). *Mulinia lateralis* is a clam which has demonstrated a strong ability to take advantage of disturbances such as increased freshwater (Flint and Younk 1983). Key behaviors associated with this opportunist are a strong ability to persist in a range of salinity levels (Parker 1975, Montagna and Kalke 1995), continual settling from the water column following a spawning event (Holland et al. 1977), and a short generation time (Calabrese 1969). These attributes are likely driving factors that make this clam an excellent discriminating species when comparing stations in a secondary bay to primary bay stations (Table 7).

However, it is not only discriminating species that can be used to differentiate between benthic communities within an estuary. In frequently disturbed systems fewer species are found because it requires special adaptations to persist in an unpredictable environment (Menge 1976). With more frequent or severe disturbances, resource monopolization is reduced, and instead abiotic conditions act as a diversity filter rather than biotic conditions (Sousa 1979). Stations A and D are not only the most dissimilar in species composition, but the total species count as well (Table 5). Station A has the fewest total species and is closest to the source of the disturbance. As stations progress towards the Gulf of Mexico the total species count increases, and the effect of a pulse of freshwater dissipates. It may therefore be concluded that community stability and diversity of benthic communities can be significantly affected by pulse disturbance events such as freshwater inflow.

Press disturbance events can also be determined using salinity variance but will be determined between estuaries using the secondary gradient oriented along the freshwater climate regime. Southwestern estuaries are situated in a climatically drier area than their northeastern counterparts, and are therefore subjected to less rainfall. When examining Fig. 3b, estuaries in the southwest, Laguna Madre and Nueces, have greater diversity, than those to the northeast. Exceptions to this trend are stations C and D located in the Lavaca-Colorado estuary. Lavaca-Colorado is the most northeastern estuary, and therefore contradicts this climatic gradient. A potential explanation to this result is that the climatic gradient in this study may not be a stronger driver of a disturbance than an actual pulse of freshwater within an estuary. Stations C and D are already subjected to more saline waters, so the within estuary trend may have a stronger influence on the system than seasonal rainfall. Based on the size of the Lavaca-Colorado estuary (Table 1) the input of freshwater may be more negligible, and have a weaker effect on the more saline stations. Overall, the Nueces estuary displayed the highest average diversity while the Guadalupe estuary displayed the lowest diversity (Table 8).

Cluster analysis of the MDS plot revealed the strong similarity in benthic community assemblages within bays (Fig. 5a). All stations located within the same bay system are at least 50% similar in benthic community composition, with the exception of stations A and B of the Nueces estuary. However, these community similarities are driven by the particular bay type, either primary or secondary, which indicates long-term average salinity does not drive overall community structure. Stations A and B of the Laguna Madre estuary have the greatest average salinity (Fig. 5b), but these high saline waters are at least a 40% similar to the stations with the lowest average salinity levels (Fig. 5a, b). Additionally, Laguna Madre stations C and D are in a grouping of their own, and these two stations are located in the only environment associated with seagrass beds (Montagna and Kalke 1995).

In the face of these disturbance events this research appears to challenge the intermediate disturbance hypothesis proposed by Connell (1978). When a disturbance occurs along a gradient within this long-term analysis, either within or between estuaries, there is no peak level of diversity at the intermediate locations. The only consistent trend within estuaries for freshwater disturbance events is that the most susceptible locations (station A) had lower diversity than the least susceptible location (station D) (Fig. 3b). Additionally, disturbance between estuaries along the climatic gradient showed that the estuaries located at the ends of the gradient demonstrated the highest levels of diversity, while the intermediate estuaries brought in the lowest levels of diversity (Table 8).

The community of every estuary must cope with both press disturbances and pulse disturbances, and there is a growing need to ascertain the implications these events have on community dynamics and how stable a system can remain when responding to the stress. The diversity-stability relationship has long been proposed as a contributing force that keeps communities from collapsing in times of stress and change (MacArthur 1955, Watt 1964). For both pulse and press disturbances, as diversity decreases stability of the system may decrease; freshwater inflow may be viewed as a benthic disturbance. This stability can be linked back to salinity variance and benthic communities establishing in certain niche salinity regimes (Pollack et al. 2009, Telesh et al. 2013). Brackish estuarine areas are dominated by a few organisms that can tolerate the constant salinity fluctuations (Montagna and Kalke 1995). Harsh environments filter out organisms incapable of establishing due to the constant stress imposed by abiotic processes, thereby decreasing diversity (Menge 1976). In the present study the more marine influenced stations in primary bays provided a more benign habitat as evidenced by increased diversity, while freshwater influenced secondary bays displayed decreased diversity.

However, it is not enough to view freshwater inflow as a benthic disturbance, but an important and essential feature shaping benthic communities in Texas estuaries. Episodic flooding of the Mission-Aransas Estuary is essential to the long-term population maintenance of the subtidal eastern oyster, *Crassostrea virginica* (Pollack et al. 2011). While flooding events are initially detrimental to populations of *C. virginica*, the low salinities introduce a harsh environment to both predators (e.g., oyster drills) and disease (*Perkinsus marinus)* bolstering the recovery of oysters in the estuary. Additionally, Montagna and Kalke (1995), showed that only estuaries with high inflow rates supported productive shellfish populations and salinity variability was more essential that absolute salinity values. They found that key recruitment events of *Mulinia lateralis* are initiated by significant changes in salinity levels instead of being structured around absolute salinity levels. However in 1992, Monatagna and Kalke determined that freshwater inflow had deleterious effects on meiofaunal populations within the same estuaries. These competing results illustrate the complex dynamics of freshwater inflow to estuarine systems.

Water resource planners have long been interested in managing salinity in estuaries. The Texas Water Planning Act was passed in 1957 to control and direct the effects upstream development had on coastal waters. An additional bill was passed in 1985 building further information into the original act to guide and inform water management decisions (Alber 2002). In section 11.147 of the Texas Water code "beneficial inflows" are defined as a "salinity, nutrient, and sediment loading regime adequate to maintain an ecologically sound environment in the receiving bay and estuary system that is necessary for the maintenance of productivity of economically important and ecologically characteristic commercial fish and shellfish species and estuarine life upon which such fish and shellfish are dependent" (Texas Water Code § 11.147 (a) [2013]). While the findings presented here could be used to argue that all freshwater inflow should be stopped because it is a disturbance that decreases diversity in an area, this line of reasoning is incorrect, as demonstrated by the outlier effects represented by Baffin Bay and Laguna Madre (Fig. a, b, c). In fact, inflow pulses act to stimulate the communities by bringing in pulses of nutrients and stimulating primary productivity. Also, the intermediate disturbance hypothesis (Connell 1978) and succession model (Rhoads et al. 1978) predict disturbance is important to the complex functioning of estuarine systems.

While average salinity can be appropriate to monitor diversity in estuarine systems, the current findings show the value of salinity variance in studying diversity across multiple estuarine systems. Salinity variance captured significant diversity relationships for both univariate and multivariate diversity measures, in the presence and absence of the anomalous estuary Laguna Madre (Fig. 3a, b, c, and Fig. 4a, b, c). However, average salinity showed a sole significant relationship to species richness in the presence of Laguna Madre (Fig. 3d), and even with the removal of Laguna Madre still did not capture a significant relationship with Pielou's Evenness Index (Fig. 4f). This study shows the potential strength of one indicator over the other and it is imperative that other coastal systems test the success of salinity variability in monitoring community diversity in future studies. This research also outlined the effect freshwater inflow can have on benthic organisms in the form of a disturbance. Both within and between estuaries overall diversity decreased as freshwater input increased. But these estuarine tendencies do not apply to specific organisms and more research should be focused on individual species in the face of inflow events. Due to its success as a more accurate indicator of benthic disturbance, this work demonstrates the importance of implementing salinity variance as an indicator of disturbance.

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Appendices

Appendix 1 Coordinates of Stations within Estuaries

Estuary	Bay	Bay Type	Station	Latitude	Longitude
Lavaca-Colorado	Lavaca	Secondary	A	28.67467	-96.58268
Lavaca-Colorado	Lavaca	Secondary	B	28.63868	-96.58437
Lavaca-Colorado	Matagorda	Primary	C	28.54672	-96.46894
Lavaca-Colorado	Matagorda	Primary	D	28.48502	-96.28972
Guadalupe	Upper San Antonio	Secondary	A	28.39352	-96.77240
Guadalupe	Upper San Antonio	Secondary	B	28.34777	-96.74573
Guadalupe	Lower San Antonio	Primary	C	28.24618	-96.76488
Guadalupe	Lower San Antonio	Primary	D	28.30210	-96.68435
Mission-Aransas	Copano	Secondary	A	28.07460	-97.21910
Mission-Aransas	Copano	Secondary	B	28.13228	-97.03443
Mission-Aransas	Aransas	Primary	C	28.08882	-96.96253
Mission-Aransas	Aransas	Primary	D	27.97975	-97.02868
Nueces-Corpus	Nueces	Secondary	A	27.86069	-97.47358
Nueces-Corpus	Nueces	Secondary	B	27.85708	-97.41025
Nueces-Corpus	Corpus Chrisit	Primary	C	27.82533	-97.35213
Nueces-Corpus	Corpus Christi	Primary	D	27.71280	-97.17872
Laguna Madre	Baffin	Secondary	A	27.27697	-97.42690
Laguna Madre	Baffin	Secondary	B	27.26388	-97.55142
Laguna Madre	Laguna Madre	Primary	C	27.34990	-97.39238
Laguna Madre	Laguna Madre	Primary	D	27.34990	-97.39238

Appendix 2 Species Distribution (#//m^2) in the Lavaca-Colorado and Guadalupe Estuaries for Entire Study Period (1988-2013). A, B, C, and D are the stations in the estuaries that were used in the analysis and represent a gradient from less saline (A) to more saline (D); see Fig. 1 for approximate locations.

	Lavaca-Colorado Estuary				Guadalupe Estuary			
Species	A	B	C	D	A	B	C	D
Mediomastus ambiseta	12134	9357	12172	13916	22869	20456	15114	15126
Streblospio benedicti	3106	2480	1090	553	13665	18795	3267	2590
Oligochaeta (unidentified)	76	17	107	3718	910	636	16	65
Mulinia lateralis	1159	861	1304	69	5034	5009	3108	1446
Polydora caulleryi	0	0	1294	2065	6	0	65	988
Texadina sphinctostoma	59	7	0	0	16370	3999	1440	383
Ampelisca abdita	1034	166	52	24	1755	137	41	181
Prionospio heterobranchia	0	0	0	0	0	0	0	0
Syllis cornuta	0	0	0	3	0	0	0	3
Tharyx setigera	0	7	920	52	0	0	0	59
Nemertea (unidentified)	270	277	792	1456	542	555	517	598
Apseudes species A	0	0	7	11138	0	0	0	0
Exogone species	0	0	0	0	0	0	0	6
Capitella capitata	190	73	17	0	982	374	90	78
Cossura delta	156	865	1660	1411	3	56	78	334
Paraprionospio pinnata	38	190	522	401	12	47	206	199
Brania furcelligera	0	0	0	0	0	0	0	3
Gyptis vittata	28	42	612	387	12	34	69	171
Sphaerosyllis species A	10	7	59	69	0	0	0	0
Caecum pulchellum	0	0	0	0	0	3	0	3
Glycinde solitaria	214	176	453	166	106	175	352	443
Cerapus tubularis	0	0	0	0	3	0	0	0
Grandidierella bonnieroides	3	0	0	0	6	0	0	0
Cerithium lutosum	0	0	0	0	0	0	0	0
Spiochaetopterus costarum	17	14	169	14	3	3	137	1842

Appendix 2. Continued.

	Lavaca-Colorado Estuary				Guadalupe Estuary			
Species	A	B	C	D	A	B	C	D
Mysella planulata	14	17	38	169	6	0	0	156
Naineris laevigata	0	0	14	439	0	0	0	0
Macoma mitchelli	398	280	28	17	171	352	221	259
Clymenella torquata	7	0	163	24	0	3	6	349
Anthozoa (unidentified)	10	17	55	253	9	3	25	16
Minuspio cirrifera	0	0	311	2221	0	0	0	12
Amphiodia atra	0	0	346	934	0	0	19	34
Branchioasychis americana	3	7	221	42	0	0	3	47
Heteromastus filiformis	48	14	0	0	16	0	0	0
Paleanotus heteroseta	0	0	73	266	0	0	0	22
Haploscoloplos foliosus	83	142	149	52	84	290	312	218
Nuculana acuta	3	3	197	73	0	6	3	62
Anomalocardia auberiana	0	0	0	0	0	0	0	0
Periploma cf. orbiculare	0	0	118	1090	0	0	0	31
Polydora ligni	38	3	3	0	324	3	0	34
Schizocardium species	0	3	287	391	0	0	0	9
Lumbrineris parvapedata	0	0	360	138	0	0	0	16
Schistomeringos rudolphi	0	0	3	35	0	0	0	9
Axiothella species A	0	0	107	7	0	6	6	561
Chone species	0	0	0	0	0	0	0	0
Corbula contracta	0	0	0	1712	0	0	0	0
Mediomastus californiensis	17	0	194	232	22	12	12	814
Cyclaspis varians	83	45	52	10	243	159	231	302
Elasmopus species	0	0	0	0	0	0	3	0
Acteocina canaliculata	118	131	100	7	84	87	90	224
Erichsonella attenuata	0	0	0	0	0	0	0	0
Parandalia ocularis	228	45	21	0	408	47	87	502
Caprellidae (unidentified)	3	0	10	7	47	0	56	16

Appendix 2. Continued.

Species	Lavaca-Colorado Estuary A	B	C	D	Guadalupe Estuary A	B	C	D
Melinna maculata	7	14	52	24	6	37	47	75
Lepton species	3	7	35	1342	0	0	0	0
Phoronis architecta	0	35	17	62	0	0	137	78
Rangia cuneata	38	0	0	0	1050	56	16	3
Hobsonia florida	28	3	7	31	997	122	6	44
Diopatra cuprea	24	24	42	86	19	9	41	87
Aligena texasiana	0	0	138	10	0	0	3	237
Nereididae (unidentified)	17	3	24	45	0	0	9	22
Leucon species	38	90	73	17	0	6	34	0
Amygdalum papyrium	0	0	0	0	3	0	0	0
Paraonidae Group B	0	0	654	287	0	3	0	0
Drilonereis magna	0	3	550	80	0	0	3	0
Monoculodes species	14	10	35	0	246	140	131	59
Sarsiella zostericola	0	0	3	0	0	0	0	0
Aricidea bryani	0	0	311	14	0	0	0	0
Rictaxis punctostriatus	7	3	3	0	12	6	6	19
Sphaerosyllis cf. sublaevis	0	0	3	3	0	0	0	3
Pomatoceros americanus	0	0	0	0	0	0	0	0
Schistomeringos species A	0	0	24	28	0	0	0	0
Maldanidae (unidentified)	0	31	201	52	0	0	28	128
Turbonilla species	0	10	118	7	0	0	6	94
Scoloplos rubra	0	0	0	0	0	0	0	0
Chironomidae (larvae)	42	10	0	0	309	44	6	3
Haploscoloplos fragilis	21	42	24	7	3	41	69	44
Lyonsia hyalina floridana	0	3	10	3	22	3	9	9
Vitrinellidae (unidentified)	0	0	0	0	0	0	0	19
Cymodoce faxoni	0	0	0	0	0	0	0	0
Ostracoda (unidentified)	17	69	0	0	31	0	0	0

Appendix 2. Continued.

Species	Lavaca-Colorado Estuary				Guadalupe Estuary			
	A	B	C	D	A	B	C	D
Listriella barnardi	3	3	45	142	0	0	3	41
Turbellaria (unidentified)	7	21	83	73	59	6	97	47
Hemicyclops species	7	0	0	24	53	3	6	365
Euclymene species B	0	0	21	0	0	0	0	112
Notomastus latericeus	7	0	10	52	0	0	0	62
Opisthosyllis species	0	0	0	0	0	0	0	0
Axiothella mucosa	21	28	152	7	0	0	19	94
Gastropoda (unidentified)	3	3	7	0	411	0	3	9
Cymadusa compta	0	0	0	0	0	0	0	6
Oxyurostylis species	0	3	66	21	44	75	78	69
Corophium louisianum	14	3	0	0	25	3	12	16
Edotea montosa	38	0	3	0	37	6	6	0
Sigambra bassi	7	3	69	62	0	0	3	6
Syllidae (unidentified)	0	0	24	3	0	0	0	0
Microprotopus species	45	10	21	14	9	28	44	25
Sabellidae (unidentified)	0	0	232	7	0	6	0	3
Eteone heteropoda	14	3	3	14	34	62	19	37
Periploma margaritaceum	0	0	107	166	0	0	3	31
Nassarius acutus	17	21	31	31	0	0	12	12
Erichthonias brasiliensis	0	0	0	14	0	0	0	28
Crepidula plana	0	0	0	0	12	0	252	3
Batea catharinensis	7	0	0	0	12	0	41	22
Malmgreniella taylori	0	0	59	86	0	0	3	0
Amphilochus species	0	0	3	0	0	0	0	3
Cirrophorus lyra	0	0	339	118	0	0	0	0
Polydora socialis	3	0	73	24	9	3	31	19
Chione cancellata	0	0	0	0	0	0	0	3
Ceratonereis irritabilis	0	0	24	0	0	0	0	47

Appendix 2. Continued.

Species	Lavaca-Colorado Estuary				Guadalupe Estuary			
	A	B	C	D	A	B	C	D
Listriella clymenellae	0	0	10	0	0	0	0	0
Scolelepis texana	3	7	0	0	19	6	56	75
Haminoea antillarum	0	0	0	0	0	0	0	0
Bivalvia (unidentified)	17	3	10	14	3	3	6	28
Sigambra tentaculata	0	0	45	239	0	0	3	6
Leptochelia rapax	0	0	0	0	0	0	0	3
Oxyurostylis salinoi	0	0	55	0	0	9	9	9
Eupomatus protulicola	0	0	3	0	3	0	0	0
Diastoma varium	0	0	0	0	0	0	0	0
Tellina texana	0	0	0	3	6	6	3	12
Phascolion strombi	0	0	28	54	0	0	0	0
Spiophanes bombyx	0	0	0	0	0	0	0	0
Eulimastoma species	28	86	69	0	9	19	22	19
Megalomma bioculatum	0	3	17	3	0	12	9	22
Pinnixa species	0	0	10	66	0	0	0	37
Oxyurostylis smithi	35	7	17	3	6	16	106	97
Paraonidae Group A	0	0	159	14	0	0	0	0
Magelona pettiboneae	0	0	14	7	0	0	0	3
Brachidontes exustus	3	3	0	0	0	62	0	0
Amaeana trilobata	0	0	31	17	0	0	0	3
Pectinaria gouldii	3	0	17	24	34	19	44	34
Lysidice ninetta	0	0	0	0	0	0	290	0
Aricidea catharinae	0	0	218	10	0	0	0	0
Cyclopoida (commensal)	38	10	66	0	6	12	9	9
Pseudodiaptomus pelagicus	7	17	31	31	9	12	19	6
Mysidopsis bahia	10	3	17	14	3	0	3	19
Asychis species	3	0	111	0	0	0	6	37
Anaitides erythrophyllus	3	0	14	7	0	0	6	0

Appendix 2. Continued.

Species	Lavaca-Colorado Estuary				Guadalupe Estuary			
	A	B	C	D	A	B	C	D
Corophium ascherusicum	0	0	0	3	0	6	0	3
Nuculana concentrica	10	21	59	31	0	0	0	28
Abra aequalis	0	0	0	104	0	0	0	0
Sarsiella texana	7	0	21	3	0	0	3	9
Laeonereis culveri	21	3	0	0	0	0	0	0
Tellina species	28	21	7	10	0	3	0	6
Syllis falgens	0	0	0	0	0	0	0	0
Glycera americana	0	3	28	52	0	0	6	37
Molgula manhattensis	0	0	24	0	109	0	0	34
Isolda pulchella	0	0	0	3	0	0	0	9
Brania clavata	0	0	183	3	0	0	0	0
Asychis elongata	0	0	42	0	3	0	3	0
Eudorella species	0	28	52	93	0	0	0	0
Mysidopsis almyra	14	3	7	0	25	28	3	3
Armandia maculata	0	0	3	90	3	0	0	9
Caecum johnsoni	3	0	45	17	0	0	6	62
Neanthes succinea	7	3	7	0	28	19	19	72
Neosamytha gracilis	0	0	0	0	0	0	0	9
Mactra fragilis	0	0	0	0	0	0	0	0
Pycnogonida (unidentified)	0	0	0	0	0	0	0	0
Pista palmata	0	0	10	0	0	3	62	9
Ogyrides limicola	3	17	10	21	0	0	0	6
Ancistrosyllis jonesi	0	0	3	55	0	0	0	0
Spionidae (unidentified)	0	0	14	131	0	3	0	0
Spio setosa	0	0	0	0	0	0	0	0
Balanus eburneus	0	0	0	0	47	9	47	0
Sthenelais boa	0	0	0	14	0	0	0	0
Crepidula fornicata	0	0	0	10	0	0	3	0

Appendix 2. Continued.

	Lavaca-Colorado Estuary				Guadalupe Estuary			
Species	A	B	C	D	A	B	C	D
Podarke obscura	0	0	7	21	0	0	3	0
Laevicardium mortoni	0	0	0	0	0	0	0	0
Pandora trilineata	0	10	35	3	0	6	9	37
Spirorbis species	0	0	0	0	0	0	0	0
Ensis minor	52	0	0	0	0	3	9	44
Mysidopsis species	10	10	10	7	19	3	3	6
Boonea impressa	0	0	0	0	0	0	22	0
Parahesione luteola	0	0	0	0	0	0	0	0
Ampelisca verrilli	0	0	10	0	0	0	0	0
Chione species	0	0	0	0	0	0	0	0
Polychaeta juv. (unidentified)	0	7	10	28	0	3	3	0
Hauchiella species	0	0	0	0	0	0	0	16
Pagurus annulipes	0	0	3	10	0	0	0	0
Aricidea fragilis	0	0	24	0	0	0	0	0
Apoprionospio pygmaea	0	0	7	0	0	0	0	9
Sabella microphthalma	0	0	7	0	0	0	0	0
Pomatoleios kraussi	0	0	0	0	0	0	0	0
Callianassa species	3	0	0	3	44	6	12	22
Polydora websteri	7	0	0	0	59	3	3	16
Magelona phyllisae	0	0	24	17	0	0	0	3
Glycinde nordmanni	7	28	10	0	0	12	3	9
Megalops	3	3	3	14	3	3	3	0
Autolytus species	0	0	0	0	0	0	0	0
Diastylis species	0	0	3	0	3	0	6	3
Pyramidella crenulata	0	0	0	0	6	3	16	9
Sabella melanostigma	0	0	0	0	0	0	0	0
Eudorella monodon	0	0	0	0	0	0	0	0
Ancistrosyllis papillosa	0	0	21	10	0	0	0	0

Appendix 2. Continued.

Species	Lavaca-Colorado Estuary				Guadalupe Estuary			
	A	B	C	D	A	B	C	D
Aricidea taylori	0	0	3	0	0	0	0	0
Pinnixa chacei	0	0	14	55	0	0	0	3
Dyspanopeus texana	0	0	0	0	0	0	0	0
Tagelus divisus	0	0	0	0	0	0	0	0
Tellina tampaensis	0	0	0	0	0	0	0	0
Nudibranchia (unidentified)	0	0	0	0	3	6	3	6
Spio pettiboneae	0	0	0	0	0	0	0	0
Terebellidae (unidentified)	0	0	7	17	0	0	0	3
Eupomatus dianthus	0	0	0	0	0	0	3	3
Polydora species	0	0	0	10	25	0	0	6
Platynereis dumerilii	0	0	0	0	0	0	0	0
Scoloplos texana	0	0	3	0	6	3	0	6
Scolelepis squamata	7	0	0	0	3	6	25	9
Pyramidella species	0	0	0	0	19	3	0	12
Holothuroidea (unidentified)	0	0	0	3	0	0	0	0
Eunoe cf. nodulosa	0	0	0	59	0	0	0	0
Dorvilleidae (unidentified)	0	0	7	0	0	0	0	0
Ischadium recurvum	0	0	0	0	31	0	0	0
Paranaitis speciosa	0	0	3	3	0	0	0	3
Haploscoloplos species	7	3	7	0	0	0	6	0
Eumida sanguinea	0	0	0	0	0	0	0	0
Tagelus plebeius	28	0	0	0	0	0	12	16
Ancistrosyllis groenlandica	0	0	21	35	0	0	0	0
Sigalionidae (unidentified)	0	0	24	28	0	0	0	3
Pista cristata	0	0	0	0	0	0	0	0
Ophryotrocha species (unidentified)	0	0	0	0	0	0	0	0
Vitrinella floridana	0	0	0	0	0	0	0	9
Leptostylis species	0	0	0	0	0	0	0	0

Appendix 2. Continued.

Species	Lavaca-Colorado Estuary A	B	C	D	Guadalupe Estuary A	B	C	D
Xenanthura brevitelson	0	0	0	0	0	0	0	22
Gammarus mucronatus	3	0	0	0	9	0	9	0
Notomastus cf. latericeus	0	0	10	21	0	0	0	0
Maldane sarsi	0	0	0	0	0	0	0	0
Sarsiella species	0	0	0	0	0	0	0	0
Paramya subovata	0	0	0	14	0	0	0	0
Xanthidae (unidentified)	0	0	3	0	0	0	0	0
Brada cf. villosa capensis	0	0	0	3	0	0	0	0
Ampelisca species B	0	0	3	35	0	0	0	0
Unidentified	0	0	0	0	0	0	0	0
Caecum glabrum	0	0	0	0	0	0	0	0
Lembos species	0	0	0	0	0	0	0	0
Sayella crosseana	0	0	0	0	0	0	0	0
Pilargiidae (unidentified)	0	0	14	10	0	0	0	0
Mystides rarica	0	0	0	0	0	0	0	0
Macoma tenta	0	0	0	17	0	0	0	3
Anachis obesa	0	0	0	0	0	0	0	0
Melita nitida	0	0	0	0	6	0	9	3
Fabricia species A	0	0	0	0	0	0	0	0
Mercenaria campechiensis	0	0	0	3	0	0	3	3
Ceriantharia (unidentified)	0	0	0	0	0	0	0	0
Capitellidae (unidentified)	0	3	7	3	0	0	0	9
Odostomia species	10	7	0	0	9	0	3	0
Serpulidae (unidentified)	0	0	0	0	0	0	0	9
Bowmaniella brasiliensis	0	0	0	0	0	0	0	0
Cabira incerta	0	0	10	0	0	0	0	0
Bowmaniella species	0	0	0	0	3	0	0	0
Photis species	0	0	7	0	0	0	0	0

Appendix 2. Continued.

Species	Lavaca-Colorado Estuary				Guadalupe Estuary			
	A	B	C	D	A	B	C	D
Thompsonula species	0	0	0	0	16	3	3	9
Corophium species	0	0	0	10	0	0	0	0
Potamilla reniformis	0	0	0	0	0	0	0	0
Ninoe nigripes	0	0	0	17	0	0	0	3
Aricidea species	0	0	0	0	0	0	0	0
Microphthalmus abberrans	0	0	0	0	0	3	0	6
Nassarius vibex	0	7	0	7	0	0	0	0
Mysidopsis bigelowi	0	0	28	0	0	0	0	0
Hesione picta	0	0	0	3	0	0	0	0
Mytilidae (unidentified)	0	0	0	0	0	0	0	3
Paranaitis polynoides	0	0	0	0	0	0	0	0
Crassostrea virginica	0	3	0	0	0	0	12	0
Petricola pholadiformes	0	0	0	0	0	0	0	0
Anachis semiplicata	0	0	0	0	0	0	0	0
Naineris bicornis	0	0	0	0	0	0	0	0
Chaetozone setosa	0	0	0	0	0	0	0	0
Marphysa sanguinea	0	0	0	0	0	0	0	0
Ascidiacea (unidentified)	0	0	0	0	0	0	0	0
Pilargis berkelyae	0	0	0	0	0	0	0	0
Sarsiella spinosa	0	0	7	7	0	0	0	0
Anomia simplex	0	0	0	0	0	0	0	0
Callinectes sapidus	0	0	0	0	0	0	0	0
Mitrella lunata	3	0	3	0	0	0	3	3
Pinnixa retinens	0	0	7	0	0	0	0	0
Serpulidae A	0	0	0	0	0	0	0	0
Glycera capitata	0	0	0	3	0	0	0	3
Magelona rosea	0	0	21	0	0	0	0	0
Sigambra cf. wassi	0	7	0	14	0	0	0	0

Appendix 2. Continued.

Species	Lavaca-Colorado Estuary				Guadalupe Estuary			
	A	B	C	D	A	B	C	D
Glyceridae (unidentified)	17	3	0	0	0	0	0	0
Euclymene species A	0	0	0	0	0	0	0	0
Owenia fusiformis	0	0	7	3	0	0	0	0
Dentalium texasianum	0	0	3	7	0	0	0	0
Brachyuran zoea	0	0	0	0	0	0	0	0
Lumbrineris latreilli	0	0	0	14	0	0	0	0
Polinices duplicatus	0	3	10	0	0	0	0	0
Texadina barretti	0	0	0	0	3	0	0	16
Phyllodocidae (unidentified)	3	0	0	0	0	0	0	0
Parametopella species	0	0	0	0	0	0	0	3
Lumbrineris branchiata	0	0	0	0	0	0	0	3
Capitellides jonesi	7	0	0	0	0	0	0	0
Clibanarius vittatus	0	0	0	0	0	0	3	3
Synchelidium americanum	0	0	0	0	0	0	0	16
Amphipoda (unidentified)	0	0	3	7	0	0	0	0
Piromis arenosus	0	0	0	0	0	0	0	0
Synsyllis longigularis	0	0	0	0	0	0	0	0
Ophiuroidea (unidentified)	0	0	0	0	0	0	0	0
Pomatoleios caerulescens	0	0	0	0	0	0	0	0
Sarsiella capsula	0	0	0	0	0	0	0	0
Sipuncula (unidentified)	0	0	0	3	0	0	0	6
Sphaerosyllis erinaceus	0	0	10	3	0	0	0	0
Sarsiella disparalis	0	0	3	0	0	0	0	0
Pinnotheridae (unidentified)	0	0	3	7	0	0	0	3
Nephtys species	0	0	0	0	9	0	0	3
Bulla striata	0	0	3	0	0	0	0	3
Ampharetidae (unidentified)	0	0	3	0	0	0	0	3
Hesionidae (unidentified)	0	0	0	0	0	0	0	3

Appendix 2. Continued.

Species	Lavaca-Colorado Estuary A	B	C	D	Guadalupe Estuary A	B	C	D
Trachypenaeus constrictus	0	0	3	7	0	0	0	0
Amphinomidae (unidentified)	0	0	10	0	0	0	0	0
Listriella species	0	0	10	0	0	0	0	0
Solen viridis	0	0	0	0	0	0	0	0
Nereis lamellosa	0	0	0	0	0	0	0	0
Onuphis eremita	0	0	0	0	0	0	0	0
Ancistrosyllis species	0	0	0	0	0	0	0	0
Euceramus praelongus	0	0	0	0	0	0	0	0
Brada species	0	0	0	0	0	0	0	0
Crassinella lunulata	0	0	0	0	0	0	0	0
Odostomia canaliculata	0	0	0	0	0	0	0	0
Pinnixa cristata	0	0	7	0	0	0	0	3
Allothyone mexicana	0	0	0	7	0	0	0	3
Henrya goldmani	0	0	0	0	0	0	0	0
Cyclaspis species	0	0	0	0	0	0	0	9
Martesia species	0	0	0	3	0	0	0	0
Tellidora cristata	0	0	3	0	0	0	0	0
Fargoa cf. gibbosa	0	0	0	0	0	0	0	3
Aglaophamus verrilli	0	0	0	7	0	0	0	0
Paguridae (juvenile)	0	0	7	0	0	0	0	0
Paramphinome jeffreysii	0	0	7	0	0	0	0	0
Polynoidae (unidentified)	0	0	0	7	0	0	0	0
Macoma species	0	0	0	7	0	0	0	0
Neopanope texana	0	0	0	0	6	0	0	0
Fabriciola trilobata	0	0	0	0	0	0	0	6
Lepidophthalamus louisianensis	0	0	0	0	0	0	3	3
Hydrozoa (unidentified)	0	0	0	0	0	0	0	0
Eteone lactea	0	0	0	0	0	0	0	0

Appendix 2. Continued.

	Lavaca-Colorado Estuary				Guadalupe Estuary			
Species	A	B	C	D	A	B	C	D
Macoma brevifrons	0	0	0	0	0	0	0	0
Callinectes species A	0	0	0	0	0	0	0	0
Cantharus cancellarius	0	0	0	0	0	0	0	0
Magelonidae (unidentified)	0	0	0	0	0	0	0	0
Labidocera aestiva	0	0	0	0	0	0	0	0
Truncatella caribaeensis	0	0	0	0	0	0	0	0
Epitonium species	0	0	0	0	0	0	0	0
Penaeus aztecus	0	0	0	0	0	0	0	0
*Mollusca (*unidentified*)*	0	0	0	0	0	0	0	0
Tharyx species	0	0	0	0	0	0	0	0
Balanus trigonus	0	0	0	0	0	0	0	0
Nematonereis hebes	0	0	0	0	0	0	0	0
Clymenella mucosa	0	0	0	0	0	0	0	0
Eupolymnia species	0	0	0	0	0	0	0	0
Nereis pelagica occidentalis	0	0	0	0	0	0	0	0
Doridella obscura	0	0	0	0	0	0	0	0
Anadara transversa	0	0	0	0	0	0	0	0
Dentalium species	0	0	0	0	0	0	0	0
Episiphon sowerbyi	0	0	0	0	0	0	0	0
Eulimastoma cf. teres	0	0	0	0	0	0	0	0
Turbonilla portoricana	0	0	0	0	0	0	0	0
Trypanosyllis gemnipara	0	0	0	0	0	0	0	0
Crepidula species	0	0	0	0	0	0	0	0
Synelmis albini	0	0	0	0	0	0	0	0
Tellina versicolor	0	0	0	0	0	0	0	0
Pilargis species	0	0	0	0	0	0	0	0
Dispio uncinata	0	0	0	0	0	0	0	0
Bowmaniella dissimilis	0	0	0	0	0	0	0	0

Appendix 2. Continued.

Species	Lavaca-Colorado Estuary				Guadalupe Estuary			
	A	B	C	D	A	B	C	D
Littorina ziczac	0	0	0	0	0	0	0	0
Prionospio treadwelli	0	0	0	0	0	0	0	0
Nephtys picta	0	0	0	3	0	0	0	0
Onuphis species	0	0	0	3	0	0	0	0
Alpheus heterochaelis	0	0	0	3	0	0	0	0
Anadara ovalis	0	0	0	3	0	0	0	0
Echiuridae (unidentified)	0	0	0	3	0	0	0	0
Cyrtopleura costata	0	0	0	3	0	0	0	0
Lumbrineris tenuis	0	0	0	3	0	0	0	0
Goniadidae (unidentified)	0	0	3	0	0	0	0	0
Lumbrineridae (unidentified)	0	0	0	3	0	0	0	0
Sthenelais species	0	0	0	3	0	0	0	0
Munna hayesi	0	0	0	3	0	0	0	0
Callinectes similis	0	0	3	0	0	0	0	0
Ancistrosyllis cf. falcata	0	0	0	3	0	0	0	0
Munnidae (unidentified)	0	0	0	3	0	0	0	0
Eurythoe species	0	0	0	3	0	0	0	0
Paramphinome pulchella	0	0	3	0	0	0	0	0
Agriopoma texasianum	0	0	0	3	0	0	0	0
Malmgreniella species	0	0	0	3	0	0	0	0
Potamanthidae (unidentified)	3	0	0	0	0	0	0	0
Cyclinella tenuis	0	0	0	3	0	0	0	0
Diptera (unidentified)	3	0	0	0	0	0	0	0
Arenicola cristata	0	0	0	0	0	0	0	3
*Chironomidae (*pupae*)*	0	0	0	0	3	0	0	0
Cassidinidea lunifrons	0	0	0	0	0	3	0	0
Insecta (unidentified)	0	0	0	0	3	0	0	0
Rithropanopeus harrisi	0	0	0	0	0	0	3	0

Appendix 3 Species distribution (#/m2) of Mission-Aransas, Nueces, and Laguna Madre Estuaries for the entire study period (1988-2012). A, B, C, and D are the stations where data were collected that were used in the analysis and represent a gradient from less saline (A) to more saline (D); see Fig. 1 for approximate locations.

	Mission-Aransas Estuary				Nueces Estuary				Laguna Madre Estuary			
Species	A	B	C	D	A	B	C	D	A	B	C	D
Mediomastus ambiseta	2978	4869	10377	13757	9778	13682	11888	13481	2931	4511	1557	2460
Streblospio benedicti	8178	4798	7847	9667	6389	5023	1950	5229	21855	28789	5193	2308
Oligochaeta (unidentified)	71	0	47	638	15	77	319	1459	5	5	23888	12793
Mulinia lateralis	425	0	95	47	3289	4992	577	753	3349	2515	335	533
Polydora caulleryi	0	0	0	567	10	4533	1155	13089	0	0	0	0
Texadina sphinctostoma	307	0	0	0	0	0	0	0	0	0	0	0
Ampelisca abdita	1702	260	47	0	1239	330	25	15	3832	6578	392	264
Prionospio heterobranchia	0	0	0	0	0	0	0	0	70	0	13419	4558
Syllis cornuta	0	0	0	0	10	150	51	5	10	0	10711	3991
Tharyx setigera	0	0	0	47	40	4162	4503	3729	0	0	0	0
Nemertea (unidentified)	236	189	378	662	204	516	1109	614	15	158	3275	386
Apseudes species A	0	0	0	0	0	0	0	0	0	0	0	0
Exogone species	0	0	0	0	0	31	20	0	90	0	8793	885
Capitella capitata	307	118	24	0	45	191	10	21	134	55	2331	4304
Cossura delta	0	0	24	355	493	376	1935	433	0	0	0	0
Paraprionospio pinnata	0	260	1087	2127	10	134	648	727	20	93	0	0
Brania furcelligera	0	0	0	0	0	196	15	5	0	0	4445	841
Gyptis vittata	24	71	355	709	249	1227	851	526	25	0	10	20
Sphaerosyllis species A	0	0	0	0	194	799	304	67	50	0	2218	1413
Caecum pulchellum	0	0	0	0	0	0	0	5	0	0	2955	2083
Glycinde solitaria	0	142	473	213	254	469	476	490	154	142	31	103
Cerapus tubularis	24	0	0	0	0	36	5	10	0	5	4595	166
Grandidierella bonnieroides	0	0	0	0	10	52	0	0	134	393	3068	675
Cerithium lutosum	0	0	0	0	0	0	0	0	0	5	3816	264
Naineris laevigata	0	0	0	0	0	5	243	144	0	0	2486	186

Appendix 3. Continued.

	Mission-Aransas Estuary				Nueces Estuary				Laguna Madre Estuary			
Species	A	B	C	D	A	B	C	D	A	B	C	D
Spiochaetopterus costarum	0	95	307	473	0	150	162	108	0	0	0	0
Mysella planulata	0	0	0	0	169	2651	56	26	0	0	0	10
Macoma mitchelli	95	307	213	0	597	160	5	0	0	0	0	0
Clymenella torquata	0	0	118	0	294	1918	10	108	0	0	0	5
Anthozoa (unidentified)	0	0	0	0	0	701	309	77	85	38	1263	59
Minuspio cirrifera	0	0	0	118	0	0	96	124	0	0	0	0
Amphiodia atra	0	0	189	213	0	72	841	227	0	0	0	0
Branchioasychis americana	0	0	47	118	20	98	162	62	40	0	748	1095
Heteromastus filiformis	47	0	0	0	5	0	5	31	0	5	1423	1003
Paleanotus heteroseta	0	0	0	0	0	144	1661	392	0	0	0	0
Haploscoloplos foliosus	0	0	0	0	55	124	25	459	25	5	21	381
Nuculana acuta	0	0	0	24	65	882	1003	98	0	0	0	0
Anomalocardia auberiana	0	0	0	0	0	0	0	0	30	0	1233	1115
Periploma cf. orbiculare	0	0	0	0	5	52	815	21	0	0	0	0
Polydora ligni	0	0	0	0	0	10	0	0	194	420	887	205
Schizocardium species	0	0	24	236	0	0	501	407	0	0	0	5
Lumbrineris parvapedata	0	0	71	284	45	170	734	15	0	0	0	0
Schistomeringos rudolphi	0	0	0	24	30	284	157	72	0	0	799	372
Axiothella species A	0	0	95	0	318	309	162	15	0	0	10	156
Chone species	0	0	0	0	0	15	5	5	0	0	995	729
Corbula contracta	0	0	0	0	0	0	0	0	0	0	0	0
Mediomastus californiensis	0	0	0	0	5	273	106	10	0	0	0	0
Cyclaspis varians	24	0	47	47	30	160	61	41	5	11	21	112
Elasmopus species	0	0	0	0	0	170	25	0	0	0	1351	29
Acteocina canaliculata	24	165	47	0	55	201	20	93	25	60	0	24
Erichsonella attenuata	0	0	0	0	0	0	0	0	0	0	1516	20
Parandalia ocularis	0	24	118	24	5	0	0	0	0	0	0	0
Caprellidae (unidentified)	0	0	0	0	25	258	106	129	20	0	727	78

Appendix 3. Continued.

Species	Mission-Aransas Estuary				Nueces Estuary				Laguna Madre Estuary			
	A	B	C	D	A	B	C	D	A	B	C	D
Melinna maculata	0	0	0	24	50	413	238	21	60	0	227	142
Lepton species	0	0	0	0	0	0	15	0	0	0	0	0
Hobsonia florida	0	0	0	0	0	0	0	0	0	0	0	0
Phoronis architecta	0	0	0	0	15	433	157	273	30	0	0	0
Rangia cuneata	0	0	0	0	0	0	0	0	0	0	0	0
Diopatra cuprea	0	0	71	118	10	83	187	113	114	5	46	73
Aligena texasiana	0	0	24	0	15	536	0	180	0	0	0	5
Nereididae (unidentified)	0	0	0	24	0	5	15	72	15	0	877	15
Leucon species	0	189	24	71	40	0	380	21	10	55	0	0
Amygdalum papyrium	0	0	0	0	0	5	0	0	0	5	861	137
Paraonidae Group B	0	0	0	0	0	0	25	15	0	0	0	0
Drilonereis magna	0	0	24	71	10	88	137	10	0	0	0	0
Monoculodes species	189	0	0	24	25	46	15	0	0	0	0	0
Sarsiella zostericola	0	0	0	0	0	0	5	0	5	0	763	127
Aricidea bryani	0	0	0	213	0	15	228	119	0	0	0	0
Rictaxis punctostriatus	0	0	24	0	10	15	0	160	274	278	62	15
Sphaerosyllis cf. sublaevis	0	0	0	0	0	0	0	5	0	0	382	469
Pomatoceros americanus	0	0	0	0	20	304	537	0	0	0	0	0
Schistomeringos species A	0	0	0	0	0	139	304	325	0	0	10	24
Maldanidae (unidentified)	0	0	142	0	25	98	127	5	0	0	5	5
Turbonilla species	0	0	24	24	0	67	116	88	0	0	175	112
Scoloplos rubra	0	0	0	0	0	0	0	0	0	0	232	602
Chironomidae (larvae)	402	0	0	0	5	0	0	0	0	0	0	0
Haploscoloplos fragilis	0	0	142	189	55	31	10	52	80	0	0	10
Lyonsia hyalina floridana	0	0	0	0	10	645	46	36	0	0	0	10
Vitrinellidae (unidentified)	0	0	0	0	5	717	0	41	0	0	0	0
Cymodoce faxoni	0	0	0	0	0	5	0	0	0	0	717	39
Ostracoda (unidentified)	0	0	0	0	5	0	0	0	40	0	361	205

Appendix 3. Continued.

	Mission-Aransas Estuary				Nueces Estuary				Laguna Madre Estuary			
Species	A	B	C	D	A	B	C	D	A	B	C	D
Listriella barnardi	0	0	0	47	15	222	91	62	25	0	0	29
Turbellaria (unidentified)	0	0	0	0	0	52	101	62	0	0	52	59
Hemicyclops species	0	0	0	0	0	227	0	0	5	0	0	10
Euclymene species B	0	0	0	0	304	191	61	10	0	0	0	0
Notomastus latericeus	0	0	0	47	15	217	147	129	0	0	5	0
Gastropoda (unidentified)	0	0	0	0	0	10	25	98	15	11	77	10
Opisthosyllis species	0	0	0	0	0	5	0	0	0	0	655	20
Axiothella mucosa	0	0	0	24	0	88	122	26	0	0	0	93
Cymadusa compta	0	0	0	0	0	0	0	5	0	0	562	83
Oxyurostylis species	0	0	71	0	30	10	10	21	10	0	31	117
Corophium louisianum	24	0	0	0	0	21	0	0	104	365	46	5
Edotea montosa	24	0	0	24	0	5	5	5	30	33	299	108
Sigambra bassi	0	95	0	355	0	0	5	10	0	0	0	0
Syllidae (unidentified)	0	0	0	0	0	0	46	5	0	0	454	64
Microprotopus species	0	0	0	47	0	67	41	160	25	5	5	49
Sabellidae (unidentified)	0	0	0	0	0	52	61	5	0	0	211	15
Eteone heteropoda	0	0	0	0	0	0	10	26	45	5	41	259
Periploma margaritaceum	0	0	0	0	5	77	132	46	0	0	0	0
Nassarius acutus	0	0	47	355	0	0	15	10	0	0	5	0
Erichthonias brasiliensis	0	0	24	0	0	139	76	36	65	125	10	10
Crepidula plana	0	0	0	0	0	155	15	21	0	0	52	10
Batea catharinensis	0	0	0	118	35	139	101	41	0	0	0	0
Malmgreniella taylori	0	0	71	24	0	0	253	10	0	0	0	0
Amphilochus species	0	0	0	0	5	119	30	0	0	0	315	0
Cirrophorus lyra	0	0	0	0	0	0	15	0	0	0	0	0
Polydora socialis	0	0	0	0	0	248	5	41	0	0	0	0
Chione cancellata	0	0	0	0	0	10	0	0	0	0	356	73
Ceratonereis irritabilis	0	0	0	47	5	186	66	62	0	0	5	0

Appendix 3. Continued.

Species	Mission-Aransas Estuary				Nueces Estuary				Laguna Madre Estuary			
	A	B	C	D	A	B	C	D	A	B	C	D
Listriella clymenellae	0	0	0	0	15	397	10	5	0	0	0	0
Scolelepis texana	0	0	71	0	10	36	0	31	0	5	0	93
Haminoea antillarum	0	0	0	0	0	0	0	0	0	0	304	73
Bivalvia (unidentified)	24	0	0	24	0	0	25	41	0	0	175	0
Sigambra tentaculata	0	24	0	24	0	0	20	10	0	0	0	0
Leptochelia rapax	0	0	0	0	0	5	0	0	0	0	278	83
Oxyurostylis salinoi	0	0	0	0	5	15	5	57	0	0	72	132
Eupomatus protulicola	0	0	0	0	0	144	157	0	0	0	15	29
Phascolion strombi	0	0	0	47	0	0	149	62	10	0	0	0
Diastoma varium	0	0	0	0	0	0	0	0	0	0	325	24
Tellina texana	0	0	0	0	0	0	0	15	0	0	180	108
Spiophanes bombyx	0	0	0	0	0	10	5	315	0	0	0	5
Eulimastoma species	0	0	24	24	0	5	0	10	0	0	0	0
Megalomma bioculatum	0	0	0	0	15	191	25	15	0	0	0	0
Pinnixa species	0	0	24	24	0	62	51	26	10	0	0	5
Oxyurostylis smithi	0	0	0	0	0	0	25	0	0	0	0	0
Paraonidae Group A	0	0	0	0	0	0	66	67	0	0	5	0
Magelona pettiboneae	0	0	0	0	0	0	20	5	0	0	144	112
Brachidontes exustus	0	0	0	0	0	36	0	0	0	0	191	10
Amaeana trilobata	0	47	0	0	0	186	10	5	0	0	0	0
Pectinaria gouldii	0	0	24	0	0	10	5	5	50	11	10	5
Lysidice ninetta	0	0	0	0	0	5	0	0	0	0	0	0
Aricidea catharinae	0	0	0	0	0	5	30	10	0	0	0	0
Cyclopoida (commensal)	0	0	0	0	15	52	0	5	30	16	0	0
Pseudodiaptomus pelagicus	0	0	0	0	0	15	15	10	40	49	0	5
Mysidopsis bahia	0	0	0	0	35	31	10	5	15	0	0	98
Asychis species	0	0	0	0	0	26	76	0	0	0	0	0
Anaitides erythrophyllus	0	0	0	0	0	15	20	41	20	22	77	24

Appendix 3. Continued.

Species	Mission-Aransas Estuary				Nueces Estuary				Laguna Madre Estuary			
	A	B	C	D	A	B	C	D	A	B	C	D
Corophium ascherusicum	0	0	0	0	5	15	20	10	0	180	5	0
Nuculana concentrica	0	0	71	0	0	0	25	0	0	0	0	0
Abra aequalis	0	0	0	24	0	10	91	5	0	0	0	0
Sarsiella texana	0	0	0	0	0	26	116	15	5	0	0	20
Laeonereis culveri	142	0	0	24	0	21	0	5	0	0	0	10
Tellina species	0	0	0	0	0	15	61	52	0	0	10	0
Syllis falgens	0	0	0	0	0	0	0	0	0	0	186	20
Glycera americana	0	0	47	0	0	0	15	15	0	0	0	0
Molgula manhattensis	0	0	0	0	0	31	5	0	0	0	0	0
Isolda pulchella	0	0	0	0	0	134	35	0	0	0	0	5
Brania clavata	0	0	0	0	0	0	0	0	0	0	0	0
Mysidopsis almyra	47	0	24	0	20	0	5	0	0	5	0	0
Asychis elongata	0	0	0	0	5	36	35	0	60	0	0	0
Eudorella species	0	0	0	0	0	0	10	0	0	0	0	0
Armandia maculata	0	0	0	0	0	0	25	52	0	0	0	0
Caecum johnsoni	0	0	0	0	0	10	30	0	0	0	0	0
Neanthes succinea	0	0	0	0	0	0	0	5	10	0	5	0
Neosamytha gracilis	0	0	0	0	45	119	0	0	0	0	0	0
Mactra fragilis	0	0	0	0	0	46	0	0	0	0	119	5
Pycnogonida (unidentified)	0	0	0	0	0	15	0	21	5	5	103	15
Pista palmata	0	0	0	0	0	36	5	15	0	0	15	0
Ogyrides limicola	0	24	24	47	0	0	0	0	0	0	0	0
Ancistrosyllis jonesi	0	0	0	24	0	10	10	46	0	0	0	0
Spionidae (unidentified)	0	0	0	0	0	0	0	0	0	0	0	0
Spio setosa	0	0	0	0	0	0	0	0	0	0	0	147
Balanus eburneus	0	0	0	0	0	36	0	0	0	0	0	0
Sthenelais boa	0	0	0	0	0	5	106	10	0	0	0	0
Crepidula fornicata	24	0	0	0	0	0	0	0	5	0	72	15

Appendix 3. Continued.

Species	Mission-Aransas Estuary				Nueces Estuary				Laguna Madre Estuary			
	A	B	C	D	A	B	C	D	A	B	C	D
Podarke obscura	0	0	0	0	0	31	15	46	0	0	0	5
Laevicardium mortoni	0	0	0	0	0	0	0	0	0	0	57	68
Pandora trilineata	0	0	0	0	0	0	0	21	0	0	0	0
Spirorbis species	0	0	0	0	0	0	0	5	0	0	108	5
Ensis minor	0	0	0	0	0	10	0	0	0	0	0	0
Mysidopsis species	0	0	0	0	5	0	20	0	15	0	0	0
Boonea impressa	0	0	0	0	0	0	0	0	0	0	72	15
Parahesione luteola	0	0	0	0	0	0	0	21	0	0	88	0
Ampelisca verrilli	0	0	0	0	0	26	5	67	0	0	0	0
Chione species	0	0	0	0	0	0	0	0	5	0	103	0
Polychaeta juv. (unidentified)	0	0	0	0	0	0	5	10	0	0	31	10
Hauchiella species	0	0	0	0	0	62	20	5	0	0	0	0
Pagurus annulipes	0	0	0	47	0	10	30	0	0	0	0	0
Pomatoleios kraussi	0	0	0	0	0	0	101	0	0	0	0	0
Aricidea fragilis	0	0	0	0	0	0	56	21	0	0	0	0
Apoprionospio pygmaea	0	0	0	0	0	0	0	83	0	0	0	0
Sabella microphthalma	0	0	0	0	0	0	91	0	0	0	0	0
Callianassa species	0	0	0	0	0	0	0	5	0	0	0	0
Polydora websteri	0	0	0	0	0	5	0	0	0	0	0	0
Magelona phyllisae	0	0	0	0	0	5	35	5	0	0	0	0
Glycinde nordmanni	0	0	0	0	10	5	5	0	0	0	0	0
Megalops	0	0	0	0	0	0	20	15	0	0	15	0
Autolytus species	0	0	0	0	65	10	5	0	0	0	0	0
Diastylis species	0	0	24	0	0	0	0	5	5	0	0	29
Pyramidella crenulata	0	0	0	24	0	5	0	0	0	0	10	5
Sabella melanostigma	0	0	0	0	0	15	51	0	0	0	10	0
Eudorella monodon	0	0	0	0	0	0	76	0	0	0	0	0
Ancistrosyllis papillosa	0	0	0	24	0	0	0	21	0	0	0	0

Appendix 3. Continued.

Species	Mission-Aransas Estuary				Nueces Estuary				Laguna Madre Estuary			
	A	B	C	D	A	B	C	D	A	B	C	D
Aricidea taylori	0	0	0	0	0	21	41	10	0	0	0	0
Pinnixa chacei	0	0	0	0	0	0	0	0	0	0	0	0
Dyspanopeus texana	0	0	0	0	0	0	0	0	0	0	72	0
Tagelus divisus	0	0	0	0	0	31	41	0	0	0	0	0
Tellina tampaensis	0	0	0	0	0	10	0	0	0	0	36	24
Nudibranchia (unidentified)	0	0	0	0	0	10	5	0	0	0	36	0
Spio pettiboneae	0	0	0	0	0	0	0	0	0	0	0	68
Terebellidae (unidentified)	0	0	0	0	0	10	25	5	0	0	0	0
Eupomatus dianthus	0	0	0	0	0	5	25	0	0	0	26	5
Polydora species	0	0	0	0	0	0	15	10	0	0	0	0
Platynereis dumerilii	0	0	0	0	0	0	0	0	0	0	67	0
Scoloplos texana	0	47	0	0	0	0	0	0	0	0	0	0
Scolelepis squamata	0	0	0	0	0	0	0	0	0	0	0	15
Pyramidella species	0	0	0	0	5	0	0	26	0	0	0	0
Holothuroidea (unidentified)	0	0	0	0	0	10	15	5	5	0	26	0
Eunoe cf. nodulosa	0	0	0	0	0	0	0	5	0	0	0	0
Haploscoloplos species	0	0	0	0	20	0	10	5	5	0	0	0
Dorvilleidae (unidentified)	0	0	0	0	0	5	10	21	0	0	15	5
Ischadium recurvum	0	0	0	0	0	31	0	0	0	0	0	0
Paranaitis speciosa	0	0	0	0	0	15	0	36	0	0	0	0
Eumida sanguinea	0	0	0	47	0	5	0	5	0	0	0	0
Tagelus plebeius	0	0	0	0	0	0	0	0	0	0	0	0
Ancistrosyllis groenlandica	0	0	0	0	0	0	0	0	0	0	0	0
Sigalionidae (unidentified)	0	0	0	0	0	0	0	0	0	0	0	0
Pista cristata	0	0	0	0	0	10	0	5	0	0	0	39
Ophryotrocha sp. (unidentified)	0	0	0	0	0	0	0	0	0	0	15	39
Vitrinella floridana	0	0	0	0	40	5	0	0	0	0	0	0
Leptostylis species	0	0	0	0	0	0	0	0	0	0	0	54

Appendix 3. Continued.

Species	Mission-Aransas Estuary				Nueces Estuary				Laguna Madre Estuary			
	A	B	C	D	A	B	C	D	A	B	C	D
Xenanthura brevitelson	0	0	0	0	10	21	0	0	0	0	0	0
Gammarus mucronatus	0	0	0	0	10	5	0	5	0	0	0	10
Notomastus cf. latericeus	0	0	0	0	0	15	0	5	0	0	0	0
Maldane sarsi	0	0	0	0	0	10	35	5	0	0	0	0
Sarsiella species	0	0	0	0	0	0	0	0	0	0	26	24
Paramya subovata	0	0	0	0	0	0	0	36	0	0	0	0
Xanthidae (unidentified)	0	0	0	0	0	10	10	0	5	0	21	0
Brada cf. villosa capensis	0	0	0	0	0	26	20	0	0	0	0	0
Ampelisca species B	0	0	0	0	0	0	5	5	0	0	0	0
Unidentified	47	0	0	0	0	0	0	0	0	0	0	0
Caecum glabrum	0	0	0	0	0	0	0	46	0	0	0	0
Lembos species	0	0	0	0	0	10	5	26	0	0	0	5
Sayella crosseana	0	0	0	0	0	0	0	0	0	0	21	24
Pilargiidae (unidentified)	0	0	0	0	0	0	0	5	0	0	5	10
Mystides rarica	0	0	0	0	0	36	5	0	0	0	0	0
Macoma tenta	0	0	0	0	0	0	10	10	0	0	0	0
Anachis obesa	0	0	0	0	0	5	30	0	0	0	5	0
Melita nitida	0	0	0	0	0	0	0	0	0	0	10	10
Capitellidae (unidentified)	0	0	0	0	0	5	0	0	0	0	10	0
Fabricia species A	0	0	0	0	0	0	0	0	0	0	36	0
Mercenaria campechiensis	0	0	0	0	0	15	0	10	0	0	0	0
Ceriantharia (unidentified)	0	0	0	0	0	0	35	0	0	0	0	0
Odostomia species	0	0	0	0	0	0	0	0	0	0	5	0
Serpulidae (unidentified)	0	0	0	0	0	0	25	0	0	0	0	0
Bowmaniella brasiliensis	0	0	0	0	0	0	0	0	0	0	0	34
Cabira incerta	0	0	0	24	0	0	0	0	0	0	0	0
Bowmaniella species	0	0	0	0	0	0	0	0	0	0	0	29
Photis species	0	0	0	0	0	0	0	21	0	0	0	5

Appendix 3. Continued.

Species	Mission-Aransas Estuary				Nueces Estuary				Laguna Madre Estuary			
	A	B	C	D	A	B	C	D	A	B	C	D
Thompsonula species	0	0	0	0	0	0	0	0	0	0	0	0
Corophium species	0	0	0	0	0	5	0	0	0	5	5	5
Potamilla reniformis	0	0	0	0	0	31	0	0	0	0	0	0
Ninoe nigripes	0	0	0	0	0	5	0	5	0	0	0	0
Aricidea species	0	0	0	0	0	0	15	15	0	0	0	0
Microphthalmus abberrans	0	0	0	0	0	15	0	5	0	0	0	0
Nassarius vibex	0	0	0	0	0	0	5	0	0	0	10	0
Mysidopsis bigelowi	0	0	0	0	0	0	0	0	0	0	0	0
Hesione picta	24	0	0	0	0	0	0	0	0	0	0	0
Mytilidae (unidentified)	24	0	0	0	0	0	0	0	0	0	0	0
Paranaitis polynoides	0	0	0	0	0	0	0	0	0	16	10	0
Crassostrea virginica	0	0	0	0	0	10	0	0	0	0	0	0
Petricola pholadiformes	0	0	0	0	0	26	0	0	0	0	0	0
Anachis semiplicata	0	0	0	0	0	0	0	0	0	0	26	0
Naineris bicornis	0	0	0	0	0	0	0	0	0	0	26	0
Chaetozone setosa	0	0	0	0	0	0	5	21	0	0	0	0
Marphysa sanguinea	0	0	0	0	5	15	5	0	0	0	0	0
Ascidiacea (unidentified)	0	0	0	0	0	0	15	0	0	0	10	0
Pilargis berkelyae	0	0	0	0	0	0	0	0	0	0	10	15
Sarsiella spinosa	0	0	0	0	0	0	10	0	0	0	0	0
Anomia simplex	0	0	24	0	0	0	0	0	0	0	0	0
Serpulidae A	0	0	24	0	0	0	0	0	0	0	0	0
Callinectes sapidus	0	0	0	24	0	0	0	0	0	0	0	0
Mitrella lunata	0	0	0	0	0	5	0	0	0	0	5	0
Pinnixa retinens	0	0	0	0	0	0	0	10	0	0	5	0
Glycera capitata	0	0	0	0	0	0	0	15	0	0	0	0
Magelona rosea	0	0	0	0	0	0	0	0	0	0	0	0
Sigambra cf. wassi	0	0	0	0	0	0	0	0	0	0	0	0

Appendix 3. Continued.

Species	Mission-Aransas Estuary				Nueces Estuary				Laguna Madre Estuary			
	A	B	C	D	A	B	C	D	A	B	C	D
Glyceridae (unidentified)	0	0	0	0	0	0	0	0	0	0	0	0
Euclymene species A	0	0	0	0	0	21	0	0	0	0	0	0
Owenia fusiformis	0	0	0	0	0	0	5	5	0	0	0	0
Dentalium texasianum	0	0	0	0	0	0	10	0	0	0	0	0
Brachyuran zoea	0	0	0	0	0	0	0	0	20	0	0	0
Lumbrineris latreilli	0	0	0	0	0	5	0	0	0	0	0	0
Polinices duplicatus	0	0	0	0	0	0	0	5	0	0	0	0
Texadina barretti	0	0	0	0	0	0	0	0	0	0	0	0
Phyllodocidae (unidentified)	0	0	0	0	0	0	0	0	0	0	10	5
Parametopella species	0	0	0	0	0	10	5	0	0	0	0	0
Lumbrineris branchiata	0	0	0	0	0	0	15	0	0	0	0	0
Capitellides jonesi	0	0	0	0	0	0	5	5	0	0	0	0
Clibanarius vittatus	0	0	0	0	0	0	10	0	0	0	0	0
Synchelidium americanum	0	0	0	0	0	0	0	0	0	0	0	0
Amphipoda (unidentified)	0	0	0	0	0	5	0	0	0	0	0	0
Piromis arenosus	0	0	0	0	0	15	0	0	0	0	0	0
Synsyllis longigularis	0	0	0	0	0	0	10	5	0	0	0	0
Ophiuroidea (unidentified)	0	0	0	0	0	0	15	0	0	0	0	0
Pomatoleios caerulescens	0	0	0	0	0	0	15	0	0	0	0	0
Sarsiella capsula	0	0	0	0	0	0	5	0	0	0	5	5
Sipuncula (unidentified)	0	0	0	0	0	0	5	0	0	0	0	0
Sphaerosyllis erinaceus	0	0	0	0	0	0	0	0	0	0	0	0
Sarsiella disparalis	0	0	0	0	0	0	0	0	0	0	10	0
Pinnotheridae (unidentified)	0	0	0	0	0	0	0	0	0	0	0	0
Hesionidae (unidentified)	0	0	0	0	0	10	0	0	0	0	0	0
Nephtys species	0	0	0	0	0	0	0	0	0	0	0	0
Bulla striata	0	0	0	0	0	0	0	0	0	0	5	0
Ampharetidae (unidentified)	0	0	0	0	0	0	0	0	0	0	0	5

Appendix 3. Continued.

	Mission-Aransas Estuary				Nueces Estuary				Laguna Madre Estuary			
Species	A	B	C	D	A	B	C	D	A	B	C	D
Trachypenaeus constrictus	0	0	0	0	0	0	0	0	0	0	0	0
Amphinomidae (unidentified)	0	0	0	0	0	0	0	0	0	0	0	0
Listriella species	0	0	0	0	0	0	0	0	0	0	0	0
Solen viridis	0	0	0	0	0	0	0	10	0	0	0	0
Nereis lamellosa	0	0	0	0	0	0	0	0	0	0	10	0
Onuphis eremita	0	0	0	0	0	5	5	0	0	0	0	0
Ancistrosyllis species	0	0	0	0	0	5	5	0	0	0	0	0
Euceramus praelongus	0	0	0	0	0	0	10	0	0	0	0	0
Brada species	0	0	0	0	0	0	10	0	0	0	0	0
Crassinella lunulata	0	0	0	0	0	0	10	0	0	0	0	0
Odostomia canaliculata	0	0	0	0	0	0	10	0	0	0	0	0
Pinnixa cristata	0	0	0	0	0	0	0	0	0	0	0	0
Allothyone mexicana	0	0	0	0	0	0	0	0	0	0	0	0
Henrya goldmani	0	0	0	0	0	0	0	0	0	0	0	10
Cyclaspis species	0	0	0	0	0	0	0	0	0	0	0	0
Martesia species	0	0	0	0	5	0	0	0	0	0	0	0
Tellidora cristata	0	0	0	0	5	0	0	0	0	0	0	0
Fargoa cf. gibbosa	0	0	0	0	0	0	5	0	0	0	0	0
Aglaophamus verrilli	0	0	0	0	0	0	0	0	0	0	0	0
Paguridae (juvenile)	0	0	0	0	0	0	0	0	0	0	0	0
Paramphinome jeffreysii	0	0	0	0	0	0	0	0	0	0	0	0
Polynoidae (unidentified)	0	0	0	0	0	0	0	0	0	0	0	0
Macoma species	0	0	0	0	0	0	0	0	0	0	0	0
Neopanope texana	0	0	0	0	0	0	0	0	0	0	0	0
Fabriciola trilobata	0	0	0	0	0	0	0	0	0	0	0	0
Lepidophthalamus louisianensis	0	0	0	0	0	0	0	0	0	0	0	0
Hydrozoa (unidentified)	0	0	0	0	0	5	0	0	0	0	0	0
Eteone lactea	0	0	0	0	0	0	0	5	0	0	0	0

Appendix 3. Continued.

Species	Mission-Aransas Estuary				Nueces Estuary				Laguna Madre Estuary			
	A	B	C	D	A	B	C	D	A	B	C	D
Macoma brevifrons	0	0	0	0	0	0	0	5	0	0	0	0
Labidocera aestiva	0	0	0	0	0	5	0	0	0	0	0	0
Callinectes species	0	0	0	0	0	5	0	0	0	0	0	0
Cantharus cancellarius	0	0	0	0	0	0	0	5	0	0	0	0
Magelonidae (unidentified)	0	0	0	0	0	0	0	5	0	0	0	0
Truncatella caribaeensis	0	0	0	0	0	0	0	0	0	0	5	0
Epitonium species	0	0	0	0	0	0	0	5	0	0	0	0
Penaeus aztecus	0	0	0	0	0	5	0	0	0	0	0	0
Mollusca (unidentified)	0	0	0	0	0	0	0	5	0	0	0	0
Tharyx species	0	0	0	0	0	5	0	0	0	0	0	0
Balanus trigonus	0	0	0	0	0	5	0	0	0	0	0	0
Nematonereis hebes	0	0	0	0	0	5	0	0	0	0	0	0
Clymenella mucosa	0	0	0	0	0	5	0	0	0	0	0	0
Eupolymnia species	0	0	0	0	0	5	0	0	0	0	0	0
Nereis pelagica occidentalis	0	0	0	0	0	0	5	0	0	0	0	0
Doridella obscura	0	0	0	0	0	0	5	0	0	0	0	0
Anadara transversa	0	0	0	0	0	0	5	0	0	0	0	0
Dentalium species	0	0	0	0	0	0	5	0	0	0	0	0
Episiphon sowerbyi	0	0	0	0	0	0	5	0	0	0	0	0
Eulimastoma cf. teres	0	0	0	0	0	0	5	0	0	0	0	0
Turbonilla portoricana	0	0	0	0	0	0	5	0	0	0	0	0
Trypanosyllis gemnipara	0	0	0	0	0	0	5	0	0	0	0	0
Crepidula species	0	0	0	0	0	0	5	0	0	0	0	0
Synelmis albini	0	0	0	0	0	0	5	0	0	0	0	0
Tellina versicolor	0	0	0	0	0	0	5	0	0	0	0	0
Pilargis species	0	0	0	0	0	0	0	0	5	0	0	0
Dispio uncinata	0	0	0	0	0	0	0	0	0	0	0	5
Bowmaniella dissimilis	0	0	0	0	0	0	0	0	0	0	0	5

Appendix 3. Continued.

Species	Mission-Aransas Estuary				Nueces Estuary				Laguna Madre Estuary			
	A	B	C	D	A	B	C	D	A	B	C	D
Littorina ziczac	0	0	0	0	0	0	0	0	0	0	0	5
Prionospio treadwelli	0	0	0	0	0	0	0	0	0	0	0	5
Nephtys picta	0	0	0	0	0	0	0	0	0	0	0	0
Onuphis species	0	0	0	0	0	0	0	0	0	0	0	0
Cyrtopleura costata	0	0	0	0	0	0	0	0	0	0	0	0
Alpheus heterochaelis	0	0	0	0	0	0	0	0	0	0	0	0
Anadara ovalis	0	0	0	0	0	0	0	0	0	0	0	0
Echiuridae (unidentified)	0	0	0	0	0	0	0	0	0	0	0	0
Lumbrineris tenuis	0	0	0	0	0	0	0	0	0	0	0	0
Goniadidae (unidentified)	0	0	0	0	0	0	0	0	0	0	0	0
Lumbrineridae (unidentified)	0	0	0	0	0	0	0	0	0	0	0	0
Sthenelais species	0	0	0	0	0	0	0	0	0	0	0	0
Munna hayesi	0	0	0	0	0	0	0	0	0	0	0	0
Callinectes similis	0	0	0	0	0	0	0	0	0	0	0	0
Ancistrosyllis cf. falcata	0	0	0	0	0	0	0	0	0	0	0	0
Munnidae (unidentified)	0	0	0	0	0	0	0	0	0	0	0	0
Eurythoe species	0	0	0	0	0	0	0	0	0	0	0	0
Paramphinome pulchella	0	0	0	0	0	0	0	0	0	0	0	0
Agriopoma texasianum	0	0	0	0	0	0	0	0	0	0	0	0
Malmgreniella species	0	0	0	0	0	0	0	0	0	0	0	0
Potamanthidae (unidentified)	0	0	0	0	0	0	0	0	0	0	0	0
Cyclinella tenuis	0	0	0	0	0	0	0	0	0	0	0	0
Diptera (unidentified)	0	0	0	0	0	0	0	0	0	0	0	0
Arenicola cristata	0	0	0	0	0	0	0	0	0	0	0	0
Chironomidae (pupae)	0	0	0	0	0	0	0	0	0	0	0	0
Cassidinidea lunifrons	0	0	0	0	0	0	0	0	0	0	0	0
Insecta (unidentified)	0	0	0	0	0	0	0	0	0	0	0	0
Rithropanopeus harrisi	0	0	0	0	0	0	0	0	0	0	0	0

Appendix 4 Overall Species Abundance (#/m^2) and Overall Species Ranking

Rank	Species No.	Species Name	Percent	Cumulative	Overall
1	562	*Mediomastus ambiseta*	27.1465%	27.1465%	10,671
2	81	*Streblospio benedicti*	19.4333%	46.5797%	7,639
3	8	Oligochaeta (unidentified)	5.7069%	52.2866%	2,243
4	162	*Mulinia lateralis*	4.4394%	56.7260%	1,745
5	72	*Polydora caulleryi*	3.0239%	59.7499%	1,189
6	504	*Texadina sphinctostoma*	2.8704%	62.6202%	1,128
7	197	*Ampelisca abdita*	2.2991%	64.9194%	904
8	86	*Prionospio heterobranchia*	2.2955%	67.2149%	902
9	545	*Syllis cornuta*	1.8996%	69.1145%	747
10	92	*Tharyx setigera*	1.7196%	70.8340%	676
11	7	Nemertea (unidentified)	1.6219%	72.4559%	638
12	509	*Apseudes* species A	1.4177%	73.8736%	557
13	547	*Exogone* species A	1.2498%	75.1233%	491
14	111	*Capitella capitata*	1.1885%	76.3118%	467
15	110	*Cossura delta*	1.0403%	77.3520%	409
16	82	*Paraprionospio pinnata*	0.8552%	78.2072%	336
17	546	*Brania furcelligera*	0.7004%	78.9076%	275
18	32	*Gyptis vittata*	0.6896%	79.5972%	271
19	382	*Sphaerosyllis* species A	0.6602%	80.2575%	260
20	424	*Caecum pulchellum*	0.6423%	80.8998%	252
21	55	*Glycinde solitaria*	0.6400%	81.5398%	252
22	359	*Cerapus tubularis*	0.6163%	82.1561%	242
23	396	*Grandidierella bonnieroides*	0.5523%	82.7084%	217
24	542	*Cerithium lutosum*	0.5197%	83.2281%	204
25	559	*Naineris laevigata*	0.4474%	83.6755%	176
26	91	*Spiochaetopterus costarum*	0.4445%	84.1200%	175
27	159	*Mysella planulata*	0.4213%	84.5413%	166
28	488	*Macoma mitchelli*	0.3947%	84.9360%	155
29	119	*Clymenella torquata*	0.3823%	85.3183%	150
30	2	Anthozoa (unidentified)	0.3716%	85.6899%	146
31	85	*Minuspio cirrifera*	0.3667%	86.0566%	144
32	357	*Amphiodia atra*	0.3656%	86.4222%	144
33	117	*Branchioasychis americana*	0.3452%	86.7674%	136
34	114	*Heteromastus filiformis*	0.3304%	87.0978%	130
35	17	*Paleanotus heteroseta*	0.3254%	87.4232%	128
36	95	*Haploscoloplos foliosus*	0.3084%	87.7317%	121
37	155	*Nuculana acuta*	0.3078%	88.0394%	121
38	269	*Anomalocardia auberiana*	0.3024%	88.3418%	119
39	510	*Periploma cf. orbiculare*	0.2711%	88.6129%	107

Appendix 4. Continued.

Rank	Species No.	Species Name	Percent	Cumulative	Overall
40	71	*Polydora ligni*	0.2701%	88.8830%	106
41	249	*Schizocardium* species	0.2372%	89.1202%	93
42	62	*Lumbrineris parvapedata*	0.2332%	89.3533%	92
43	68	*Schistomeringos rudolphi*	0.2270%	89.5804%	89
44	539	*Axiothella* species A	0.2232%	89.8035%	88
45	267	*Chone* species	0.2226%	90.0261%	87
46	174	*Corbula contracta*	0.2178%	90.2439%	86
47	113	*Mediomastus californiensis*	0.2160%	90.4599%	85
48	192	*Cyclaspis varians*	0.2142%	90.6741%	84
49	309	*Elasmopus* species	0.2009%	90.8750%	79
50	256	*Acteocina canaliculata*	0.1981%	91.0731%	78
51	373	*Erichsonella attenuata*	0.1953%	91.2684%	77
52	508	*Parandalia ocularis*	0.1919%	91.4603%	75
53	200	Caprellidae (unidentified)	0.1886%	91.6489%	74
54	125	*Melinna maculata*	0.1826%	91.8314%	72
55	160	*Lepton* species	0.1784%	92.0098%	70
56	492	*Hobsonia florida*	0.1575%	92.1673%	62
57	245	*Phoronis architecta*	0.1574%	92.3247%	62
58	498	*Rangia cuneata*	0.1480%	92.4727%	58
59	58	*Diopatra cuprea*	0.1468%	92.6195%	58
60	161	*Aligena texasiana*	0.1462%	92.7657%	57
61	323	Nereididae (unidentified)	0.1455%	92.9111%	57
62	399	*Leucon sp.*	0.1332%	93.0443%	52
63	157	*Amygdalum papyrium*	0.1287%	93.1730%	51
64	341	*Paraonidae* Group B	0.1253%	93.2983%	49
65	65	*Drilonereis magna*	0.1241%	93.4224%	49
66	205	*Monoculodes* species	0.1189%	93.5412%	47
67	374	*Sarsiella zostericola*	0.1150%	93.6562%	45
68	840	*Aricidea bryani*	0.1145%	93.7707%	45
69	557	*Rictaxis punctostriatus*	0.1138%	93.8845%	45
70	322	*Sphaerosyllis cf. sublaevis*	0.1102%	93.9947%	43
71	777	*Pomatoceros americanus*	0.1095%	94.1042%	43
72	334	*Schistomeringos* species A	0.1087%	94.2130%	43
73	122	*Maldanidae (unidentified)*	0.1076%	94.3206%	42
74	279	*Turbonilla* species	0.1070%	94.4275%	42
75	94	*Scoloplos rubra*	0.1060%	94.5336%	42
76	487	*Chironomidae (larvae)*	0.1043%	94.6379%	41
77	96	*Haploscoloplos fragilis*	0.1039%	94.7418%	41
78	180	*Lyonsia hyalina floridana*	0.1027%	94.8445%	40
79	412	Vitrinellidae (unidentified)	0.0994%	94.9439%	39

Appendix 4. Continued.

Rank	Species No.	Species Name	Percent	Cumulative	Overall
80	278	*Cymodoce faxoni*	0.0968%	95.0407%	38
81	181	Ostracoda (unidentified)	0.0927%	95.1334%	36
82	254	*Listriella barnardi*	0.0927%	95.2261%	36
83	499	Turbellaria (unidentified)	0.0912%	95.3173%	36
84	460	*Hemicyclops* species	0.0890%	95.4064%	35
85	579	*Euclymene* species B	0.0888%	95.4952%	35
86	116	*Notomastus latericeus*	0.0879%	95.5831%	35
87	377	Gastropoda (unidentified)	0.0870%	95.6702%	34
88	618	*Opisthosyllis* species	0.0865%	95.7566%	34
89	118	*Axiothella mucosa*	0.0854%	95.8420%	34
90	431	*Cymadusa compta*	0.0835%	95.9256%	33
91	553	*Oxyurostylis* species	0.0833%	96.0089%	33
92	201	*Corophium louisianum*	0.0813%	96.0901%	32
93	196	*Edotea montosa*	0.0793%	96.1694%	31
94	30	*Sigambra bassi*	0.0783%	96.2477%	31
95	321	Syllidae (unidentified)	0.0758%	96.3235%	30
96	365	*Microprotopus* species	0.0757%	96.3992%	30
97	353	Sabellidae (unidentified)	0.0753%	96.4745%	30
98	22	*Eteone heteropoda*	0.0730%	96.5475%	29
99	179	*Periploma margaritaceum*	0.0722%	96.6197%	28
100	258	*Nassarius acutus*	0.0709%	96.6907%	28
101	297	*Erichthonias brasiliensis*	0.0670%	96.7577%	26
102	145	*Crepidula plana*	0.0661%	96.8239%	26
103	199	*Batea catharinensis*	0.0657%	96.8896%	26
104	644	*Malmgreniella taylori*	0.0644%	96.9540%	25
105	296	*Amphilochus sp.*	0.0604%	97.0144%	24
106	901	*Cirrophorus lyra*	0.0600%	97.0744%	24
107	70	*Polydora socialis*	0.0581%	97.1325%	23
108	449	*Chione cancellata*	0.0563%	97.1888%	22
109	43	*Ceratonereis irritabilis*	0.0562%	97.2450%	22
110	203	*Listriella clymenellae*	0.0557%	97.3007%	22
111	83	*Scolelepis texana*	0.0525%	97.3532%	21
112	561	*Haminoea antillarum*	0.0480%	97.4012%	19
113	358	Bivalvia (unidentified)	0.0477%	97.4488%	19
114	31	*Sigambra tentaculata*	0.0472%	97.4960%	19
115	195	*Leptochelia rapax*	0.0471%	97.5431%	18
116	194	*Oxyurostylis salinoi*	0.0470%	97.5901%	18
117	565	*Eupomatus protulicola*	0.0449%	97.6350%	18
118	244	*Phascolion strombi*	0.0445%	97.6795%	17
119	452	*Diastoma varium*	0.0444%	97.7239%	17

Appendix 4. Continued.

Rank	Species No.	Species Name	Percent	Cumulative	Overall
120	167	*Tellina texana*	0.0426%	97.7666%	17
121	75	*Spiophanes bombyx*	0.0426%	97.8091%	17
122	402	*Eulimastoma* species	0.0400%	97.8492%	16
123	131	*Megalomma bioculatum*	0.0400%	97.8892%	16
124	380	*Pinnixa* species	0.0399%	97.9291%	16
125	500	*Oxyurostylis smithi*	0.0397%	97.9688%	16
126	340	*Paraonidae* Group A	0.0396%	98.0083%	16
127	88	*Magelona pettiboneae*	0.0389%	98.0473%	15
128	403	*Brachidontes exustus*	0.0389%	98.0862%	15
129	563	*Amaeana trilobata*	0.0381%	98.1243%	15
130	124	*Pectinaria gouldii*	0.0376%	98.1620%	15
131	56	*Lysidice ninetta*	0.0375%	98.1995%	15
132	520	*Aricidea catharinae*	0.0349%	98.2344%	14
133	186	*Cyclopoida* (commensal)	0.0343%	98.2686%	13
134	183	*Pseudodiaptomus pelagicus*	0.0341%	98.3027%	13
135	453	*Mysidopsis bahia*	0.0335%	98.3363%	13
136	121	*Asychis* species	0.0330%	98.3693%	13
137	26	*Anaitides erythrophyllus*	0.0319%	98.4012%	13
138	390	*Corophium ascherusicum*	0.0317%	98.4329%	12
139	262	*Nuculana concentrica*	0.0312%	98.4641%	12
140	170	*Abra aequalis*	0.0298%	98.4939%	12
141	362	*Sarsiella texana*	0.0287%	98.5226%	11
142	491	*Laeonereis culveri*	0.0287%	98.5513%	11
143	168	*Tellina* species	0.0271%	98.5784%	11
144	619	*Syllis falgens*	0.0261%	98.6045%	10
145	54	*Glycera americana*	0.0260%	98.6305%	10
146	419	*Molgula manhattensis*	0.0259%	98.6564%	10
147	126	*Isolda pulchella*	0.0238%	98.6802%	9
148	39	*Brania clavata*	0.0238%	98.7040%	9
149	493	*Mysidopsis almyra*	0.0235%	98.7275%	9
150	446	*Asychis elongata*	0.0234%	98.7509%	9
151	564	*Eudorella* species	0.0233%	98.7742%	9
152	360	*Armandia maculata*	0.0232%	98.7974%	9
153	533	*Caecum johnsoni*	0.0223%	98.8197%	9
154	44	*Neanthes succinea*	0.0222%	98.8419%	9
155	648	*Neosamytha gracilis*	0.0220%	98.8639%	9
156	543	*Mactra fragilis*	0.0216%	98.8855%	8
157	427	Pycnogonida (unidentified)	0.0209%	98.9064%	8
158	128	*Pista palmata*	0.0200%	98.9264%	8
159	218	*Ogyrides limicola*	0.0194%	98.9458%	8

Appendix 4. Continued.

Rank	Species No.	Species Name	Percent	Cumulative	Overall
160	28	*Ancistrosyllis jonesi*	0.0190%	98.9648%	7
161	335	Spionidae (unidentified)	0.0189%	98.9837%	7
162	79	*Spio setosa*	0.0187%	99.0024%	7
163	187	*Balanus eburneus*	0.0177%	99.0200%	7
164	15	*Sthenelais boa*	0.0173%	99.0373%	7
165	144	*Crepidula fornicata*	0.0164%	99.0537%	6
166	34	*Podarke obscura*	0.0163%	99.0700%	6
167	272	*Laevicardium mortoni*	0.0159%	99.0859%	6
168	311	*Pandora trilineata*	0.0155%	99.1015%	6
169	480	*Spirorbis* species	0.0151%	99.1165%	6
170	163	*Ensis minor*	0.0150%	99.1316%	6
171	428	*Mysidopsis* species	0.0139%	99.1455%	5
172	566	*Boonea impressa*	0.0138%	99.1593%	5
173	33	*Parahesione luteola*	0.0138%	99.1731%	5
174	198	*Ampelisca verrilli*	0.0138%	99.1868%	5
175	416	*Chione* species	0.0138%	99.2006%	5
176	512	Polychaeta juv. (unidentified)	0.0136%	99.2142%	5
177	440	*Hauchiella* species	0.0131%	99.2273%	5
178	225	*Pagurus annulipes*	0.0130%	99.2403%	5
179	136	*Pomatoleios kraussi*	0.0129%	99.2532%	5
180	99	*Aricidea fragilis*	0.0128%	99.2660%	5
181	84	*Apoprionospio pygmaea*	0.0126%	99.2785%	5
182	133	*Sabella microphthalma*	0.0125%	99.2910%	5
183	501	*Callianassa* species	0.0122%	99.3032%	5
184	69	*Polydora websteri*	0.0118%	99.3151%	5
185	89	*Magelona phyllisae*	0.0115%	99.3266%	5
186	580	*Glycinde nordmanni*	0.0115%	99.3380%	5
187	469	*Megalops*	0.0108%	99.3488%	4
188	41	*Autolytus* species	0.0102%	99.3590%	4
189	531	*Diastylis* species	0.0101%	99.3691%	4
190	379	*Pyramidella crenulata*	0.0100%	99.3790%	4
191	132	*Sabella melanostigma*	0.0097%	99.3887%	4
192	418	*Eudorella monodon*	0.0097%	99.3984%	4
193	29	*Ancistrosyllis papillosa*	0.0096%	99.4080%	4
194	102	*Aricidea taylori*	0.0095%	99.4175%	4
195	540	*Pinnixa chacei*	0.0092%	99.4267%	4
196	548	*Dyspanopeus texana*	0.0092%	99.4359%	4
197	169	*Tagelus divisus*	0.0091%	99.4450%	4
198	555	*Tellina tampaensis*	0.0090%	99.4540%	4
199	408	Nudibranchia (unidentified)	0.0089%	99.4629%	4

Appendix 4. Continued.

Rank	Species No.	Species Name	Percent	Cumulative	Overall
200	78	*Spio pettiboneae*	0.0087%	99.4717%	3
201	352	Terebellidae (unidentified)	0.0087%	99.4803%	3
202	554	*Eupomatus dianthus*	0.0086%	99.4889%	3
203	73	*Polydora* species	0.0085%	99.4974%	3
204	573	*Platynereis dumerilii*	0.0085%	99.5059%	3
205	98	*Scoloplos texana*	0.0084%	99.5144%	3
206	507	*Scolelepis squamata*	0.0083%	99.5227%	3
207	503	*Pyramidella* species	0.0083%	99.5310%	3
208	393	Holothuroidea (unidentified)	0.0083%	99.5392%	3
209	12	*Eunoe cf. nodulosa*	0.0081%	99.5473%	3
210	324	*Haploscoloplos* species	0.0081%	99.5554%	3
211	333	Dorvilleidae (unidentified)	0.0080%	99.5635%	3
212	904	*Ischadium recurvum*	0.0079%	99.5714%	3
213	24	*Paranaitis speciosa*	0.0078%	99.5792%	3
214	23	*Eumida sanguinea*	0.0073%	99.5865%	3
215	502	*Tagelus plebeius*	0.0071%	99.5936%	3
216	290	*Ancistrosyllis groenlandica*	0.0070%	99.6007%	3
217	316	Sigalionidae (unidentified)	0.0070%	99.6077%	3
218	752	*Pista cristata*	0.0069%	99.6146%	3
219	596	Ophryotrocha species (unidentified)	0.0069%	99.6216%	3
220	142	*Vitrinella floridana*	0.0069%	99.6285%	3
221	572	*Leptostylis* species	0.0068%	99.6353%	3
222	292	*Xenanthura brevitelson*	0.0067%	99.6420%	3
223	202	*Gammarus mucronatus*	0.0066%	99.6486%	3
224	344	*Notomastus cf. latericeus*	0.0066%	99.6552%	3
225	120	*Maldane sarsi*	0.0065%	99.6617%	3
226	367	*Sarsiella sp.*	0.0064%	99.6681%	3
227	568	*Paramya subovata*	0.0064%	99.6744%	2
228	238	Xanthidae (unidentified)	0.0063%	99.6807%	2
229	541	*Brada cf. villosa capensis*	0.0063%	99.6870%	2
230	209	*Ampelisca* species B	0.0061%	99.6932%	2
231	511	*Unidentified*	0.0060%	99.6992%	2
232	271	*Caecum glabrum*	0.0059%	99.7051%	2
233	465	*Lembos* species	0.0059%	99.7109%	2
234	544	*Sayella crosseana*	0.0057%	99.7167%	2
235	319	Pilargiidae (unidentified)	0.0056%	99.7223%	2
236	299	*Mystides rarica*	0.0052%	99.7275%	2
237	165	*Macoma tenta*	0.0052%	99.7327%	2
238	355	*Anachis obesa*	0.0052%	99.7379%	2
239	204	*Melita nitida*	0.0049%	99.7428%	2

Appendix 4. Continued.

Rank	Species No.	Species Name	Percent	Cumulative	Overall
240	343	Capitellidae (unidentified)	0.0049%	99.7478%	2
241	575	*Fabricia* species A	0.0046%	99.7524%	2
242	273	*Mercenaria campechiensis*	0.0045%	99.7569%	2
243	3	Ceriantharia (unidentified)	0.0045%	99.7614%	2
244	151	*Odostomia* species	0.0044%	99.7658%	2
245	354	Serpulidae (unidentified)	0.0044%	99.7702%	2
246	190	*Bowmaniella brasiliensis*	0.0044%	99.7746%	2
247	270	*Cabira incerta*	0.0043%	99.7789%	2
248	191	*Bowmaniella* species	0.0041%	99.7830%	2
249	207	*Photis* species	0.0041%	99.7872%	2
250	506	*Thompsonula* species	0.0040%	99.7911%	2
251	387	*Corophium* species	0.0039%	99.7951%	2
252	457	*Potamilla reniformis*	0.0039%	99.7990%	2
253	800	*Ninoe nigripes*	0.0039%	99.8029%	2
254	841	*Aricidea* species	0.0039%	99.8068%	2
255	127	*Microphthalmus abberrans*	0.0038%	99.8106%	1
256	149	*Nassarius vibex*	0.0037%	99.8144%	1
257	188	*Mysidopsis bigelowi*	0.0035%	99.8179%	1
258	567	*Hesione picta*	0.0034%	99.8213%	1
259	869	Mytilidae (unidentified)	0.0034%	99.8247%	1
260	283	*Paranaitis polynoides*	0.0034%	99.8281%	1
261	470	*Crassostrea virginica*	0.0033%	99.8315%	1
262	173	*Petricola pholadiformes*	0.0033%	99.8347%	1
263	421	*Anachis semiplicata*	0.0033%	99.8380%	1
264	774	*Naineris bicornis*	0.0033%	99.8413%	1
265	93	*Chaetozone setosa*	0.0033%	99.8446%	1
266	57	*Marphysa sanguinea*	0.0032%	99.8478%	1
267	395	Ascidiacea (unidentified)	0.0032%	99.8511%	1
268	293	*Pilargis berkelyae*	0.0032%	99.8542%	1
269	551	*Sarsiella spinosa*	0.0030%	99.8573%	1
270	36	*Anomia simplex*	0.0030%	99.8603%	1
271	138	*Serpulidae A*	0.0030%	99.8633%	1
272	232	*Callinectes sapidus*	0.0030%	99.8663%	1
273	147	*Mitrella lunata*	0.0030%	99.8693%	1
274	241	*Pinnixa retinens*	0.0028%	99.8721%	1
275	327	*Glycera capitata*	0.0028%	99.8749%	1
276	90	*Magelona rosea*	0.0026%	99.8776%	1
277	552	*Sigambra cf. wassi*	0.0026%	99.8802%	1
278	326	Glyceridae (unidentified)	0.0026%	99.8829%	1
279	650	*Euclymene* species A	0.0026%	99.8855%	1

Appendix 4. Continued.

Rank	Species No.	Species Name	Percent	Cumulative	Overall
280	123	*Owenia fusiformis*	0.0026%	99.8881%	1
281	154	*Dentalium texasianum*	0.0026%	99.8907%	1
282	549	*Brachyuran zoea*	0.0025%	99.8932%	1
283	64	*Lumbrineris latreilli*	0.0024%	99.8957%	1
284	146	*Polinices duplicatus*	0.0024%	99.8981%	1
285	629	*Texadina barretti*	0.0024%	99.9005%	1
286	306	Phyllodocidae (unidentified)	0.0024%	99.9028%	1
287	438	*Parametopella* species	0.0024%	99.9052%	1
288	651	*Lumbrineris branchiata*	0.0023%	99.9075%	1
289	112	*Capitellides jonesi*	0.0022%	99.9097%	1
290	224	*Clibanarius vittatus*	0.0021%	99.9118%	1
291	208	*Synchelidium americanum*	0.0020%	99.9138%	1
292	447	Amphipoda (unidentified)	0.0020%	99.9157%	1
293	281	*Piromis arenosus*	0.0020%	99.9177%	1
294	578	*Synsyllis longigularis*	0.0019%	99.9196%	1
295	612	Ophiuroidea (unidentified)	0.0019%	99.9216%	1
296	782	*Pomatoleios caerulescens*	0.0019%	99.9235%	1
297	620	*Sarsiella capsula*	0.0019%	99.9254%	1
298	372	Sipuncula (unidentified)	0.0019%	99.9273%	1
299	532	*Sphaerosyllis erinaceus*	0.0018%	99.9291%	1
300	366	*Sarsiella disparalis*	0.0018%	99.9308%	1
301	356	Pinnotheridae (unidentified)	0.0017%	99.9325%	1
302	320	Hesionidae (unidentified)	0.0017%	99.9342%	1
303	52	*Nephtys* species	0.0016%	99.9358%	1
304	318	*Bulla striata*	0.0015%	99.9373%	1
305	350	Ampharetidae (unidentified)	0.0015%	99.9388%	1
306	211	*Trachypenaeus constrictus*	0.0013%	99.9401%	1
307	317	Amphinomidae (unidentified)	0.0013%	99.9414%	1
308	369	*Listriella* species A	0.0013%	99.9427%	1
309	420	*Solen viridis*	0.0013%	99.9441%	1
310	623	*Nereis lamellosa*	0.0013%	99.9454%	1
311	59	*Onuphis eremita*	0.0013%	99.9467%	1
312	407	*Ancistrosyllis* species	0.0013%	99.9480%	1
313	221	*Euceramus praelongus*	0.0013%	99.9493%	1
314	461	*Brada* species	0.0013%	99.9505%	1
315	560	*Crassinella lunulata*	0.0013%	99.9518%	1
316	589	*Odostomia canaliculata*	0.0013%	99.9531%	1
317	240	*Pinnixa cristata*	0.0013%	99.9544%	1
318	837	*Allothyone mexicana*	0.0013%	99.9557%	1
319	622	*Henrya goldmani*	0.0012%	99.9569%	0

Appendix 4. Continued.

Rank	Species No.	Species Name	Percent	Cumulative	Overall
320	409	*Cyclaspis* species	0.0012%	99.9581%	0
321	177	*Martesia* species	0.0011%	99.9592%	0
322	275	*Tellidora cristata*	0.0011%	99.9603%	0
323	490	*Fargoa cf. gibbosa*	0.0010%	99.9613%	0
324	47	*Aglaophamus verrilli*	0.0009%	99.9622%	0
325	227	*Paguridae (juvenile)*	0.0009%	99.9631%	0
326	252	*Paramphinome jeffreysii*	0.0009%	99.9639%	0
327	314	Polynoidae (unidentified)	0.0009%	99.9648%	0
328	411	*Macoma* species	0.0009%	99.9657%	0
329	234	*Neopanope texana*	0.0008%	99.9665%	0
330	527	*Fabriciola trilobata*	0.0008%	99.9673%	0
331	634	*Lepidophthalamus louisianensis*	0.0008%	99.9681%	0
332	1	Hydrozoa (unidentified)	0.0007%	99.9687%	0
333	20	*Eteone lactea*	0.0007%	99.9694%	0
334	164	*Macoma brevifrons*	0.0007%	99.9700%	0
335	182	*Labidocera aestiva*	0.0007%	99.9707%	0
336	233	*Callinectes* species	0.0007%	99.9714%	0
337	286	*Cantharus cancellarius*	0.0007%	99.9720%	0
338	336	Magelonidae (unidentified)	0.0007%	99.9727%	0
339	388	*Truncatella caribaeensis*	0.0007%	99.9733%	0
340	398	*Epitonium* species	0.0007%	99.9740%	0
341	429	*Penaeus aztecus*	0.0007%	99.9746%	0
342	534	Mollusca (unidentified)	0.0007%	99.9753%	0
343	581	*Tharyx* species	0.0007%	99.9759%	0
344	582	*Balanus trigonus*	0.0007%	99.9766%	0
345	617	*Nematonereis hebes*	0.0007%	99.9773%	0
346	621	*Clymenella mucosa*	0.0007%	99.9779%	0
347	645	*Eupolymnia* species	0.0007%	99.9786%	0
348	45	*Nereis pelagica occidentalis*	0.0006%	99.9792%	0
349	153	*Doridella obscura*	0.0006%	99.9799%	0
350	156	*Anadara transversa*	0.0006%	99.9805%	0
351	435	*Dentalium* species	0.0006%	99.9811%	0
352	652	*Episiphon sowerbyi*	0.0006%	99.9818%	0
353	780	*Eulimastoma cf. teres*	0.0006%	99.9824%	0
354	781	*Turbonilla portoricana*	0.0006%	99.9831%	0
355	783	*Trypanosyllis gemnipara*	0.0006%	99.9837%	0
356	836	*Crepidula* species	0.0006%	99.9844%	0
357	900	*Synelmis albini*	0.0006%	99.9850%	0
358	907	*Tellina versicolor*	0.0006%	99.9857%	0
359	625	*Pilargis* species	0.0006%	99.9863%	0

Appendix 4. Continued.

Rank	Species No.	Species Name	Percent	Cumulative	Overall
360	77	*Dispio uncinata*	0.0006%	99.9869%	0
361	295	*Bowmaniella dissimilis*	0.0006%	99.9875%	0
362	556	*Littorina ziczac*	0.0006%	99.9882%	0
363	558	*Prionospio treadwelli*	0.0006%	99.9888%	0
364	48	*Nephtys picta*	0.0004%	99.9892%	0
365	60	*Onuphis* species	0.0004%	99.9897%	0
366	176	*Cyrtopleura costata*	0.0004%	99.9901%	0
367	215	*Alpheus heterochaelis*	0.0004%	99.9905%	0
368	277	*Anadara ovalis*	0.0004%	99.9910%	0
369	285	Echiuridae (unidentified)	0.0004%	99.9914%	0
370	294	*Lumbrineris tenuis*	0.0004%	99.9919%	0
371	328	Goniadidae (unidentified)	0.0004%	99.9923%	0
372	331	Lumbrineridae (unidentified)	0.0004%	99.9927%	0
373	406	*Sthenelais* species	0.0004%	99.9932%	0
374	417	*Munna hayesi*	0.0004%	99.9936%	0
375	422	*Callinectes similis*	0.0004%	99.9941%	0
376	550	*Ancistrosyllis cf. falcata*	0.0004%	99.9945%	0
377	576	Munnidae (unidentified)	0.0004%	99.9949%	0
378	607	*Eurythoe* species	0.0004%	99.9954%	0
379	616	*Paramphinome pulchella*	0.0004%	99.9958%	0
380	647	*Agriopoma texasianum*	0.0004%	99.9963%	0
381	657	*Malmgreniella* species	0.0004%	99.9967%	0
382	795	Potamanthidae (unidentified)	0.0004%	99.9971%	0
383	805	*Cyclinella tenuis*	0.0004%	99.9976%	0
384	854	Diptera (unidentified)	0.0004%	99.9980%	0
385	426	*Arenicola cristata*	0.0004%	99.9984%	0
386	494	*Chironomidae (pupae)*	0.0004%	99.9988%	0
387	505	*Cassidinidea lunifrons*	0.0004%	99.9992%	0
388	574	Insecta (unidentified)	0.0004%	99.9996%	0
389	613	*Rithropanopeus harrisi*	0.0004%	100.000%	0
		Total			39,308