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ST. JOHNS ESTUARY:
ESTUARINE BENTHIC MACROINVERTEBRATES
PHASE 2 FINAL REPORT

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Estuarine Benthic Macroinvertebrates
Phase 2 Final Report

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Introduction

Benthic macrofaunal communities can be strongly influenced by changes in freshwater inflows in an estuary. Macrofauna are affected by changes in estuarine condition (including nutrient concentrations, sediment supply and salinity) caused by variation in freshwater inflows to an estuary. Although freshwater inflows affect more than one water quality variable in an estuary, salinity is a good proxy for many variables because:

- temporal changes in freshwater inflow can be directly correlated with temporal changes in estuarine salinity, and
- the downstream influence of freshwater inflows can be determined by identifying spatial changes in salinity.

Changes in salinity have been correlated with changes in macrofaunal abundance (e.g. Montagna and Kalke 1992, Montague and Ley 1993, Palmer at al. 2002), diversity (e.g. Mannino and Montagna 1997, Montagna et al. 2002), biomass (e.g. Rosenberg 1992, Kim and Montagna 2009) and community composition (e.g. Giberto et al. 2004, Mooraki et al. 2009). The high number of correlations between salinity and macrofaunal characteristics makes macrofauna ideal indicators of freshwater inflows.

The purpose of this report is twofold: 1) to determine specific macrofaunal bioindicators of changes in salinity and therefore freshwater inflows in the St Johns Estuary, Florida, and 2) to speculate the possible implications of decreasing volumes of freshwater inflows into the St Johns Estuary. The analysis within the report involves using previously collected data from more than one data source to determine what these bioindicators are and how they change with changes in salinity. This report is phase two of a two-phase project. The first phase was a preliminary analysis correlating salinity and macrofauna collected alongside Submerged Aquatic Vegetation (SAV) sampling (Montagna et al. 2008b). However the ability to use the results of that report were largely hindered by the data available being restricted to an oligohaline portion of the St. Johns Estuary. Phase two (this report) aims to use a broader spatial scope to better represent the whole estuary in relation to changes in salinity and hence changes in freshwater inflow.

Methods

This current analysis utilized data from the National Oceanic and Atmospheric Administration (NOAA) and the Florida Department of Environmental Protection (FDEP). Water quality and macrofauna data from 7 NOAA stations and 10 FDEP stations were used (Figure 1, Table 1). The FDEP stations reported in this current study are aggregations of more specific station locations but are grouped by their FDEP determined water body identification (WBID) zones. Three FDEP stations (2213H, 2213K and 2213L) were excluded from any analysis because they were only sampled two or three times each.

FDEP macrofauna samples were taken between 1974 and 1998 by petite ponar with a sample area of between 0.02 and 0.43 m^{-2} per sample (Table 1). It is unknown why the sample sizes differed. The NOAA macrofauna samples were taken between July 2000 and July 2002 with a sample area of 0.04 m^{-2} per sample.

Although various water quality parameters were measured by each agency, the only common parameters were temperature, dissolved oxygen, pH and salinity. Salinity was often not measured by FDEP however specific conductivity was. Salinity was calculated from specific conductivity using an approximate polynomial equation (Fofonoff and Millard 1981) when no *in situ* salinity values were measured. FDEP water quality measurements were not necessarily sampled on the same day or location as when macrofauna samples were taken. Overall averages were used to mitigate the effects of these sampling errors. NOAA water quality was sampled simultaneously with macrofauna sampling.

Macrofaunal community structure

Non-metric multi-dimensional scaling (MDS) was used to compare macrofaunal community structure differences among station-substrate combinations. The distance between stations in an MDS plot can be related to community similarities or differences between different stations. Differences and similarities among communities were highlighted using cluster analysis. Significant clusters were determined using the SIMPROF permutation (Clarke, 1993). Macrofaunal communities were analyzed using different taxonomic levels, species, genus, family and higher taxa (predominantly using classifications of phyla and class). MDS and cluster analysis were performed using a Bray-Curtis similarity matrix on $\log_n(x+1)$ transformed data in Primer software (Clarke and Warwick, 2001).

Comparing macrofauna and salinity

Mean macrofaunal abundance and the abundances of the most abundant taxa were compared with mean salinity values for each station. Macrofaunal abundance relationships with salinity station means were examined with a non-linear model. The model used was used successfully in Texas and Florida estuaries in the Gulf of Mexico (Montagna et al., 2002b; Montagna et al., 2008a). The assumption behind the model is that there is an optimal range for salinity and values decline prior to and after meeting this maximum value. That is, the relationship resembles a bell-shaped curve. The shape of this curve can be predicted with a three-parameter, log normal model:

$$Y = ae^{\left[-0.5\left(\frac{ln\left(\frac{X}{X_c}\right)}{b}\right)^2\right]}$$

The model was used to characterize the nonlinear relationship between a biological characteristic (*Y*) and salinity (*X*). The three parameters characterize different attributes of the curve, where *a* is the maximum value, *b* is the skewness or rate of change of the response as a function of salinity, and *Xc* the location of the peak response value on the salinity axis. The model was fit to data using the Regression Wizard in SigmaPlot, which uses the Marquardt-Levenberg algorithm to find coefficients (parameters) of the independent variables that give the best fit between the equation and the data (Systat, 2006).

Correlations between multivariate macrofauna community structure and physical water quality variables were determined using the BIO-ENV procedure. The BIO-ENV procedure is a multivariate method that matches biotic (i.e. community structure) with environmental variables (Clarke and Warwick, 2001). This is carried out by calculating weighted Spearman rank correlations (ρ_w) between sample ordinations from all of the environmental variables and an ordination of biotic variables (Clarke and Ainsworth, 1993). Correlations are then compared to determine the best match. The BIO-ENV procedure uses different numbers of abiotic sample variables in calculating correlations to investigate the different levels of environmental complexity. For this study, the species abundance MDS ordination was compared with all hydrographic variables (temperature, salinity, dissolved oxygen and pH). The significance of relationships were tested using RELATE, a non-parametric form of the Mantel test. The BIO-ENV and RELATE procedures were calculated with Primer software (Clarke and Warwick 2001).

Comparing macrofauna and sediment grain size

Sediment grain size is often an important factor that can influence macrofaunal species distributions and abundances (Rhoads, 1974; Mannino and Montagna, 1997; Kennish, 2004). Sediment grain size data from over three hundred sampling stations within the St Johns Estuary were available for analysis. However few of the sediment samples were taken within one kilometer of the macrofauna sampling stations and very few samples were taken within 40 km (25 mi) of the estuary mouth where nine of the macrofauna stations exist. Grain size data included the proportion of clay, sand and silt in sediments as determined using the methods of Folk (1974). Spatial trends in grain size throughout the estuary were approximated by interpolating the grain size values. Ordinary kriging using a spherical semivariogram model was the interpolation method and was calculated in ArcGIS 9.3.1.

Results

Thirty species out of the 545 species found accounted for eighty percent of the mean macrofaunal abundance of the estuary (Table 2, Appendix). The mean macrofaunal density among the seventeen stations sampled was 3,100 individuals m^{-2} (n m^{-2}) with densities ranged from 250 n m^{-2} at Mill Cove, toward the mouth of the Estuary, to 12,000 n m^{-2} at station 2213F, midway between the mouth of the estuary and the upstream-most sampling station. The five upstream-most stations, which cover approximately half of the sampled length of the estuary, had average salinities below 2 ppt over their respective sampling periods (Figures 2 and 4). All average downstream salinities ranged from 4 to 26 ppt. The mean salinities of the sampling stations used in this study are similar to those modeled by ECT (2002). Mean macrofaunal abundance was significantly correlated with mean salinity over the length of the estuary (r^2 = 0.55, $p \leq 0.004$). The model used to correlate macrofaunal abundance and salinity determines that the peak abundance occurs at 0.4 ppt however there were no average salinity values below 0.4 ppt in our analysis.

The relationships of community composition among stations within the estuary vary depending on which taxa level is analyzed (Figure 3). When comparing community composition based on species, the communities gradually change with an increase in salinity but there is a significant difference between communities sampled by each sampling agency rather than between communities at different salinities. When comparing communities based on higher taxa levels (genera, family and phyla), there is a significant difference between macrofaunal communities occurring in lower and higher salinities. The eight low salinity communities occurred in mean salinities ranging from 0.4 to 5.8 ppt except for at Cedar/Ortega, which had a mean salinity of 8.5 ppt. The nine high salinity communities occurred in mean salinities ranging from 13.6 to 25.7 ppt except for at station 2213D, which had a men salinity of 6.5 ppt.

High salinity communities generally contained higher concentrations of individuals from the Cnidaria, Echinodermata and Chordata phyla but had much fewer individuals from the Insecta class. Individuals from the Chiromonidae (Insecta, Diptera), Dreissenidae (Bivalvia), Hydrobiidae (Gastropoda) and Anthuridae (Isopoda) families occurred in greater abundances at low salinity communities whereas individuals from the Orbiniidae and Capitellidae families (both Polychaeta) were almost exclusively found in high salinity communities. Common genera in the low salinity communities that occurred in low frequencies in the high salinity communities included *Coelotanypus*, *Polypedilum*, *Chironomus* (all Insecta), Mytilopsis (Bivalvia) and *Cyathura* (Isopoda). There were few common genera that were much more prevalent in the high salinity communities than the low salinity communities and these included *Mediomastus*, *Capitella* (both Polycheata) and *Mulinia* (Bivalvia). The increase in similarity (decrease in difference) between each cluster of communities as the taxa level used in MDS analysis increases is partially attributed to a similar increase in similarity among all stations as higher taxa levels are analyzed.

The unidentified amphipod *Corophium* sp. and the bivalve *Mytilopsis leucophaeata* (the false dark mussel or Conrad's false mussel) were numerically the most dominant species over the entire study period (Table 2). These two species made up twelve and eleven percent of the mean abundance respectively and were both present at nine of the seventeen stations sampled. However, almost all (99 %) *Corophium* sp. individuals were found at station 2213F. Amphipod *Apocorophium lacustre*, oligochaete *Limnodrilus hoffmeisteri*, polychaete *Streblospio benedicti* and barnacle *Balanus improvisus* were the next most abundant species. These four species had mean abundances of 150 n m^{-2} and were present at seven to fifteen stations depending on the species.

Crustaceans were the most abundant higher taxa group throughout the estuary (1,070 n m^{-2}) and were found at all stations sampled within the estuary (Table 3). The next most abundant higher taxa groups are molluscs (620 n m^{-2}), polychaetes (530 n m^{-2}) and insects (500 n m^{-2}). These next three groups are present at seventeen, sixteen and fourteen stations respectively. The 3-parameter log-normal model was unsuccessful in determining relationships between salinity and higher taxa even though some relationships were visually obvious. Because of this problem, Spearman correlations were determined between the rest of the higher taxa groups and salinity (Table 3). Eleven of the seventeen higher taxa groups are significantly correlated with salinity (Figure 5). Higher taxa groups Cnidaria, Holothuroidea, Nemertea, Ophiuroida, Phoronida and Urochordata all are significantly positively correlated with salinity although the mean abundance at each station of these taxa is always low (< 300 n m^{-2}). Cnidaria, Holothuroidea, Ophiuroida, and Urochordata all start to increase in abundance at approximately 15 ppt. Polychaeta have a positive but nnon-significant relationship with salinity. Arachnida, Crustacea, Insecta, Mollusca and Oligochaeta are negatively correlated with salinity. These five taxa groups are most abundant below 2 ppt, where their abundances are 180 to 8000 n m^{-2} except Arachnida, whose abundances are always less than 25 n m^{-2}.

Seven of the twelve most abundant macrofauna families had an obvious relationship with salinity, although the log normal model did not detect all of these relationships (Table 4, Figure 6). Anthuridae (Isopoda), Chironomidae (Insecta), Corophidae (Amphipoda), Tubificidae (Oligochaeta) and Hydrobiidae (Gastropoda) were all most abundant where mean salinities were less than 5 ppt. Balanidae (Sessilia) and Dreissenidae (Bivalvia) were most abundant where mean salinities were below 10 ppt. Capitellidae (Polychaeta) were only present where mean salinities were above 10 ppt and Mactridae (Bivalvia) only occurred in high abundances (> 500 n m^{-2}) at two stations, both with a mean salinity close to 15 ppt.

Twelve of the twenty-four most abundant genera were significantly correlated with mean salinity (Table 4, Figure 7). The bivalves *Rangia cuneata* and *Mytilopsis leucophaeata* (only one species was found in each genus), chironomids *Polypedilum* sp. and *Cladotanytarsus* sp., gastropod *Littoridinops* sp., oligochaete *Limnodrilus* sp., amphipods *Apocorophium lacustre* and *Corophium* sp., and barnacle *Balanus* sp. all had peaks in abundance in stations where the mean salinity was less than 5 ppt. The chironomids *Coelotanypus* sp., *Chironomus* sp., Glyptotendipes sp. and *Tanytarsus* sp., amphipods *Gammarus* sp. and *Melita* sp. and isopod *Cyathura* sp. were predominantly found where mean salinities were less than 5 ppt although the log-normal models either could not be computed or were not significant. Bivalve *Mulinia lateralis* only occurred in high densities at around 15 ppt and polychaete *Mediomastus* sp. only occurred where average salinities were above 10 ppt. The spionid polychaete *Marenzelleria viridis* only occurred in high densities (> 10 n m^{-2})between 2 and 7 ppt

The macrofaunal community composition was significantly related to salinity irrespective of what taxanomic level was used to represent community composition (Table 5). The significance level as determined by the BIO-ENV procedure for each taxonomic level was less than 0.1 %, which is equivalent to a p-value of less than 0.001. The sample statistics (Rho) for species, genera, family and higher taxa were 0.73, 0.80, 0.80 and 0.65 respectively. In addition, the community structure was most highly correlated with salinity out of the four water quality variables compared (DO pH, temp and salinity).

Macrofaunal communities could not be compared with sediment grain size because of limited spatial coverage over which sediment samples were taken. Sediment grain size data is missing for the mouth of the estuary to approximately 35 kilometers (22 miles) upstream. In the portion of the estuary where there are data, the sediment changes from being silt dominated to being sand dominated as you go upstream (southward) in the estuary (Figure 8). The proportion of clay decreases as you travel upstream, however the proportion of clay consistently makes up less than 10 % of the sediment.

Discussion

The overall goal of this project was to investigate the relationship between freshwater inflows and estuarine benthic macroinvertebrates in the St Johns Estuary. Phase one of the project investigated previously sampled macrofaunal community data at eight stations from the oligohaline upstream (southern) part of the estuary. Macrofaunal communities were related to salinity, a proxy for freshwater inflow, and other water quality variables. Although the dataset was unbalanced and implications limited, a clear relationship between salinity and macrofaunal communities was observed. It is also important that the mean salinities taken from the NOAA and FDEP datasets roughly matched the recent salinities modeled by ECT (2002). This matching means that although some of the macrofauna samples were taken up to thirty years ago, the data from those samples can still be applied to modern environmental scenarios.

Phase two, like phase one, used previously sampled data (Montagna et al. 2008b). However, the spatial range of data was extended in phase two so that macrofaunal communities from a wider range of salinities could be analyzed. Phase one involved using data from the Submerged Aquatic Vegetation (SAV) dataset, however this dataset was incompatible with other available datasets because of reasons such as different sampling environments. For phase two, salinity and macrofauna data from seventeen stations were combined from National Oceanic and Atmospheric Administration (NOAA) and Florida Department of Environmental Protection (FDEP) data. Although using these two data sets in phase two involves some temporal and sample-size discrepancies, the increased spatial range and number of stations sampled makes the phase two analysis an overall improvement on phase one. Discrepancies in macrobenthic sampling area both within and between the NOAA and FDEP sampling strategies make the use of diversity indices difficult and objectionable. For this reason, diversity indices were not included in phase two analyses. The larger shortfall of the phase two analysis is that only four water quality variables; salinity, temperature, pH and dissolved oxygen could be analyzed because of lack of consistent spatial data. However, for spatial analyses such as these performed in phase two, salinity is arguably the best proxy for freshwater inflows of any single measurable variable.

Multivariate macrobenthic community structure had the highest correlation with salinity out of all single or combination of water quality variables that were available to be analyzed (temperature, dissolved oxygen, pH and salinity; from BIO-ENV analysis; Table 5). This high correlation between community structure and salinity was consistent irrespective of which taxa level (species, genera, family or higher taxa) was used as the underlying basis for the community structure. The relationship between salinity and community structure was significant.

There was also a significant correlation between mean macrofaunal abundance and salinity using the three-parameter, log normal model. The peak in abundance was calculated using the log-normal model as being 0.4 ppt, although the highest mean abundances occurred between 0.5 and 1.7 ppt. In comparison, peak abundance in the phase one analysis (SAV data) occurred at a mean salinity of 1.5 ppt (Montagna et al. 2008b). The high abundance at salinities below 1.7 ppt is attributed to high abundances of several taxa including the phylum Mollusca, subphylum Crustacea, class Insecta and the subclass Oligochaeta (Figure 5).

The peak in mollusc abundance between 0.5 and 1.7 ppt in this study was similar to those of other studies. The peak abundance for molluscs was 0.6 and 1.0 ppt in the Myakka and Peace Rivers in southwest Florida respectively (Montagna et al 2008a) and approximately 1.5 ppt in the Guadalupe Estuary, Texas (Kalke and Montagna 1991). The most abundant mollusc at low salinities in the current study was the bivalve *Mytilopsis leucophaeata* (Conrad's false mussel, family Dreissenidae). *M. leucophaeata* peaked where station averages were 1.2 ppt and reached averages of up to 1,800 n m^{-2}. *M. leucophaeata* is a euryhaline species with a wide tolerance of salinity and temperatures for its' adult (0.1 - 31 ppt, 5 - 30 °C) and larval stages(3 - 22 ppt, 10 - 30 °C; Rajagopal et al. 2005, Verween et al. 2007). *M. leucophaeata* natively occurs in the Atlantic and Gulf of Mexico coasts of the USA and Mexico but has established itself as a biofouling pest in numerous countries world-wide (Marelli and Gray 1983, Laine et al. 2006).

Other molluscs in the St Johns Estuary that occurred in high mean abundances at salinities below 5 ppt were gastropods from the family Hydrobiidae including *Littoridinops* sp. (up to 300 n m^{-2}) and unidentified Hydrobiidae specimens (up to 200 n m^{-2}). In southeast Florida, fossil *Littoridinops* spp. are shown to have preferred fresh to slightly brackish water with an optimum salinity of 8.3 ppt (Gaiser et al. 2006). Another hydrobid gastropod, *Littoridina sphinctostoma* is found in one to three orders of magnitude greater abundance in mean salinities of 1.5 ppt than mean salinities of 6.9 ppt in Guadalupe Estuary, Texas. (Montagna and Kalke 1992)

The bivalve *Rangia cuneata* peaked in abundance where mean salinities were 2.3 ppt but abundances were low relative to other species (< 100 n m^{-2}). *R. cuneata* are reportedly common below 18 ppt but are mostly limited by their need for a 5 - 10 ppt salinity shock to spawn and their juvenile toleration of 2 to 20 ppt and 8 to 32 °C (LaSalle and Cruz 1985). *R. cuneata* was only found in sampling areas with mean salinities of less than 12 ppt in nineteen estuarine sampling stations along the Texas coast (Montagna and Kalke 1995). *R. cuneata* peaked in abundance where the mean salinity was 3.7 ppt and barely occurred where mean salinity was above 10 ppt in southwest Florida estuaries (Montagna et al. 2008).

Although the seven most abundant crustaceans all were more abundant at mean salinities below 1.7 ppt, two amphipods from the Corophiidae family and one barnacle genera, *Balanus* spp. were the numerically dominant by an order of magnitude in the same salinity range (Table 2 and 4, Figures 6 and 7). The two abundant amphipods, *Corophium* sp. and *Apocorophium lacustre* were most abundant between 1 and 2 ppt, and less than 1 ppt respectively. Almost all *Corophium* sp. specimens were only found at one sampling station however (2213F). *Apocorophium lacustre* is a surface deposit species found among oligiohaline reaches of a Netherlands estuary (Faasse and van Moorsel 2003) and mesohaline reaches of a Belgium estuary (Ysebaert et al. 2000). Twelfth mosty abundant macrobenthic organism. This eastern Atlantic native has been reported in boulder fields of a Netherlands estuary but is more common around banks and pilings on the South Atlantic Bight of the USA (Power et al. 2006).

The species present in the genus *Balanus* were *Balanus improvisus* (72.2 %), unknown *Balanus* sp. (27.6 %) and *Balanus amphitrite* (0.2 %). *B. improvisus* was found to be more dominant on the Louisiana/Mississippi coast in regions where fluctuating but low (< 16 ppt) salinities occurred (Porrier and Partridge 1979). *B. improvisus* was the dominant barnacle in salinities less than 12 ppt in Chesapeake Bay (Gordon 1969). In both the Louisiana /Mississippi coast and Chespeake Bay, *B. improvisus* is replaced by *B. subalbidus* in oligohaline waters (Dineen and Hines 1992, Porrier and Partridge 1979).

It is commonly known that aquatic insects generally inhabit only freshwater or oligohaline zones of estuaries (e.g. Palmer et al. 2002, Shokhin et al. 2005, Nohren et al. 2009). Insects from the Chironomidae family make up virtually all occurrences of insects found in a Texas estuary, but only occur at average salinities below 7 ppt (Montagna and Kalke 1992) which is the approximate survival limit for Chironomidae egg and hatchlings (Hassell et al. 2006, Kefford et al. 2007). In another Texas estuary, chironomid larvae abundances increased after freshwater inflow event and were significantly correlated with a 14 -day lag flow (Kalke and Montagna 1991).

Oligochaetes are also commonly found in fresh and oligohaline zones of estuaries. *Limnodrilus hoffmeisteri* was the most abundant oligochaete in this study, making up 80 % of all oligochaetes found (179 n m^{-2}; Tables 2 and 3). *L. hoffmeisteri* only occurred in salinities below 6 ppt in a German fjord (Pfannkuche 1980) and only in regions of a Belgian estuary where minimum salinities were below 3ppt (maximum below 11 ppt; Ysebaert et al. 1993, Seys et al. 1999). *Bratislavia unidentata*, the second most dominant oligochaete species, was only found in locations with mean salinities less than 1.5 ppt but mostly where mean salinities were less than 0.5 ppt. The distribution of *B. unidentata* is consistent with its other studies that identify it as primarily a feshwater species(Gluzman de Pascar 1987, Wang and Liang 2001). In addition to spatial salinity ranges, the distribution of oligochaetes in an estuary is largely driven by salinity fluctuations (Giere 2006). Therefore the high abundance of oligochaetes in the upper (southern)

St Johns Estuary could be result of low salinity fluctuations in addition to the low salinities that exist there.

Only two abundant organisms were identified as being indicative of relatively higher salinities in this study. The spionid polychaete *Marenzelleria viridis* was only present in high abundances between 2 and 7 ppt salinity (Figure 7M). In European waters, where it is an introduced species, *M. virids* occurs in salinities up to 15 ppt (Kube et al. 1996) but is most abundant at salinities between 5 and 7 ppt (Zettler et al. 1995) as occured in the Nuese Estuary , North Carolina (Balthis et al. 2006) and in this current study. The capitellid polychaete *Mediomastus* sp. only occurred at salinities above 10 ppt (Figure 7N). *Mediomastus ambiseta* was most abundant in high salinities in the Nueces Estuary, Texas (>23 ppt) but also very abundant in low salinities in Guadalupe estuary, Texas (< 7 ppt; Montagna and Kalke 1992, Mannino and Montagna 1997). *Mediomastus* spp. are classified as opportunistic pioneer species because of their rapid rate of reproduction and development and are common after disturbances such as organic enrichment or salinity changes (Pearson and Rosenberg 1978, Dauer 1993). It is possible that the increase in *Mediomastus* spp. in salinities above 10 ppt may be caused by possible greater salinity ranges and greater human impacts downstream in the St Johns Estuary.

Much of this report has dwelled on the occurrence of macrofaunal species in relation to mean salinities of an area of the St Johns Estuary. However, changes in inflow to the estuary not only change mean salinities but also the range of daily maximum salinities that parts of the estuary experience (partly as a consequence of tidal inundation; see Slater *et al.* 2011). Slater *et al.* (2011) modeled bottom salinity changes at three stations within the estuary over a baseline or existing conditions inflow regime (Base1995NN) and two regimes of altered inflow (FwOR1995NN and FwOR2030PS). The stations in the salinity analyses were adjacent to macrofauna stations Tallyrand Docks, 2213E and 2213I (Figure 1; JAXSJR17, JAXSJR40 and SJR16 in Slater *et al.* (2011) respectively). For all stations, increases in frequency of high salinities (> 15 ppt) were small (< 20 days per yr) and increases in the frequency of low salinities (< 15 ppt) increased by a large range of frequencies (0- 75 days per year) depending on the station and actual salinity.

The largest modeled changes in salinity occurred midway down the estuary, near benthic station 2213E (salinity station JAXSJR40). At least 30 % of the time, modeled maximum salinities from altered inflows were similar to those of the baseline inflows, however durations of 5-10 ppt maximum salinity events may increase by 40 – 60 days per year, depending on the altered inflow scenario. Exposure of the station to salinities of 15 - 25 ppt was only 2 - 5 days greater when flows were altered relative to baseline flows.

The smallest modeled changes in modeled maximum salinities occurred at the most upstream station (2213I / SJSR16). The greatest increase in maximum salinity events is an increase of 5 – 12 days per year for 1 ppt events. Maximum salinities events from 2 – 4 ppt had an increase in frequency of less than 3 days per year.

In the St Johns Estuary, the effects of potential increases in daily maximum salinities and daily salinity ranges on macrofauna communities are similar to the effects from changes in mean salinities. This is because even under natural conditions, as you move upstream, the ranges in salinities decrease, as do mean salinities. With a decrease in inflows, the salinity regime effectively moves upstream. In the current analysis of benthic communities, the association of specific macrofauna communities or individuals along a gradient of mean salinities implies that the same association holds with the increase in salinity ranges (and maximum salinities) that occurs simultaneously with an increase in mean salinities. For example, stenohaline species e.g. *Polypedilum* sp. are most common in the most upstream regions of the estuary where changes in salinity range (and maxima) are smallest. Therefore additional analyses among macrofauna communities and daily salinity ranges are unnecessary as they are inadvertently included in the analyses among macrofauna communities and mean salinities.

Implications

Average salinities of each station were significantly correlated with macrofauna community composition, total abundance and individual taxa abundance for many species and taxonomic groupings. The consequence of these significant relationships is that macrofauna can be successfully used as a spatial indicator of the downstream influence of freshwater inflows. The results of this analysis imply that as a reduction of freshwater inflows to the St Johns Estuary causes isohalines to shift upstream, associated species and taxa groups will shift upstream also. High reductions in inflow (95^{th} percentile) will cause the water downstream of Jacksonville to become above 25 ppt and allow salinities over 5 ppt to reach approximately 40 km (25 mi) upstream of Jacksonville (Figure 21, ECT 2002). This will reduce the spatial range for the abundant oligohaline and freshwater species within the estuary. The increase in areal extent of mesohaline conditions and the reduction of oligohaline conditions around Jacksonville from a large reduction in inflow is substantial.

This current analysis identifies many indicators of salinity in the St Johns Estuary. Insects and oligochaetes (dominantly *Limnodrilus hoffmeisteri* and *Bratislavia unidentata*) are obvious broad taxa groups that can be used as indicators for salinities less than 2 ppt. Amphipods *Apocorophium lacustre* and *Corophium* sp. are also most abundant below 2 ppt. Another crustacean, barnacle *Balanus* sp., is most abundant at salinities less than 2 ppt but is abundant in a wider range of salinities then the two amphipods. The bivalves *Mytilopsis leucophaeta* and *Rangia cuneata* are probably the most easily identifiable indicators of low salinities (peaks around 2 ppt) although the abundance of the *R. cuneata* is generally low at peak abundances (< 100 n m^{-2}). Another bivalve, *Mulinia lateralis*, may be a good indicator for salinities of approximately 15 ppt and the polychaete *Mediomastus* sp. is a reliable indicator for salinities above 10 ppt.

Although indicators of salinity and hence freshwater inflows have been identified in this study, their robustness as indicators is weakened by the inconsistent sampling strategies between the two data sets used in this analysis. A frequent and consistent sampling of macrofauna along the length of the estuary would greatly strengthen any knowledge of relationships between indicator species and freshwater inflows. Further sampling of sediment grain size and water nutrients at each potential sampling site would also enable us to account for confounding factors and elucidate effects of freshwater inflows on macrofauna in the St Johns Estuary.

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Table 1. List of stations / WBIB sampled for macrofauna and their temporal sampling ranges

Sampling Agency	Station / WBIB	Start Date	End Date	No. of Samples
FDEP	2213A	21 May 1980	24 Sep 1986	12
FDEP	2213B	05 Jan 1978	29 Sep 1997	25
FDEP	2213C	19 May 1980	16 Oct 1995	22
FDEP	2213D	12 Aug 1974	16 Oct 1995	53
FDEP	2213E	06 Sep 1977	24 Jul 1995	23
FDEP	2213F	20 Aug 1986	24 Jul 1995	7
FDEP	2213G	18 Aug 1976	09 Dec 1997	13
FDEP	2213I	14 Mar 1984	19 Oct 1998	16
FDEP	2213J	01 Jul 1975	11 Jun 1996	8
FDEP	2213M	28 Mar 1974	27 Sep 1982	24
NOAA	Cedar/Ortega	11 July 2000	23 July 2002	7
NOAA	Clapboard Creek	11 July 2000	23 July 2002	7
NOAA	Dames Point	11 July 2000	23 July 2002	7
NOAA	Doctors Lake	11 July 2000	23 July 2002	7
NOAA	Mill Cove	11 July 2000	22 July 2002	6
NOAA	Tallyrand Docks	11 July 2000	22 July 2002	7
NOAA	Trout River	11 July 2000	23 July 2002	7

Table 2. Lowest practical identifiable level (LPIL) organism abundance list for top 80 % of organsisms. C = Crustacea, CN = Cnidaria, I = Insecta, M = Mollusca, N = Nemertea, O = Oligochaeta, P = Polychaeta, PH = Phoronida, U = Urochordata. See Appendix X for complete list.

Organism	**Higher Taxa**	**Abundance ($n\ m^{-2}$)**	**Family**	**Percent of total**	**Cumulative percent**	**# of stations that species occurs**
Corophium sp.	C	395	Corophiidae	12.59	12.59	9
Mytilopsis leucophaeata	M	350	Dreissenidae	11.17	23.76	9
Apocorophium lacustre	C	194	Corophiidae	6.18	29.94	11
Limnodrilus hoffmeisteri	O	179	Tubificidae	5.72	35.66	7
Streblospio benedicti	P	178	Spionidae	5.67	41.32	15
Balanus improvisus	C	151	Balanidae	4.80	46.12	9
Rheotanytarsus exiguus	I	143	Chironomidae	4.55	50.68	2
Glyptotendipes sp.	I	105	Chironomidae	3.35	54.03	3
Mulinia lateralis	M	93	Mactridae	2.96	56.99	12
Mediomastus sp	P	82	Capitellidae	2.60	59.59	7
Cladotanytarsus sp.	I	61	Chironomidae	1.96	61.55	3
Balanus sp.	C	58	Balanidae	1.84	63.39	6
Chironomus sp.	I	57	Chironomidae	1.83	65.22	9
Tanytarsus	I	45	Chironomidae	1.43	66.65	4
Coelotanypus sp.	I	40	Chironomidae	1.26	67.91	9
Gammarus cf *tigrinus*	C	39	Gammaridae	1.26	69.17	5
Cyathura polita	C	37	Anthuridae	1.19	70.36	12
Marenzelleria viridis	P	37	Spionidae	1.18	71.54	8
Polydora socialis	P	33	Spionidae	1.06	72.60	6
Polypedilum halterale	I	26	Chironomidae	0.83	73.43	8
Coelotanypus concinnus	I	25	Chironomidae	0.81	74.24	7
Littoridinops sp.	M	25	Hydrobiidae	0.79	75.03	4
Hydrobiidae	M	24	Hydrobiidae	0.78	75.81	6
Melita nitida	C	21	Melitidae	0.67	76.48	8
Gemma gemma	M	21	Veneridae	0.66	77.14	1
Sabellaria vulgaris	P	20	Sabellariidae	0.64	77.78	3
Rangia cuneata	M	20	Mactridae	0.63	78.40	13
Neanthes succinea	P	19	Nereididae	0.60	79.00	11
Bratislavia unidentata	O	18	Naididae	0.59	79.59	2
Phoronis sp.	PH	17	Phoronida	0.54	80.13	2
Top 80 % (30 spp)		2512		80.13		
Total (100 % - 545 spp)		3135		100.00		17

Table 3. Spearman Correlation Coefficients(r) between taxa and salinity. Taxa are highlighted in **bold** if relationships are significant ($p \leq 0.05$). Correlations were not carried out for taxa found at less than 3 stations. N = 17.

Higher Taxa	r	p	Mean abundance (n m^{-2})	#of stations taxa was found
Arachnida	**-0.66**	**0.0038**	**2.1**	**3**
Bryozoa	0.27	0.2990	1.7	5
Cnidaria	**0.74**	**0.0007**	**15.5**	**10**
Crustacea	**-0.61**	**0.0096**	**1015.3**	**17**
Hirudinea	-0.19	0.4591	0.1	2
Holothuroidea	**0.69**	**0.0021**	**2.3**	**4**
Insecta	**-0.99**	**<0.0001**	**615.4**	**14**
Mollusca	**-0.49**	**0.0483**	**660.2**	**17**
Nemertea	**0.76**	**0.0004**	**27.9**	**13**
Oligochaeta	**-0.76**	**0.0004**	**263.00**	**15**
Ophiuroida	**0.66**	**0.0038**	**1.0**	**4**
Phoronida	**0.67**	**0.0033**	**17.2**	**4**
Platyhelminthes	-0.07	0.7823	0.2	4
Polychaeta	0.47	0.0551	495.10	16
Porifera	0.42	0.0970	3.90	2
Sipunculida	-0.11	0.6637	0.20	2
Urochordata	**0.67**	**0.0033**	**13.20**	**7**

Table 4. Model details for the three parameter log normal model of salinity versus total abundance, numerically dominant family abundances and numerically dominant genus/species abundances. Correlation statistics are between the model and measured values. Parameter values are for the equation: $Y = ae^{\left[-0.5\left(\frac{ln\left(\frac{X}{X_c}\right)}{b}\right)^2\right]}$, where Y = abundance and X = salinity.

Taxa	Correlation Statistics		Parameter Values		
	r^2	p	a	b	Xc
Total abundance	0.55	0.004	7535	1.93	0.37
Family					
Anthuridae	-	-	-	-	-
Balanidae	0.38	0.037	608	1.16	1.02
Capitellidae	0.31	0.075	288	0.33	16.21
Chironomidae	0.69	0.0003	1167	0.55	0.54
Corophiidae	0.87	< 0.0001	9836	0.13	1.95
Dreissenidae	0.45	0.016	1079	1.11	1.19
Gammaridae	-	-	-	-	-
Hydrobiidae	0.80	< 0.0001	395	0.42	2.31
Mactridae	0.98	< 0.0001	1632	0.04	14.16
Nereididae	0.07	0.605	55	1.78	9.45
Spionidae	0.27	0.106	590	1.05	3.18
Tubificidae	-	-	-	-	-
Genus					
Apocorophium lacustre	1.00	< 0.0001	2664	0.05	0.49
Balanus sp.	0.37	0.038	608	1.16	1.02
Chironomus sp.	-	-	-	-	-
Cladotanytarsus sp.	0.89	< 0.0001	3936	0.17	0.74
Coelotanypus sp.	-	-	-	-	-
Corophium sp.	1.00	< 0.0001	9935	0.11	1.91
Cyathura sp.	-	-	-	-	-
Gammarus sp.	-	-	-	-	-
Gemma gemma	-	-	-	-	-
Glyptotendipes sp.	-	-	-	-	-
Limnodrilus sp.	0.90	< 0.0001	996	1.00	0.29
Littoridinops sp.	1.00	< 0.0001	874	0.24	2.47
Marenzelleria viridis	1.00	< 0.0001	734	0.11	5.23
Mediomastus sp.	0.27	0.110	246	0.35	16.48
Melita sp.	-	-	-	-	-
Mulinia lateralis	1.00	< 0.0001	2009	0.04	14.19
Mytilopsis leucophaeata	0.45	0.016	1079	1.11	1.19
Polydora sp.	0.92	< 0.0001	1567	0.05	1.89

Taxa	Correlation Statistics		Parameter Values		
	r^2	p	a	b	Xc
Polypedilum sp.	0.82	< 0.0001	1769	2.59	0.00
Rangia cuneata	0.80	< 0.0001	85	0.71	2.32
Rheotanytarsus sp.	-	-	-	-	-
Sabellaria vulgaris	-	-	-	-	-
Streblospio benedicti	0.15	0.3189	301	1.32	4.24
Tanytarsus sp.	-	-	-	-	-

Table 5. The five highest Spearman rank correlations (ρ_w) between sample ordinations from all of the environmental variables and ordinations of macrofauna community composition using different taxonomic bases (BIO-ENV). Salinity was significantly correlated (significance = 0.1 %) with community composition regardless of the taxonomic base. Tests of significance were not carried out on other correlations.

Variables	**Species**	**Genera**	**Family**	**Phyla**
Salinity	0.731	0.795	0.797	0.652
pH, Salinity	0.680	0.697	0.678	0.519
Temperature, Salinity	0.569	0.617	0.614	0.510
Temperature, pH, Salinity	0.581	0.604	0.586	0.455
DO, pH, Salinity	0.536	0.560	0.528	0.384

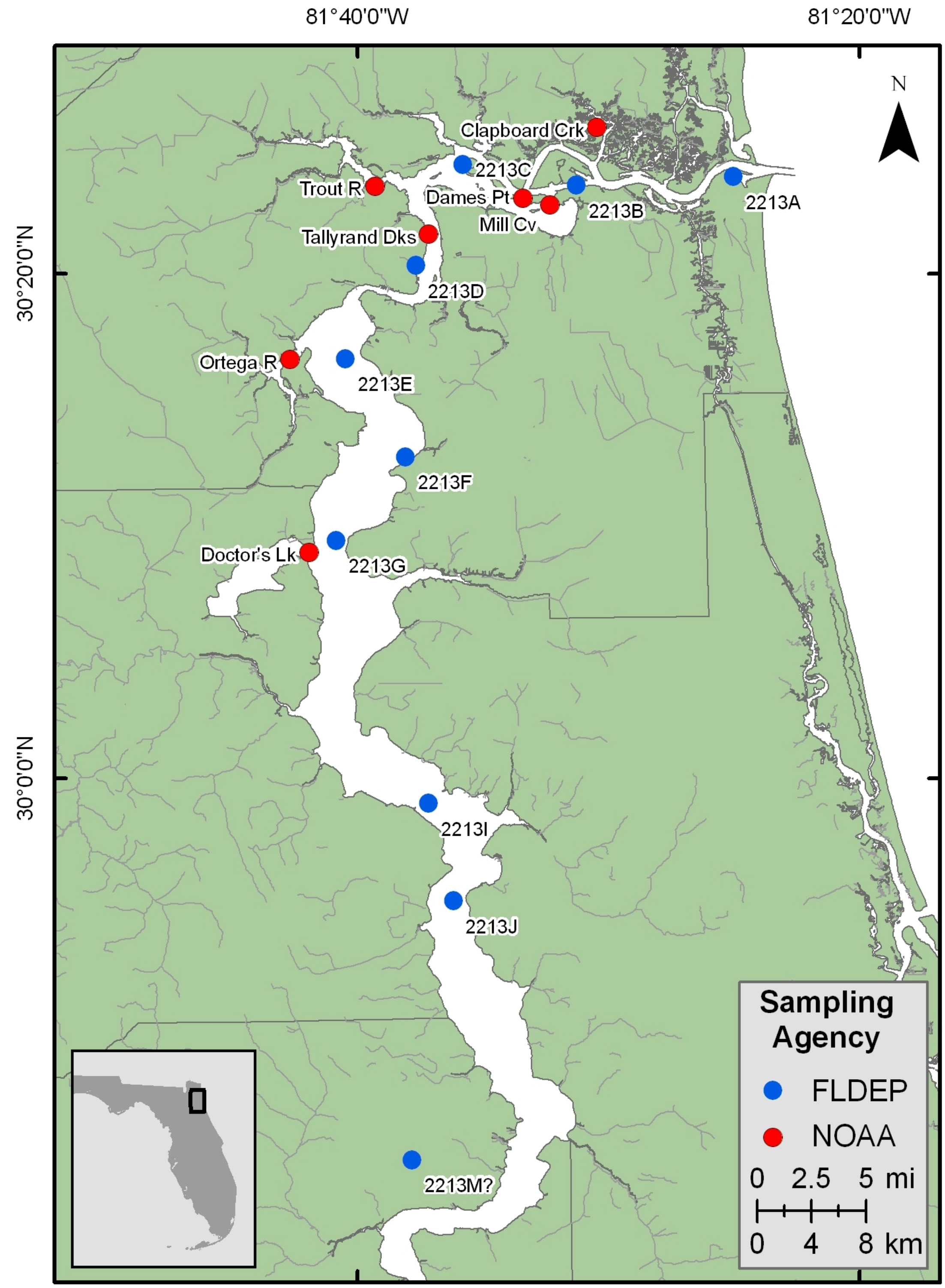


Figure 1. Sampling stations map

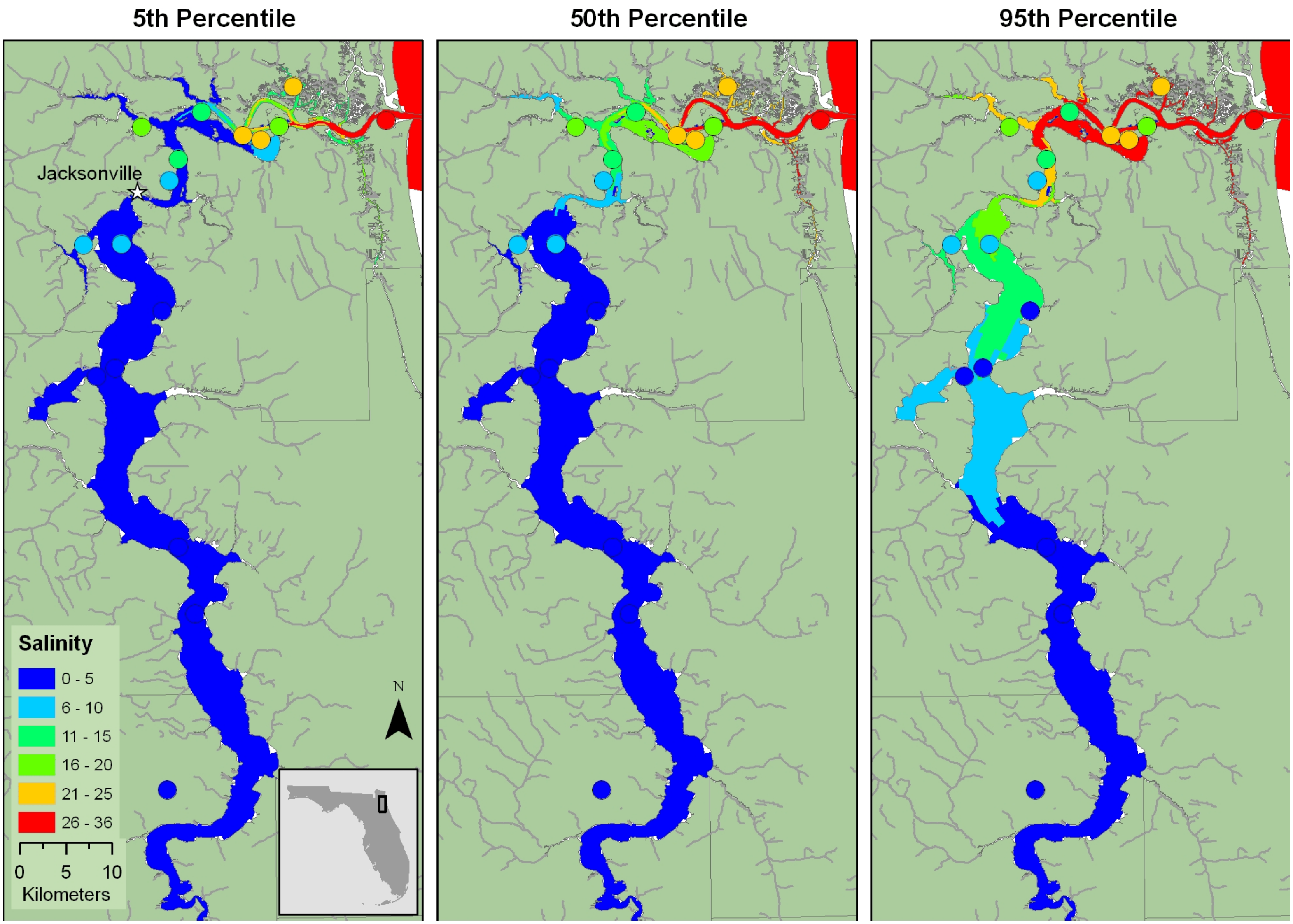


Figure 2. Map showing salinity of each station over the sampling periods and modeled 5th, 50th and 95th percentiles of bottom salinity from ECT (2002).

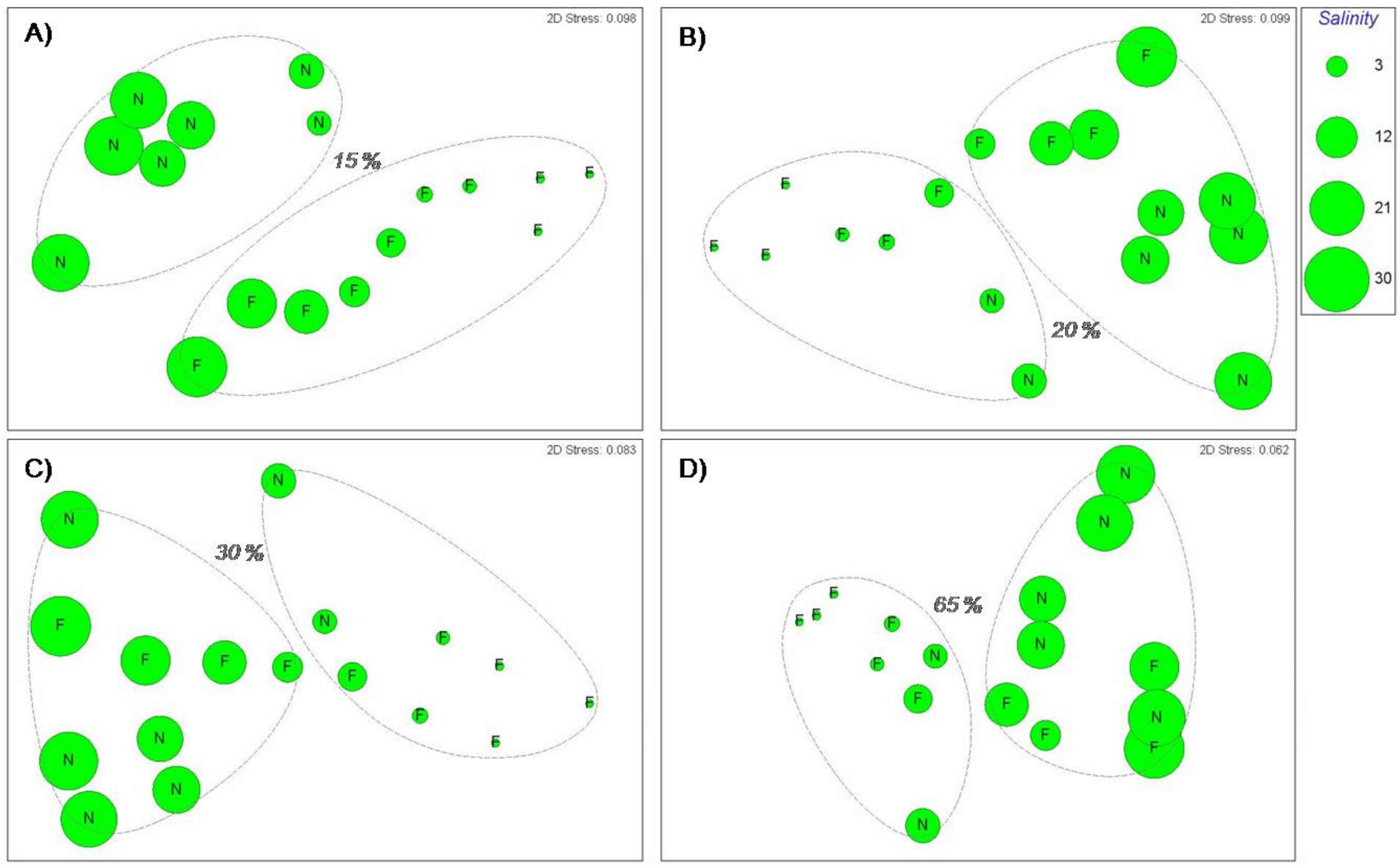


Figure 3. Multidimensional Scaling plot of macrofaunal community structure overlaid with significant similarity contours from cluster analysis (shown in italics). MDS analyses of community structure were based on A) species, B) genera, C) family and D) phyla. Station-scores are labeled by sampling agency and overlaid with salinity-proportional bubbles. N = NOAA station, F = FDEP station.

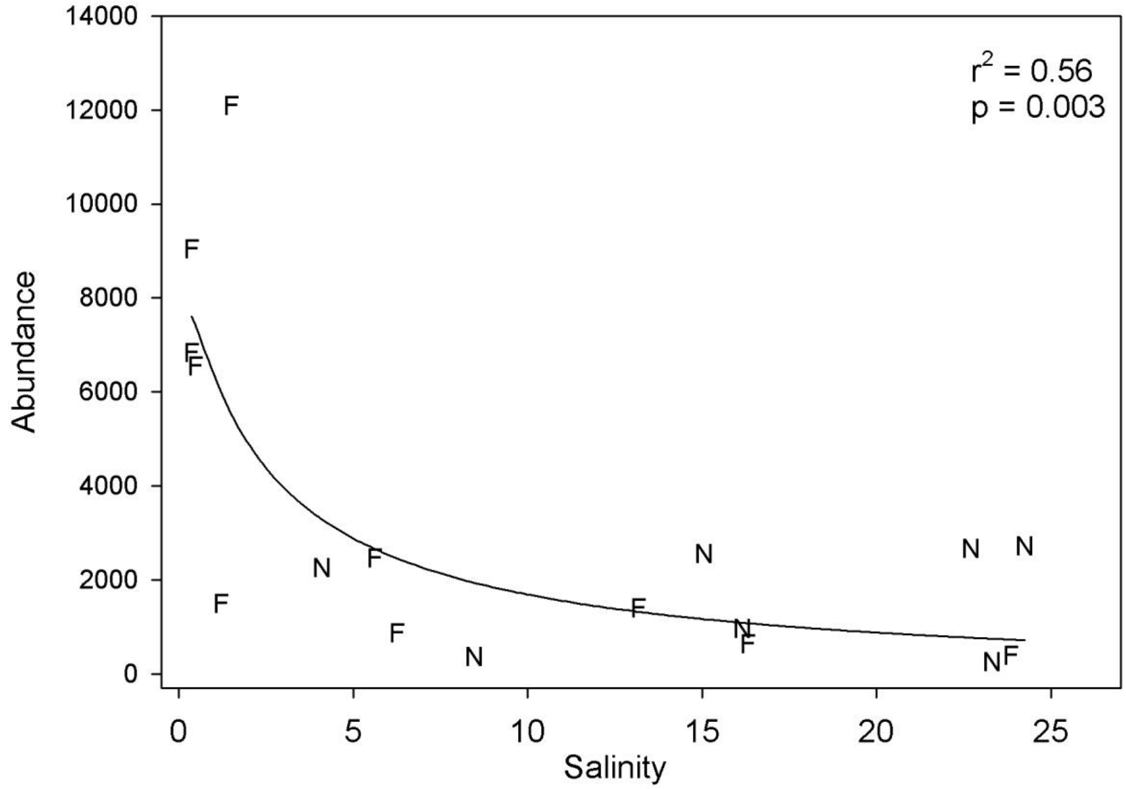


Figure 4. Mean abundance versus mean salinity for each station. N= NOAA, F = FDEP

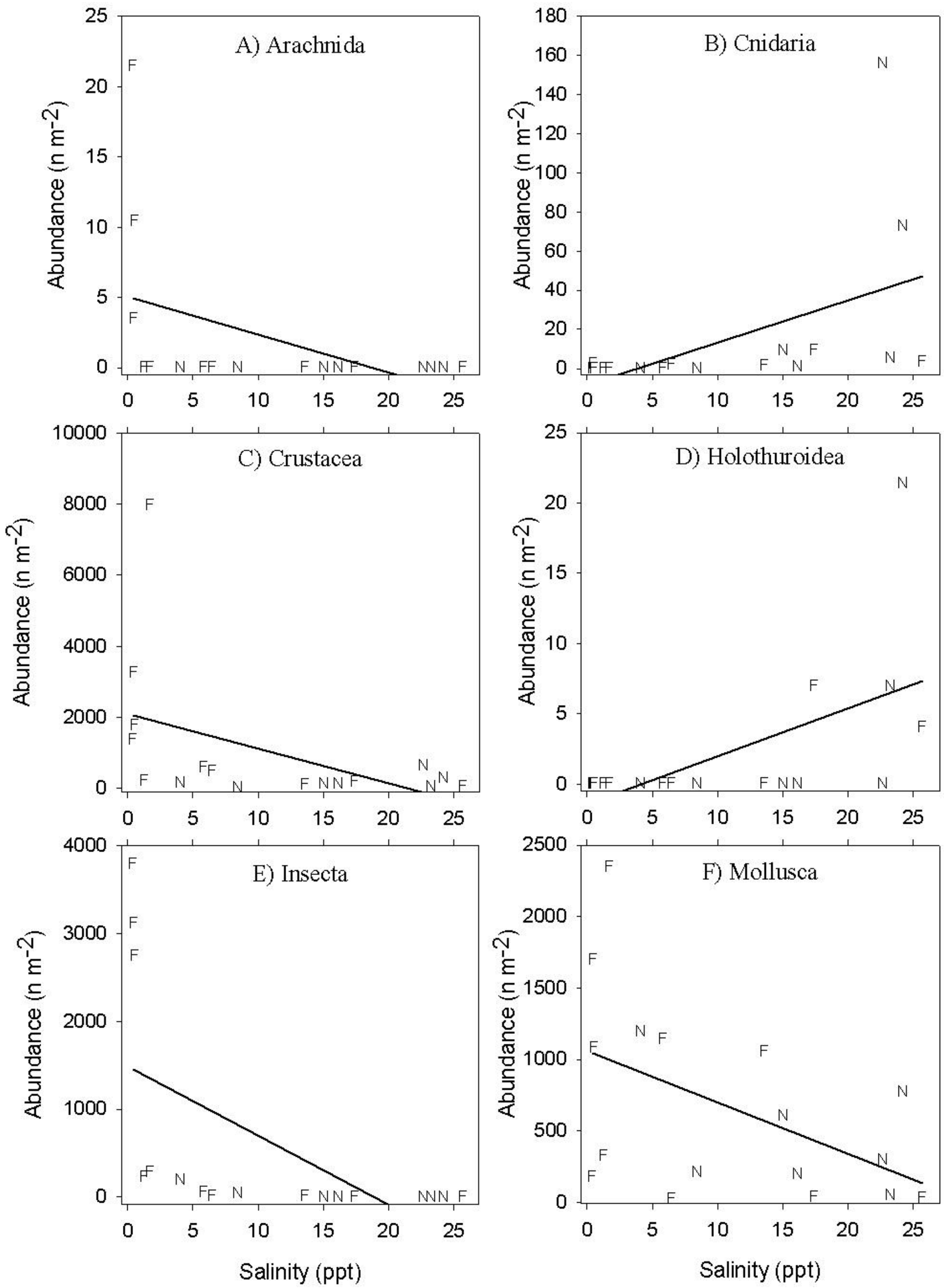


Figure 5. Linear regressions of salinity and higher taxa that had significant Spearman correlations with salinity. N = NOAA stations and F = FDEP stations. Solid line = significant log normal relationship ($p < 0.05$), dashed line = non significant relationship ($0.05 < p < 0.08$).

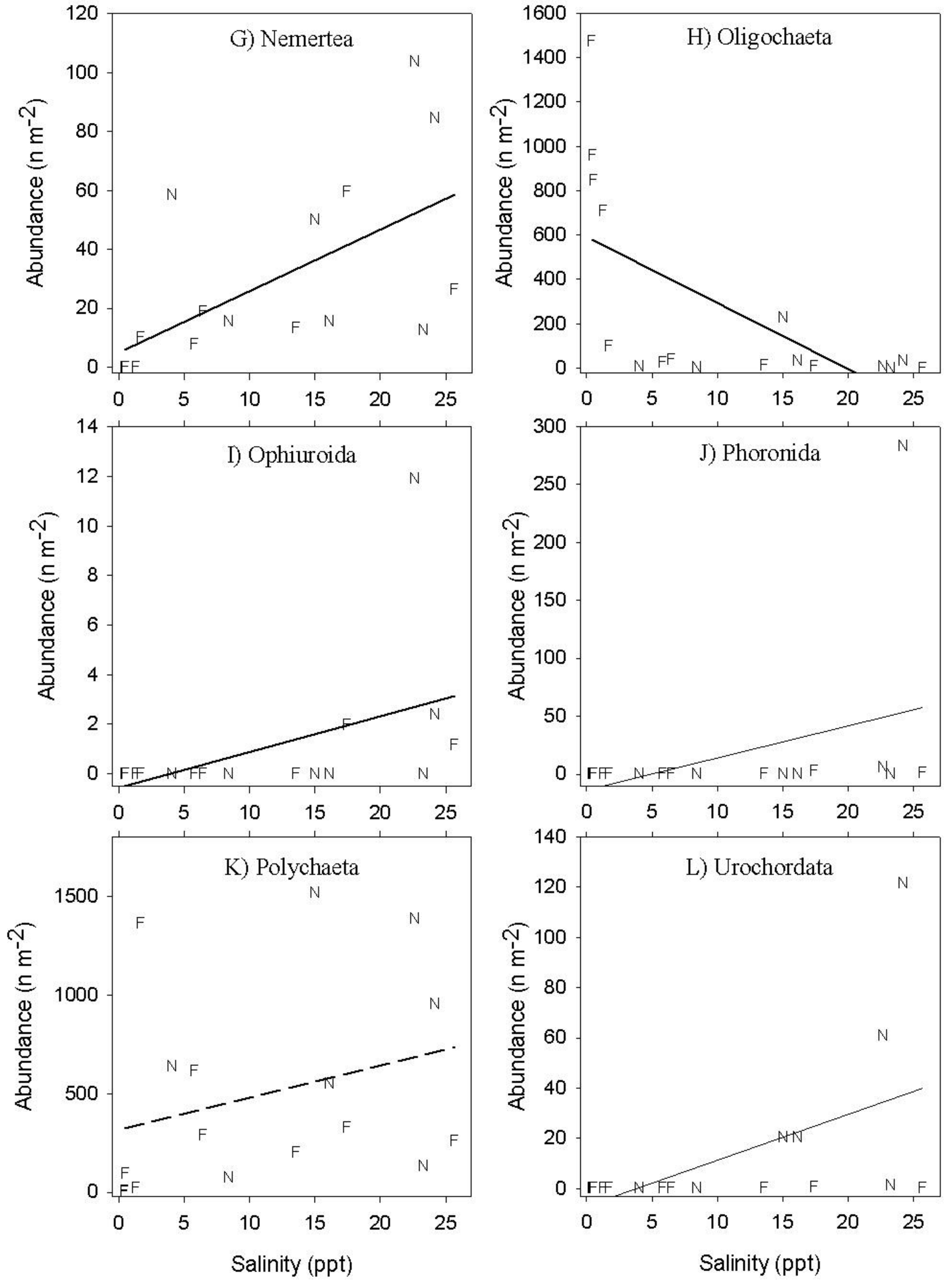


Figure 5. Continued.

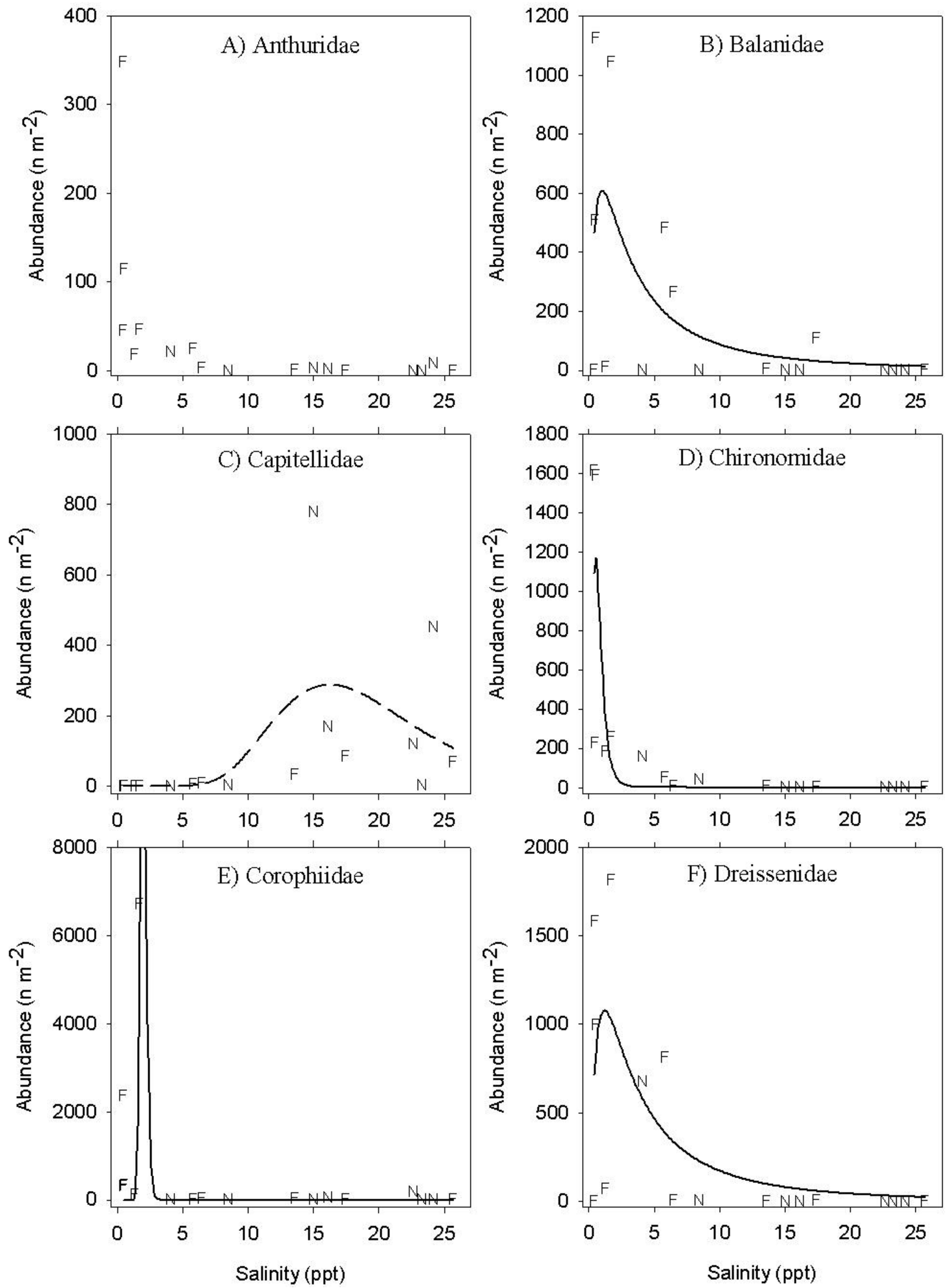
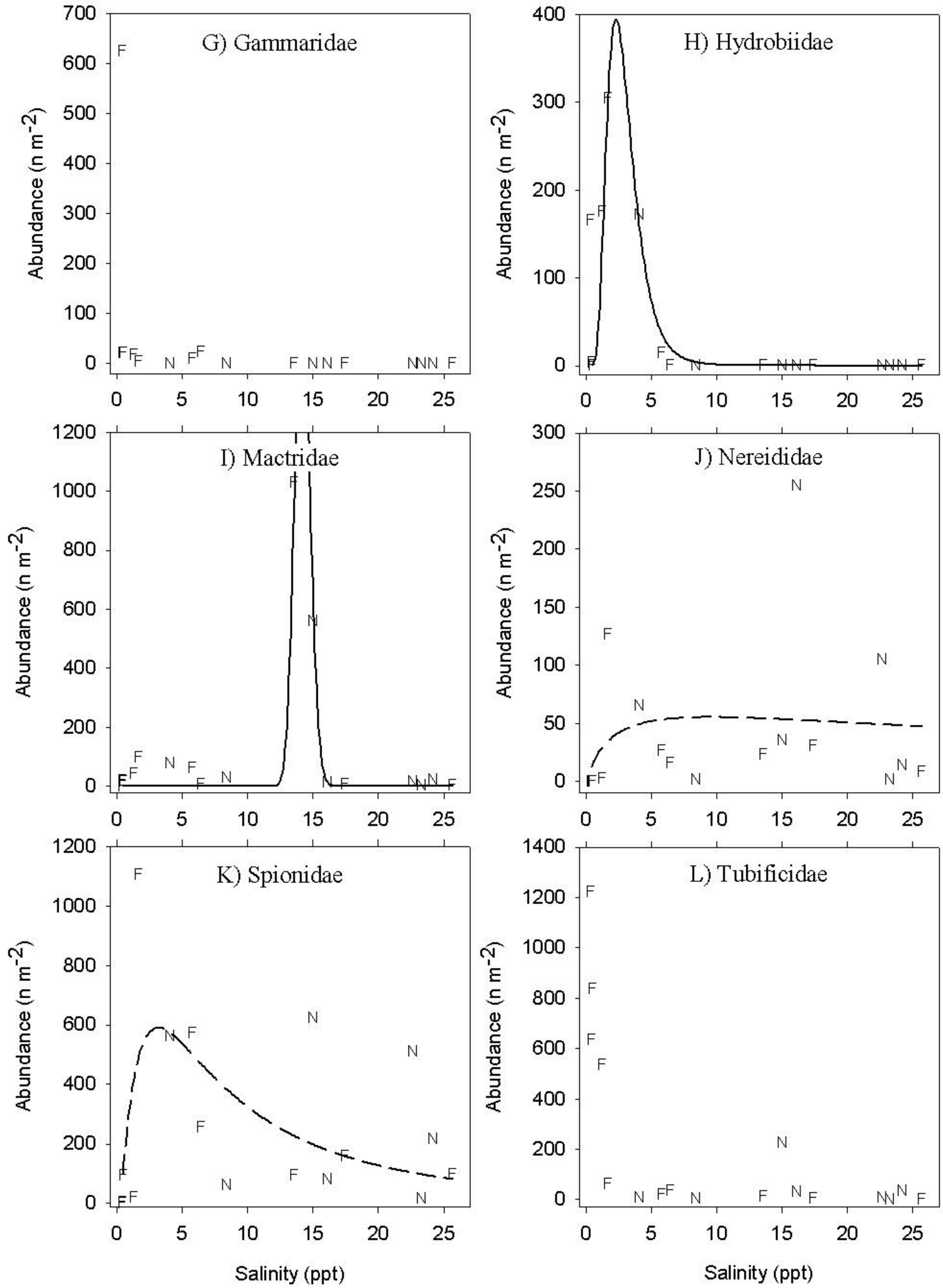


Figure 6. Relationships between salinity and the abundance of the twelve numerically dominant macrobenthic families. Solid line = significant log normal relationship ($p < 0.05$), dashed line = non significant relationship, no line = log normal relationship could not be calculated.



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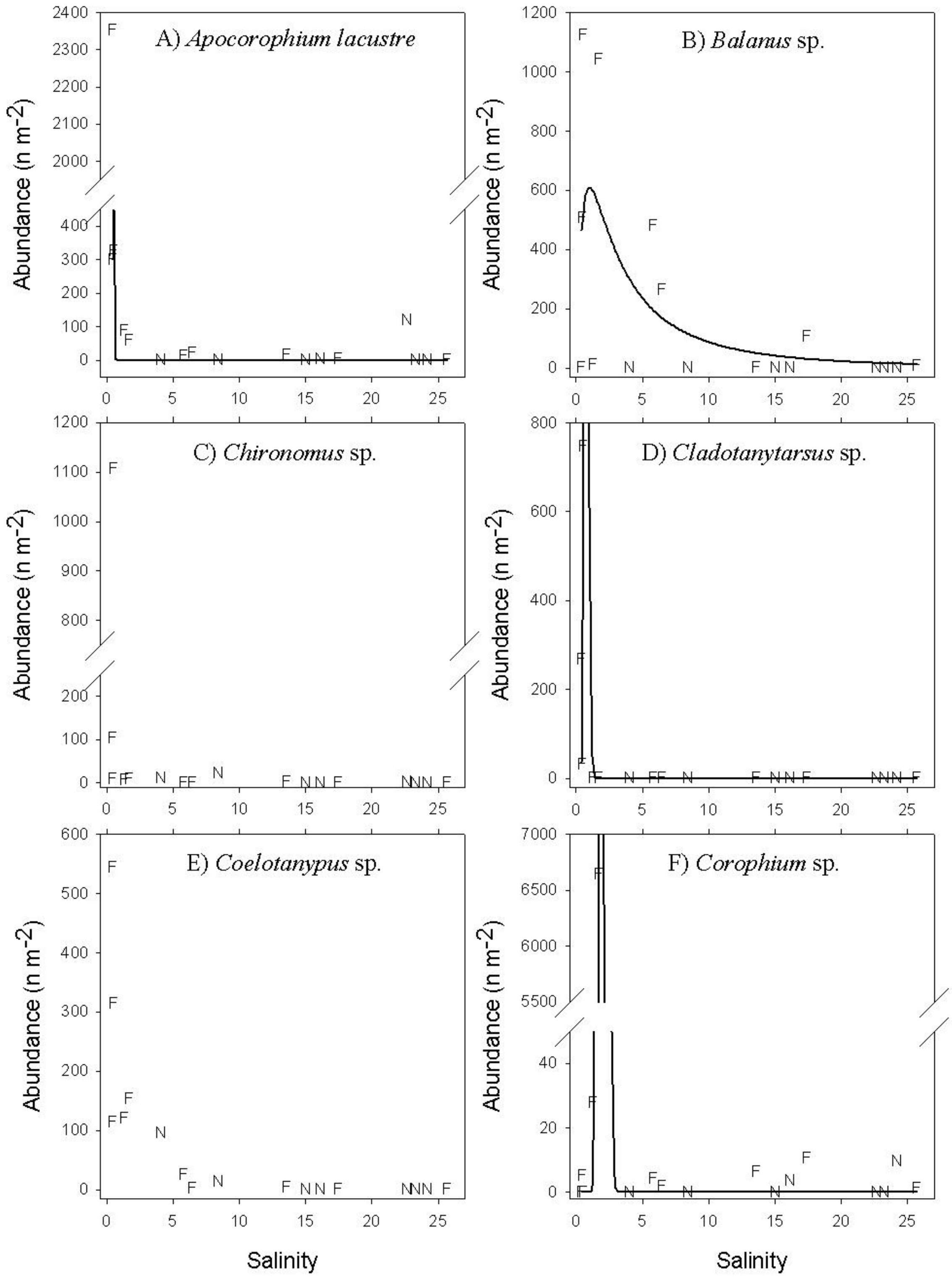

Figure 7. Relationships between salinity and the abundance of the twenty-four numerically dominant macrobenthic genera. Solid line = significant log normal relationship ($p < 0.05$), dashed line = non significant relationship, no line = log normal relationship could not be calculated. Species names stated if only one species in a genus occurred.

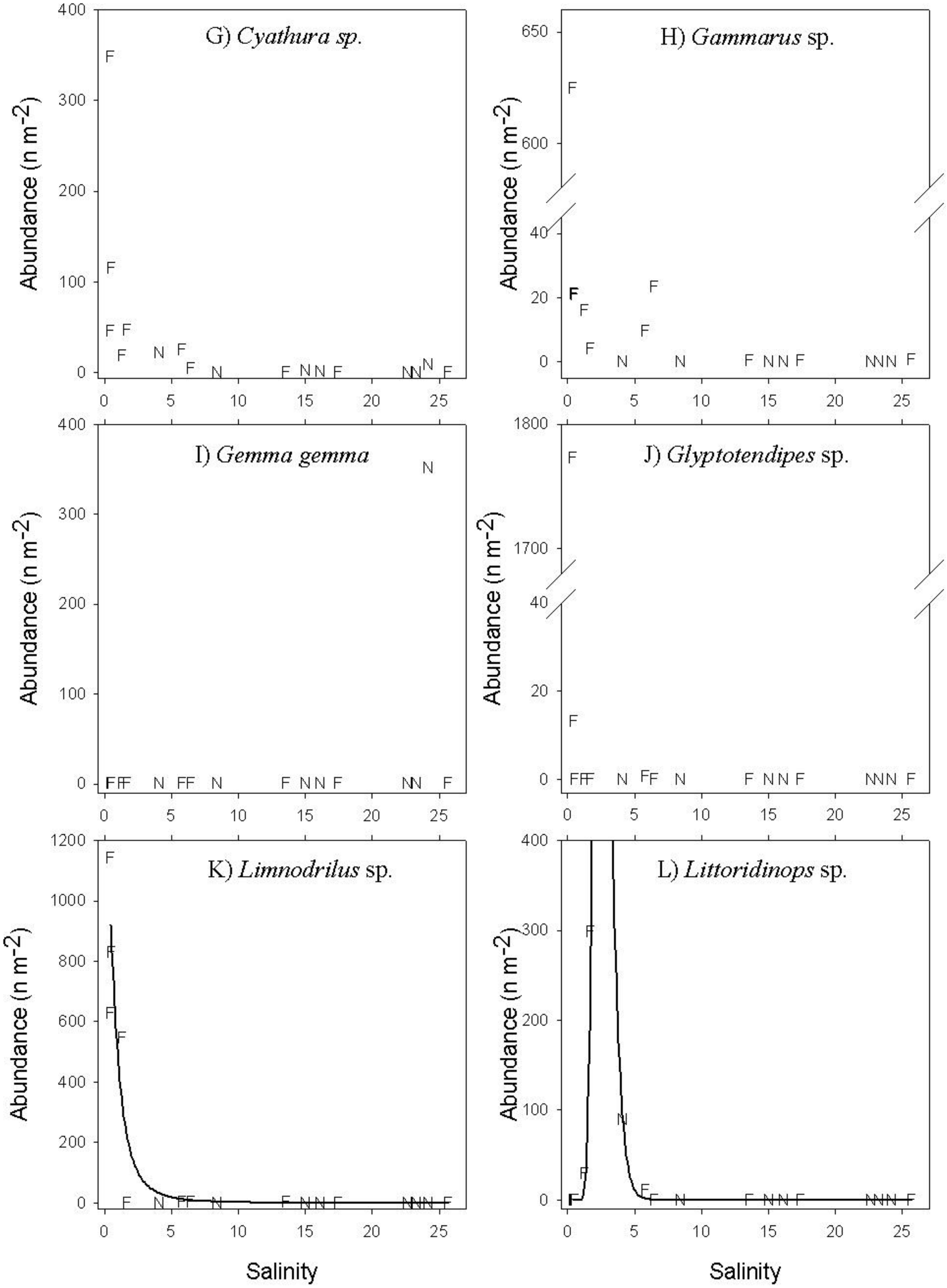

Figure 7. Continued.

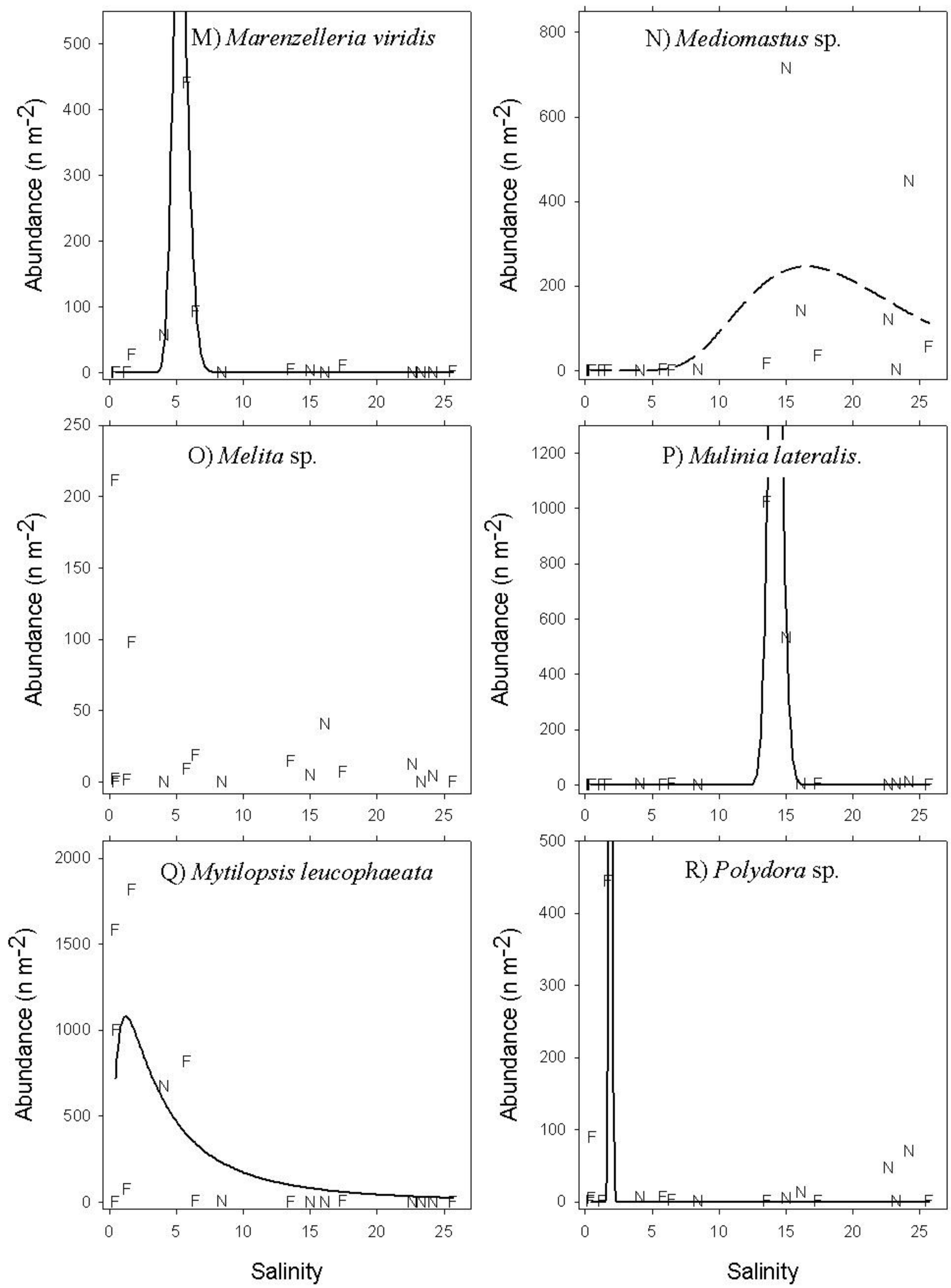

Figure 7. Continued.

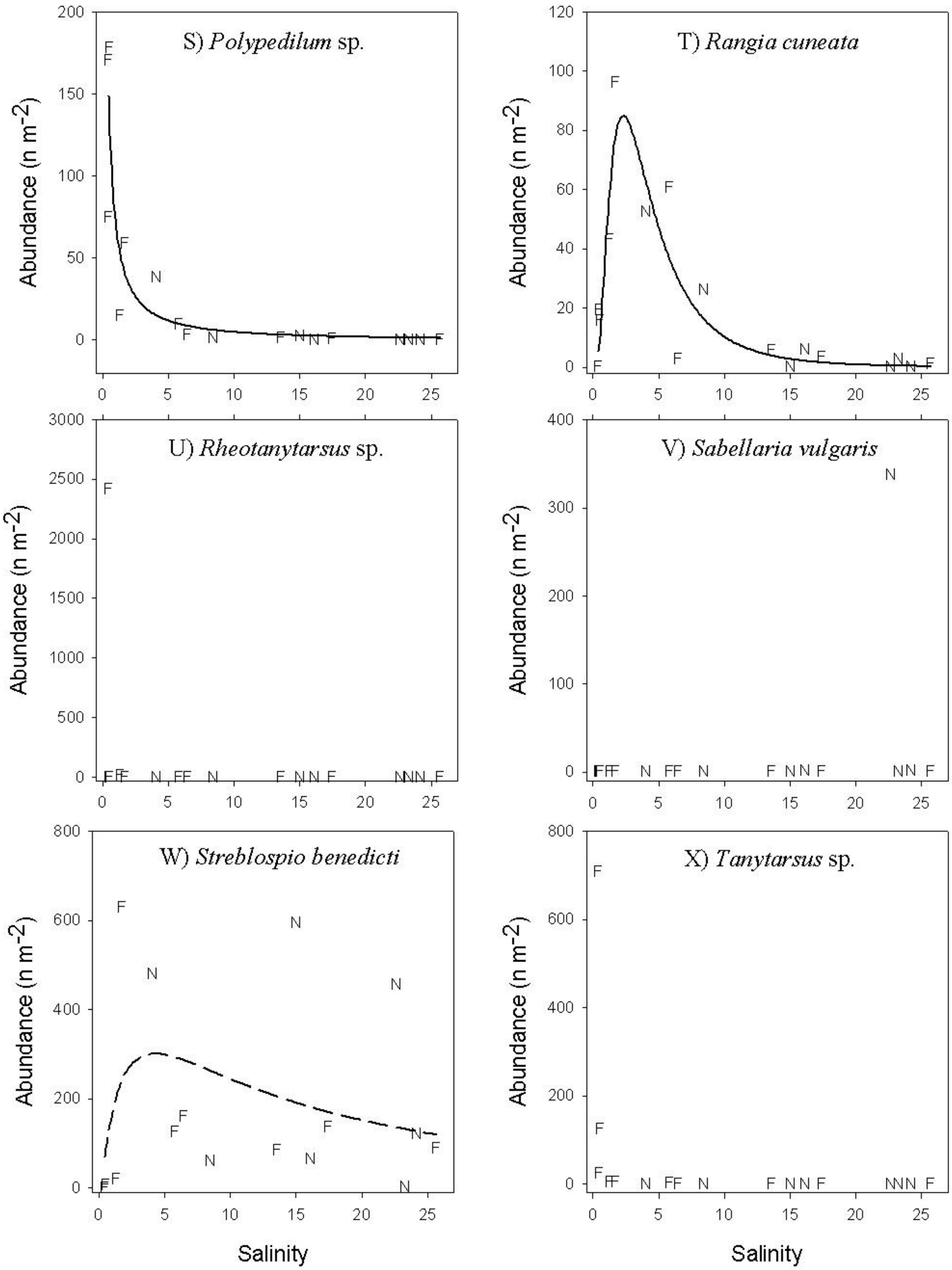

Figure 7. Continued.

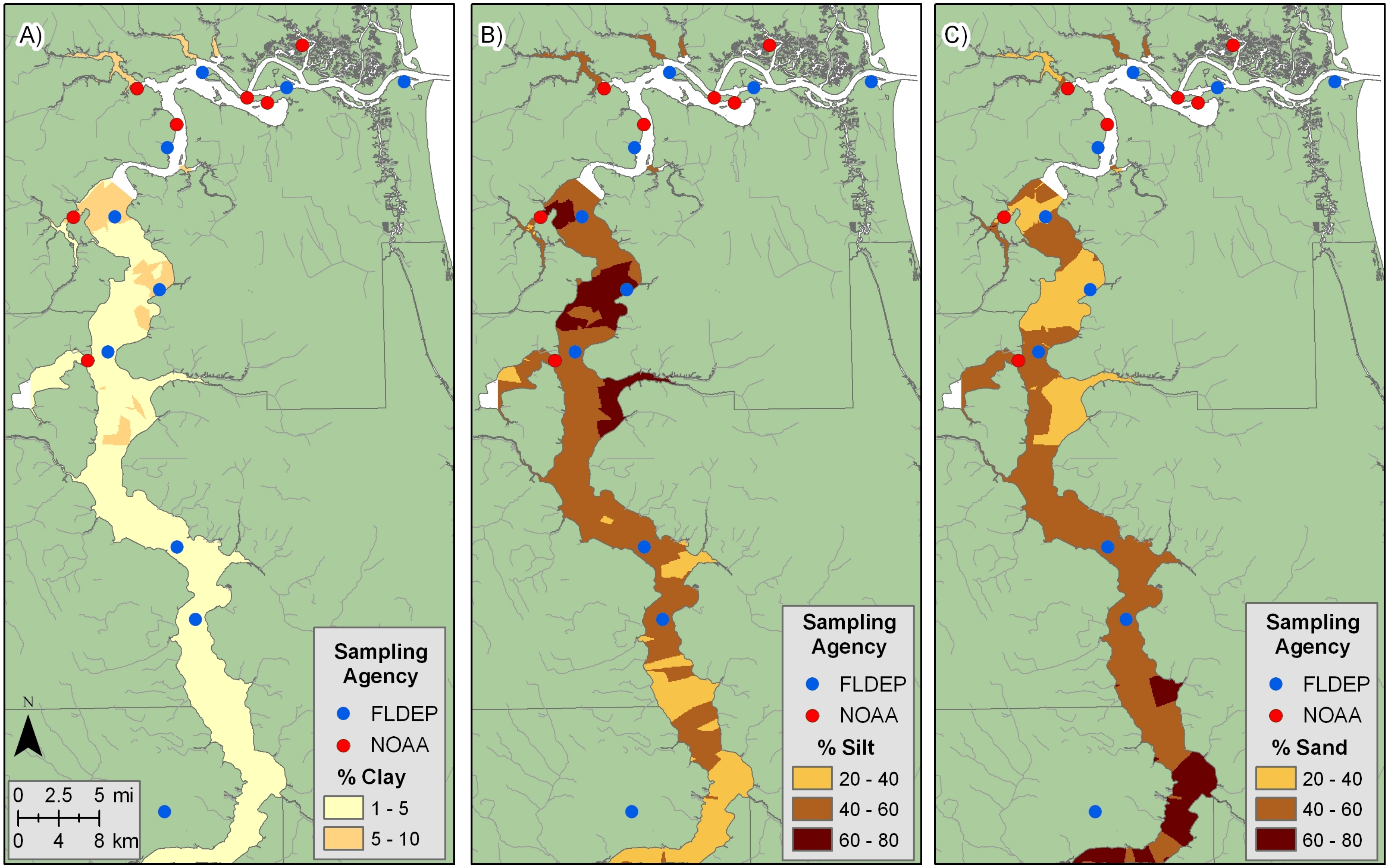

Figure 8. Grain size in the upper (southern) reaches of the St Johns Estuary. A) Clay, B) Silt and C) Sand.

Appendix

Complete Lowest practical identifiable level (LPIL) organism abundance list. B = Bryozoa, C = Crustacea, CN = Cnidaria, HI = Hirudinea, HO = Holothuroidea, I = Insecta, M = Mollusca, N = Nemertea, O = Oligochaeta, OP = Ophiuroida, P = Polychaeta, PH = Phoronida, PL = Platyhelminthes, PO = Porifera, U = Urochordata. Maximum number of stations is 17.

Organism	**Taxa**	**Abundance ($n\ m^{-2}$)**	**Percent of total**	**Cumulative percent**	**# of stations that species occurs**
Corophium sp.	C	394.701	12.5917	12.5917	9
Mytilopsis leucophaeata	M	350.167	11.1709	23.7626	9
Apocorophium lacustre	C	193.640	6.1775	29.9400	11
Limnodrilus hoffmeisteri	O	179.158	5.7155	35.6555	7
Streblospio benedicti	P	177.648	5.6673	41.3228	15
Balanus improvisus	C	150.506	4.8014	46.1242	9
Rheotanytarsus exiguus	I	142.723	4.5531	50.6773	2
Glyptotendipes sp.	I	105.073	3.3520	54.0293	3
Mulinia lateralis	M	92.797	2.9604	56.9897	12
Mediomastus sp	P	81.522	2.6007	59.5904	7
Cladotanytarsus sp.	I	61.458	1.9606	61.5510	3
Balanus sp.	C	57.587	1.8371	63.3881	6
Chironomus sp.	I	57.413	1.8316	65.2197	9
Tanytarsus	I	44.737	1.4272	66.6469	4
Coelotanypus sp.	I	39.518	1.2607	67.9076	9
Gammarus cf tigrinus	C	39.489	1.2598	69.1674	5
Cyathura polita	C	37.260	1.1887	70.3560	12
Marenzelleria viridis	P	37.084	1.1831	71.5391	8
Polydora socialis	P	33.255	1.0609	72.6000	6
Polypedilum halterale	I	26.169	0.8348	73.4348	8
Coelotanypus concinnus	I	25.287	0.8067	74.2415	7
Littoridinops sp.	M	24.728	0.7889	75.0304	4
Hydrobiidae	M	24.318	0.7758	75.8061	6
Melita nitida	C	21.114	0.6736	76.4797	8
Gemma gemma	M	20.658	0.6590	77.1387	1
Sabellaria vulgaris	P	19.958	0.6367	77.7754	3
Rangia cuneata	M	19.687	0.6281	78.4035	13
Neanthes succinea	P	18.767	0.5987	79.0022	11
Bratislavia unidentata	O	18.442	0.5883	79.5905	2
Phoronis sp.	PH	17.017	0.5429	80.1334	2
Chironomus attenuatus	I	16.014	0.5109	80.6443	2
Procladius sp.	I	15.856	0.5058	81.1501	6
Actiniaria	CN	14.627	0.4666	81.6167	7
Peloscolex heterochaetus	O	13.515	0.4312	82.0479	5
Ascidiacea	U	13.225	0.4219	82.4698	7
Nereis sp.	P	12.815	0.4088	82.8786	6
Amygdalum papyrium	M	12.494	0.3986	83.2772	6
Nemertea	N	12.380	0.3949	83.6721	12
Tubificidae	O	11.332	0.3615	84.0337	13
Rhithropanopeus harrisii	C	11.282	0.3599	84.3936	11
Endochironomus nigricans	I	10.956	0.3495	84.7431	2

Organism	Taxa	Abundance ($n\ m^{-2}$)	Percent of total	Cumulative percent	# of stations that species occurs
Paracaprella pusilla	C	10.936	0.3489	85.0920	5
Macoma mitchelli	M	10.924	0.3485	85.4405	6
Tubulanus sp.	N	10.738	0.3425	85.7830	7
Coelotanypus tricolor	I	10.698	0.3413	86.1243	4
Ameroculodes edwardsi	C	10.492	0.3347	86.4590	9
Nassarius obsoletus	M	9.607	0.3065	86.7655	4
Aulodrilus pigueti	O	8.514	0.2716	87.0371	5
Laeonereis culveri	P	8.353	0.2665	87.3036	8
Capitella capitata	P	8.284	0.2643	87.5679	8
Ampelisca sp.	C	7.530	0.2402	87.8081	5
Batea catharinensis	C	6.956	0.2219	88.0300	3
Tellinidae	M	6.839	0.2182	88.2482	5
Amphicteis gunneri	P	6.824	0.2177	88.4659	3
Geukensia demissa	M	6.781	0.2163	88.6822	5
Boonea impressa	M	6.583	0.2100	88.8922	2
Bivalvia	M	6.173	0.1969	89.0892	9
Coelotanypus scapularis	I	5.966	0.1903	89.2795	8
Limnodrilus angustipenis	O	5.782	0.1845	89.4640	1
Polydora sp.	P	5.707	0.1821	89.6460	6
Mediomastus californiensis	P	5.634	0.1797	89.8258	7
Nais communis complex	O	5.634	0.1797	90.0055	2
Polypedilum scalaenum	I	5.590	0.1783	90.1839	9
Ischadium recurvum	M	5.461	0.1742	90.3581	4
Texadina sphinctostoma	M	5.322	0.1698	90.5278	2
Melitidae	C	5.322	0.1698	90.6976	5
Ceratopogonidae	I	5.011	0.1599	90.8575	4
Mactridae	M	4.972	0.1586	91.0161	6
Oligochaeta	O	4.718	0.1505	91.1666	4
Chiridotea caeca	C	4.663	0.1487	91.3154	1
Tanytarsus sp l epler	I	4.442	0.1417	91.4571	2
Parvilucina multilineata	M	4.412	0.1407	91.5978	2
Sphenia antillensis	M	4.389	0.1400	91.7379	4
Paraonis fulgens	P	4.155	0.1326	91.8704	2
Lymnaea	M	3.983	0.1271	91.9975	1
Porifera	PO	3.922	0.1251	92.1226	1
Corophiidae	C	3.852	0.1229	92.2454	4
Stylaria lacustris	O	3.779	0.1206	92.3660	1
Scoloplos rubra	P	3.737	0.1192	92.4852	6
Xanthidae	C	3.640	0.1161	92.6013	9
Diopatra cuprea	P	3.479	0.1110	92.7123	5
Anadara transversa	M	3.465	0.1106	92.8229	4
Tubulanus pellucidus	N	3.417	0.1090	92.9319	6
Chironomidae	I	3.380	0.1078	93.0397	8
Cryptochironomus sp.	I	3.371	0.1075	93.1473	7
Cirrophorus sp. C	P	3.303	0.1054	93.2526	2
Ericthonius brasiliensis	C	3.257	0.1039	93.3565	3
Spionidae	P	3.105	0.0990	93.4556	11
Gyraulus sp.	M	3.081	0.0983	93.5539	1

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Mediomastus ambiseta	P	3.063	0.0977	93.6516	5
Cryptochironomus fulvus	I	3.013	0.0961	93.7477	6
Ampelisca vadorum	C	3.011	0.0961	93.8438	2
Peloscolex benedeni	O	2.961	0.0945	93.9382	5
Dicrotendipes lobus	I	2.696	0.0860	94.0242	3
Gammarus sp.	C	2.659	0.0848	94.1090	5
Clinotanypus sp.	I	2.619	0.0836	94.1926	3
Dicrotendipes neomodestus	I	2.560	0.0817	94.2743	2
Abra aequalis	M	2.549	0.0813	94.3556	3
Hydroides dianthus	P	2.483	0.0792	94.4348	4
Paraprionospio pinnata	P	2.482	0.0792	94.5140	8
Eusarsiella zostericola	C	2.451	0.0782	94.5922	3
Heteromastus filiformis	P	2.435	0.0777	94.6699	5
Grandidierella bonnieroides	C	2.381	0.0759	94.7458	6
Boccardia sp.	P	2.241	0.0715	94.8173	2
Serpulidae	P	2.171	0.0693	94.8866	2
Peloscolex gabriellae	O	2.143	0.0684	94.9549	2
Oecetis sp.	I	2.134	0.0681	95.0230	4
Dyspanopeus texanus	C	2.103	0.0671	95.0901	7
Spiophanes bombyx	P	2.073	0.0661	95.1562	7
Melita sp.	C	2.031	0.0648	95.2210	3
Cyclaspis varians	C	1.992	0.0635	95.2845	6
Oxyurostylis smithi	C	1.946	0.0621	95.3466	5
Brachidontes exustus	M	1.944	0.0620	95.4086	3
Mytilus sp.	M	1.913	0.0610	95.4697	2
Acteocina canaliculata	M	1.898	0.0606	95.5302	5
Nereis micromma	P	1.891	0.0603	95.5905	2
Tubifex tubifex	O	1.817	0.0580	95.6485	3
Sigambra tentaculata	P	1.816	0.0579	95.7065	5
Corbicula fluminea	M	1.811	0.0578	95.7642	2
Dicrotendipes nervosus	I	1.787	0.0570	95.8212	3
Ferrissia sp.	M	1.722	0.0550	95.8762	2
Panopeus herbstii	C	1.707	0.0545	95.9307	6
Leptosynapta tenuis	HO	1.669	0.0532	95.9839	2
Leitoscoloplos sp.	P	1.576	0.0503	96.0342	4
Melita longisetosa	C	1.541	0.0491	96.0833	4
Potamothrix hammoniensis	O	1.493	0.0476	96.1309	2
Podarkeopsis levifuscina	P	1.471	0.0469	96.1778	4
Caenis sp.	I	1.430	0.0456	96.2235	3
Neanthes acuminata	P	1.387	0.0443	96.2677	5
Nephtys picta	P	1.361	0.0434	96.3111	3
Bugula sp.	B	1.341	0.0428	96.3539	5
Polydora cornuta	P	1.331	0.0424	96.3964	4
Americamysis bigelowi	C	1.295	0.0413	96.4377	5
Paralauterborniella nigrohaltera	I	1.268	0.0404	96.4781	4
Ampelisca cristata	C	1.261	0.0402	96.5183	1
Xenochironomus xenolabis	I	1.226	0.0391	96.5574	1
Parahaustorius sp.	C	1.223	0.0390	96.5965	4

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Asabellides oculata	P	1.202	0.0384	96.6348	4
Cirratulidae	P	1.196	0.0382	96.6730	3
Mytilidae	M	1.190	0.0380	96.7109	4
Hyalella azteca	C	1.170	0.0373	96.7483	4
Edotia triloba	C	1.143	0.0365	96.7847	6
Pista quadrilobata	M	1.132	0.0361	96.8209	2
Nucula proxima	M	1.126	0.0359	96.8568	4
Leucon americanus	C	1.120	0.0357	96.8925	3
Caulleriella	P	1.103	0.0352	96.9277	2
Amphipoda	C	1.095	0.0349	96.9627	6
Macoma tenta	M	1.089	0.0347	96.9974	6
Tanytarsus guerlus	I	1.081	0.0345	97.0319	1
Nassarius vibex	M	1.080	0.0345	97.0663	5
Armandia maculata	P	1.076	0.0343	97.1007	4
Djalmabatista pulcher	I	1.059	0.0338	97.1345	2
Monoculodes sp D	C	1.050	0.0335	97.1680	4
Lucina sp.	M	1.050	0.0335	97.2015	2
Dicrotendipes modestus	I	1.012	0.0323	97.2338	3
Magelona sp H	P	0.980	0.0313	97.2650	2
Pectinaria gouldi	P	0.955	0.0305	97.2955	5
Oedicerotidae	C	0.928	0.0296	97.3251	6
Americamysis sp.	C	0.919	0.0293	97.3545	2
Neomysis americana	C	0.895	0.0286	97.3830	4
Capitella	P	0.845	0.0270	97.4100	3
Phyllodocidae	P	0.840	0.0268	97.4368	4
Caprellidae	C	0.840	0.0268	97.4636	1
Hypereteone sp.	P	0.840	0.0268	97.4904	3
Eurypanopeus depressus	C	0.840	0.0268	97.5172	3
Protohaustorius wigleyi	C	0.817	0.0261	97.5433	2
Unionicola sp.	AR	0.817	0.0261	97.5693	2
Amphicteis floridus	P	0.807	0.0257	97.5951	2
Chaoborus sp	I	0.786	0.0251	97.6201	6
Chthamalus fragilis	C	0.782	0.0249	97.6451	1
Cricotopus bicinctus	I	0.777	0.0248	97.6699	2
Eobrolgus spinosus	C	0.770	0.0246	97.6944	2
Assiminea succinea	M	0.770	0.0246	97.7190	2
Cerebratulus lacteus	N	0.770	0.0245	97.7436	5
Stylodrilus heringianus	O	0.754	0.0241	97.7676	1
Spiochaetopterus oculatus	P	0.745	0.0238	97.7914	4
Glycera dibranchiata	P	0.716	0.0228	97.8142	3
Alotanypus sp.	I	0.715	0.0228	97.8370	1
Americhelidium americanum	C	0.712	0.0227	97.8597	2
Allonais inequalis	O	0.700	0.0223	97.8821	1
Glycinde solitaria	P	0.700	0.0223	97.9044	4
Prionospio sp.	P	0.700	0.0223	97.9267	2
Nereis lamellosa	P	0.700	0.0223	97.9491	2
Ophiuroidea	OP	0.698	0.0223	97.9714	2
Aphelochaeta marioni	P	0.695	0.0222	97.9935	2

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Gastropoda	M	0.649	0.0207	98.0142	7
Haploscoloplos fragilis	P	0.646	0.0206	98.0348	3
Odostomia sp.	M	0.642	0.0205	98.0553	6
Tellina	M	0.641	0.0205	98.0758	5
Holothuroidea	HO	0.632	0.0202	98.0960	2
Owenia fusiformis	P	0.630	0.0201	98.1161	2
Petricolidae	M	0.630	0.0201	98.1362	1
Tiphys sp.	AR	0.613	0.0195	98.1557	1
Boccardia hamata	P	0.594	0.0190	98.1747	1
Gitanopsis sp.	C	0.577	0.0184	98.1931	3
Physella sp.	M	0.577	0.0184	98.2115	3
Polypedilum illinoense	I	0.562	0.0179	98.2294	1
Amphilochidae	C	0.561	0.0179	98.2473	3
Tharyx acutus	P	0.560	0.0179	98.2652	2
Diplodonta semiaspera	M	0.560	0.0179	98.2831	2
Demonax microphthalmus	P	0.560	0.0179	98.3009	2
Monocorophium acherusicum	C	0.537	0.0171	98.3181	3
Caenis diminuta	I	0.536	0.0171	98.3352	3
Ogyrides alphaerostris	C	0.525	0.0167	98.3519	3
Melongena corona	M	0.520	0.0166	98.3685	1
Bowmaniella floridana	C	0.514	0.0164	98.3849	5
Haber speciosus	O	0.511	0.0163	98.4012	1
Scoloplos robustus	P	0.502	0.0160	98.4172	2
Cirrophorus sp.	P	0.490	0.0156	98.4328	1
Exogone sp.	P	0.490	0.0156	98.4484	2
Ampelisca abdita	C	0.490	0.0156	98.4641	2
Ostreidae	M	0.490	0.0156	98.4797	2
Hydrozoa	CN	0.485	0.0155	98.4952	8
Boccardiella ligerica	P	0.482	0.0154	98.5106	2
Tellina versicolor	M	0.472	0.0151	98.5256	4
Terebellidae	P	0.469	0.0150	98.5406	3
Chironomus riparius	I	0.467	0.0149	98.5555	1
Ilyodrilus templetoni	O	0.460	0.0147	98.5701	2
Acari	AR	0.443	0.0141	98.5843	2
Eteone heteropoda	P	0.439	0.0140	98.5983	5
Mytilidae	M	0.433	0.0138	98.6121	1
Aglaophamus verrilli	P	0.420	0.0134	98.6255	2
Turbonilla sp.	M	0.420	0.0134	98.6389	1
Syllis beneliahui	P	0.420	0.0134	98.6523	1
Ampelisca sp C	C	0.420	0.0134	98.6657	1
Syllidae	P	0.420	0.0134	98.6791	3
Podarke obscura	C	0.420	0.0134	98.6925	3
Mitrella lunata	M	0.420	0.0134	98.7059	3
Ampharetidae	P	0.420	0.0134	98.7193	3
Epitonium multistriatum	M	0.420	0.0134	98.7327	3
Balanus amphitrite	C	0.409	0.0130	98.7458	1
Ablabesmyia rhamphe	I	0.409	0.0130	98.7588	1
Nephtys sp.	P	0.397	0.0127	98.7715	2

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Enallagma sp.	I	0.373	0.0119	98.7834	2
Nereididae	P	0.363	0.0116	98.7949	6
Oxyurostylis sp.	C	0.362	0.0115	98.8065	3
Ampelisca declivitatis	C	0.360	0.0115	98.8180	1
Macoma sp.	M	0.357	0.0114	98.8293	3
Monoculodes sp.	C	0.352	0.0112	98.8406	5
Vitrinella floridana	M	0.350	0.0112	98.8517	2
Streptosyllis pettiboneae	P	0.350	0.0112	98.8629	2
Spiophanes missionensis	P	0.350	0.0112	98.8741	2
Cerapus benthophilus	C	0.350	0.0112	98.8853	3
Aoridae	P	0.350	0.0112	98.8964	3
Turbonilla interrupta	M	0.350	0.0112	98.9076	1
Decapoda	C	0.330	0.0105	98.9181	3
Campanulariidae	CN	0.329	0.0105	98.9286	4
Paraonis sp.	P	0.315	0.0101	98.9387	2
Crangonyx sp.	C	0.314	0.0100	98.9487	1
Melinna maculata	P	0.313	0.0100	98.9587	3
Psammoryctides convolutus	O	0.306	0.0098	98.9684	1
Chironomus crassicaudatus	I	0.306	0.0098	98.9782	1
Cassidinidea lunifrons	C	0.306	0.0098	98.9880	1
Lineidae	N	0.303	0.0097	98.9977	2
Polycentropus	I	0.289	0.0092	99.0069	2
Sabaco americanus	P	0.280	0.0089	99.0158	1
Lepidonotus sublevis	P	0.280	0.0089	99.0248	1
Amphicteis floridus	P	0.280	0.0089	99.0337	1
Sabellariidae	P	0.280	0.0089	99.0426	2
Nereis falsa	P	0.280	0.0089	99.0516	2
Demonax sp.	P	0.280	0.0089	99.0605	2
Americamysis bahia	C	0.280	0.0089	99.0694	2
Glycera americana	P	0.278	0.0089	99.0783	2
Glyceridae	P	0.277	0.0088	99.0871	3
Caenis hilaris	I	0.273	0.0087	99.0958	1
Littoridinops monroensis	M	0.269	0.0086	99.1044	2
Dicrotendipes leucoscelis	I	0.255	0.0081	99.1126	1
Lumbriculidae	O	0.255	0.0081	99.1207	1
Ogyrides hayi	C	0.249	0.0080	99.1287	3
Cirrophorus sp A	P	0.245	0.0078	99.1365	1
Polynoidae	P	0.244	0.0078	99.1443	3
Sipuncula	S	0.244	0.0078	99.1521	2
Phyllodoce arenae	P	0.243	0.0077	99.1598	3
Lumbrineris impatiens	P	0.242	0.0077	99.1675	2
Prionospio cristata	P	0.238	0.0076	99.1751	1
Prostoma graecense	N	0.233	0.0074	99.1826	1
Crangonyx richmondensis	C	0.233	0.0074	99.1900	3
Polychaeta	P	0.230	0.0073	99.1974	3
Membranipora tenuis	B	0.224	0.0071	99.2045	2
Gammarus palustris	C	0.222	0.0071	99.2116	6
Pseudoleptocuma minus	C	0.222	0.0071	99.2187	2

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Trichophoxus floridanus	C	0.221	0.0071	99.2258	5
Tanytarsus sp g epler	I	0.219	0.0070	99.2327	2
Crassostrea virginica	M	0.218	0.0069	99.2397	2
Vitrinellidae	M	0.210	0.0067	99.2464	1
Puberella intapurpurea	M	0.210	0.0067	99.2531	1
Gyptis pluriseta	P	0.210	0.0067	99.2598	1
Exogone rolani	P	0.210	0.0067	99.2665	1
Corophium lacustre	C	0.210	0.0067	99.2732	1
Corbulidae	M	0.210	0.0067	99.2799	1
Synidotea sp.	C	0.210	0.0067	99.2866	2
Sphenia sp.	M	0.210	0.0067	99.2933	2
Nereiphylla fragilis	P	0.210	0.0067	99.3000	2
Marphysa sp.	P	0.210	0.0067	99.3067	2
Latreutes parvulus	C	0.210	0.0067	99.3134	2
Onuphidae	P	0.210	0.0067	99.3201	2
Hesionidae	P	0.210	0.0067	99.3268	2
Hemipholis elongata	OP	0.210	0.0067	99.3335	2
Eulimastoma weberi	M	0.210	0.0067	99.3402	2
Cerapus sp.	C	0.210	0.0067	99.3469	2
Capitellidae	P	0.210	0.0067	99.3536	2
Calotrophon ostrearum	M	0.210	0.0067	99.3603	2
Boonea seminuda	M	0.210	0.0067	99.3670	2
Automate sp.	C	0.210	0.0067	99.3737	2
Piromis roberti	P	0.210	0.0067	99.3804	3
Smittia sp.	I	0.204	0.0065	99.3869	1
Piona sp.	AR	0.204	0.0065	99.3935	1
Slavina appendiculata	O	0.204	0.0065	99.4000	1
Planorbella scalaris	M	0.204	0.0065	99.4065	1
Synchelidium americanum	C	0.202	0.0065	99.4129	2
Thienemanniella sp.	I	0.189	0.0060	99.4190	1
Maccaffertium exiguum	I	0.188	0.0060	99.4250	2
Phoronis architecta	PH	0.181	0.0058	99.4307	2
Enchytraeidae	O	0.180	0.0057	99.4365	2
Paraonidae	P	0.179	0.0057	99.4422	3
Batea sp.	C	0.178	0.0057	99.4478	1
Pagurus longicarpus	C	0.172	0.0055	99.4533	2
Tellina lineata	M	0.170	0.0054	99.4588	1
Leitoscoloplos fragilis	P	0.170	0.0054	99.4642	4
Callinectes sapidus	C	0.164	0.0052	99.4694	3
Magelona sp.	P	0.164	0.0052	99.4747	1
Ectoprocta / Bryzoa	B	0.157	0.0050	99.4797	3
Chironomus decorus	I	0.153	0.0049	99.4846	1
Neureclipsis sp.	I	0.153	0.0049	99.4894	1
Menetus sp.	M	0.153	0.0049	99.4943	1
Pentaneura sp.	I	0.153	0.0049	99.4992	1
Parakiefferiella	I	0.153	0.0049	99.5041	1
Orthotrichia sp.	I	0.153	0.0049	99.5090	1
Odonata	I	0.153	0.0049	99.5139	1

Organism	Taxa	Abundance ($n\ m^{-2}$)	Percent of total	Cumulative percent	# of stations that species occurs
Nanocladius minimus	I	0.153	0.0049	99.5188	1
Diptera	I	0.153	0.0049	99.5236	1
Pseudohaustorius borealis	C	0.153	0.0049	99.5285	1
Cassidinidea ovalis	C	0.152	0.0049	99.5334	2
Lophogastrida	C	0.150	0.0048	99.5382	4
Tagelus plebeius	M	0.140	0.0045	99.5427	1
Synidotea sp. F	C	0.140	0.0045	99.5471	1
Paraeupolymnia sp. A.	P	0.140	0.0045	99.5516	1
Odontosyllis enopla	P	0.140	0.0045	99.5561	1
Notomastus hemipodus	P	0.140	0.0045	99.5605	1
Lumbrineris verrilli	P	0.140	0.0045	99.5650	1
Lepidonotus variabilis	P	0.140	0.0045	99.5695	1
Eunicidae	P	0.140	0.0045	99.5739	1
Euceramus praelongus	C	0.140	0.0045	99.5784	1
Podocopida	C	0.140	0.0045	99.5829	1
Ceratonereis irritabilis	P	0.140	0.0045	99.5873	1
Bateidae	C	0.140	0.0045	99.5918	1
Autolytus sp.	P	0.140	0.0045	99.5963	1
Arcidae	M	0.140	0.0045	99.6007	1
Ampithoidae	C	0.140	0.0045	99.6052	1
Nereis riisei	P	0.140	0.0045	99.6097	2
Hargeria rapax	C	0.140	0.0045	99.6141	2
Anachis lafresnayi	M	0.140	0.0045	99.6186	2
Alpheus armillatus	C	0.140	0.0045	99.6231	2
Paraonis gracilis	P	0.136	0.0044	99.6274	1
Bowmaniella portoricensis	C	0.136	0.0044	99.6318	1
Petricolaria pholadiformis	M	0.131	0.0042	99.6360	1
Leptochelia sp.	C	0.130	0.0042	99.6401	4
Anachis avara	M	0.128	0.0041	99.6442	2
Dreissenidae	M	0.126	0.0040	99.6482	1
Stylaria sp.	O	0.126	0.0040	99.6522	1
Einfeldia sp.	I	0.125	0.0040	99.6562	2
Peloscolex sp.	O	0.125	0.0040	99.6602	2
Asabellides sp.	P	0.123	0.0039	99.6641	2
Haustoriidae	C	0.121	0.0039	99.6680	2
Harnischia sp.	I	0.119	0.0038	99.6718	1
Orchestia uhleri	C	0.118	0.0038	99.6755	2
Uromunna reynoldsi	C	0.118	0.0037	99.6793	2
Gloiobdella elongata	HI	0.117	0.0037	99.6830	1
Dicrotendipes simpsoni	I	0.117	0.0037	99.6867	1
Paratendipes subaequalis	I	0.117	0.0037	99.6905	1
Stenochironomus sp.	I	0.117	0.0037	99.6942	1
Ancyronyx variegatus	I	0.117	0.0037	99.6979	1
Sphaeroma quadridentatum	C	0.109	0.0035	99.7014	2
Pomatiopsis sp.	M	0.109	0.0035	99.7049	1
Spio pettiboneae	P	0.107	0.0034	99.7083	1
Polymesoda caroliniana	M	0.107	0.0034	99.7117	1
Americamysis almyra	C	0.105	0.0033	99.7150	1

Organism	Taxa	Abundance ($n\ m^{-2}$)	Percent of total	Cumulative percent	# of stations that species occurs
Crassinella lunulata	M	0.104	0.0033	99.7184	2
Parapionosyllis longicirrata	P	0.102	0.0033	99.7216	1
Bowmaniella dissimilis	C	0.102	0.0033	99.7249	1
Alpheus heterochaelis	C	0.102	0.0033	99.7281	1
Trichoptera	I	0.102	0.0033	99.7314	1
Leptoceridae	I	0.102	0.0033	99.7347	1
Kiefferulus sp.	I	0.102	0.0033	99.7379	1
Planorbella campanulata	M	0.102	0.0033	99.7412	1
Cirrophorus lyriformis	P	0.101	0.0032	99.7444	2
Ogyrides limicola	M	0.101	0.0032	99.7476	2
Magelona phyllisae	P	0.098	0.0031	99.7508	1
Lyonsia sp.	M	0.098	0.0031	99.7539	1
Amphiporus	N	0.096	0.0031	99.7569	2
Nassarius trivittatus	M	0.086	0.0028	99.7597	2
Streblosoma hartmanae	P	0.086	0.0028	99.7625	2
Cyathura burbancki	C	0.084	0.0027	99.7651	2
Cnidaria	C	0.084	0.0027	99.7678	2
Scolelepis texana	P	0.082	0.0026	99.7704	1
Rhepoxynius epistomus	C	0.082	0.0026	99.7730	1
Pinnotheridae	C	0.082	0.0026	99.7756	1
Nephtys bucera	P	0.082	0.0026	99.7782	1
Mancocuma stelliferum	C	0.082	0.0026	99.7808	1
Armandia agilis	P	0.082	0.0026	99.7835	1
Apoprionospio dayi	P	0.082	0.0026	99.7861	1
Polypedilum convictum	I	0.078	0.0025	99.7886	2
Almyracuma proximoculi	C	0.077	0.0025	99.7910	1
Tanytarsus glabrescens	I	0.077	0.0024	99.7935	1
Chiridotea almyra	C	0.077	0.0024	99.7959	2
Corophium ascherisicium	C	0.075	0.0024	99.7983	3
Tagelus divisus	M	0.071	0.0023	99.8006	1
Veneridae	M	0.070	0.0022	99.8028	1
Upogebia affinis	C	0.070	0.0022	99.8050	1
Ungulinidae	M	0.070	0.0022	99.8073	1
Unciola serrata	C	0.070	0.0022	99.8095	1
Turridae	M	0.070	0.0022	99.8117	1
Syllis sp.	P	0.070	0.0022	99.8140	1
Porcellanidae	C	0.070	0.0022	99.8162	1
Pinnixa	C	0.070	0.0022	99.8184	1
Petrolisthes politus	C	0.070	0.0022	99.8207	1
Pagurus	C	0.070	0.0022	99.8229	1
Nematonereis hebes	P	0.070	0.0022	99.8251	1
Nassariidae	M	0.070	0.0022	99.8274	1
Ischyroceridae	C	0.070	0.0022	99.8296	1
Nuculidae	M	0.070	0.0022	99.8318	1
Pista palmata	M	0.070	0.0022	99.8341	1
Goniada littorea	P	0.070	0.0022	99.8363	1
Fimbriosthenelais minor	P	0.070	0.0022	99.8385	1
Eumida sanguinea	P	0.070	0.0022	99.8408	1

Organism	Taxa	Abundance ($n\ m^{-2}$)	Percent of total	Cumulative percent	# of stations that species occurs
Epitonium sp.	M	0.070	0.0022	99.8430	1
Dorvilleidae	P	0.070	0.0022	99.8452	1
Doridella obscura	M	0.070	0.0022	99.8475	1
Doridella sp.	M	0.070	0.0022	99.8497	1
Diplodonta sp.	M	0.070	0.0022	99.8519	1
Cyclostremiscus pentagonus	M	0.070	0.0022	99.8542	1
Crepidula	M	0.070	0.0022	99.8564	1
Corbula sp.	M	0.070	0.0022	99.8586	1
Columbellidae	M	0.070	0.0022	99.8609	1
Chione cancellata	M	0.070	0.0022	99.8631	1
Carazziella hobsonae	P	0.070	0.0022	99.8653	1
Caprella scaura	C	0.070	0.0022	99.8676	1
Brania clavata	P	0.070	0.0022	99.8698	1
Stylochus ellipticus	PL	0.070	0.0022	99.8720	2
Dosinia discus	M	0.069	0.0022	99.8742	1
Arcidae	M	0.069	0.0022	99.8764	1
Gilvossius setimanus	C	0.068	0.0022	99.8786	1
Pseudeusythoe ambrigua	P	0.068	0.0022	99.8808	1
Ostrea equestri	M	0.068	0.0022	99.8830	1
Epidiopatra hupferiana	P	0.068	0.0022	99.8851	1
Lumbrineris tenuis	P	0.068	0.0022	99.8873	1
Eupleura caudata	M	0.068	0.0022	99.8895	1
Cura foremanii	PL	0.068	0.0022	99.8916	1
Seila adamsi	M	0.067	0.0021	99.8938	2
Bowmaniella brasiliensis	C	0.066	0.0021	99.8959	1
Sigambra bassi	P	0.066	0.0021	99.8980	1
Prionospio cirrobranchiata	P	0.065	0.0021	99.9001	1
Acteocina candei	M	0.065	0.0021	99.9021	1
Mactra fragilis	M	0.065	0.0021	99.9042	1
Leucozonia sp.	M	0.065	0.0021	99.9063	1
Corixidae	I	0.063	0.0020	99.9083	1
Pisidiidae	M	0.063	0.0020	99.9103	1
Rheotanytarsus	I	0.063	0.0020	99.9123	1
Larsia sp.	I	0.063	0.0020	99.9143	1
Dero pectinata	O	0.063	0.0020	99.9163	1
Hydroptila sp.	I	0.063	0.0020	99.9183	1
Littoridinops tenuipes	M	0.063	0.0020	99.9204	1
Turbellaria	PL	0.054	0.0017	99.9221	1
Lucifer faxoni	C	0.053	0.0017	99.9238	2
Hemipodus borealis	P	0.051	0.0016	99.9254	2
Callibaetis floridanus	I	0.051	0.0016	99.9270	1
Tanypus neopunctipennis	I	0.051	0.0016	99.9287	1
Peloscolex ferox	O	0.051	0.0016	99.9303	1
Orthocladius sp.	I	0.051	0.0016	99.9319	1
Taphromysis bowmani	C	0.051	0.0016	99.9336	1
Tanytarsus sp t epler	I	0.051	0.0016	99.9352	1
Procladius bellus	I	0.051	0.0016	99.9368	1
Pinnixa chaetopterana	C	0.050	0.0016	99.9384	2

Organism	Taxa	Abundance ($n\ m^{-2}$)	Percent of total	Cumulative percent	# of stations that species occurs
Scolelepis squamata	P	0.049	0.0016	99.9400	1
Malmgrenia sp.	P	0.049	0.0016	99.9416	1
Amphiuridae	OP	0.049	0.0016	99.9431	1
Physella hendersoni	M	0.043	0.0014	99.9445	2
Alpheus viridari	C	0.037	0.0012	99.9457	1
Polypedilum tritum	I	0.037	0.0012	99.9469	1
Polycladida	PL	0.037	0.0012	99.9481	1
Brasilomysis	C	0.036	0.0011	99.9492	1
Cyrnellus	I	0.036	0.0011	99.9504	1
Penaeus sp.	I	0.036	0.0011	99.9515	1
Ectopleura crocea	CN	0.034	0.0011	99.9526	1
Callinectes sp.	C	0.034	0.0011	99.9537	1
Sabellaria vulgaris vulgaris	P	0.034	0.0011	99.9548	1
Ophelina cylindricaudata	P	0.034	0.0011	99.9559	1
Tellina tenella	M	0.034	0.0011	99.9569	1
Natica pusilla	M	0.034	0.0011	99.9580	1
Chione sp.	M	0.034	0.0011	99.9591	1
Antinoella sarsi	P	0.034	0.0011	99.9602	1
Acetes americanus carolinae	C	0.034	0.0011	99.9613	1
Orthocladius annectens	I	0.034	0.0011	99.9624	1
Aphylla williamsoni	I	0.034	0.0011	99.9635	1
Psectrocladius sp.	I	0.034	0.0011	99.9646	1
Parachironomus schneideri	I	0.034	0.0011	99.9656	1
Chironomus stigmaterus	I	0.034	0.0011	99.9667	1
Cirratulus grandis	P	0.034	0.0011	99.9678	1
Streptosyllis arenae	P	0.033	0.0010	99.9689	1
Ophiuridae	OP	0.033	0.0010	99.9699	1
Ophiomyxidae	OP	0.033	0.0010	99.9709	1
Glycera sphyrabrancha	P	0.033	0.0010	99.9720	1
Acanthohaustorius millsi	C	0.033	0.0010	99.9730	1
Tellina laevigata	M	0.033	0.0010	99.9741	1
Tellina alternata	M	0.033	0.0010	99.9751	1
Sigambra sp.	P	0.033	0.0010	99.9762	1
Polydora websteri	P	0.033	0.0010	99.9772	1
Mercenaria campechiensis	M	0.033	0.0010	99.9782	1
Thoracica	C	0.033	0.0010	99.9793	1
Armandia sp.	P	0.033	0.0010	99.9803	1
Bowmaniella sp.	C	0.033	0.0010	99.9814	1
Semelidae	M	0.033	0.0010	99.9824	1
Ischnura sp.	I	0.026	0.0008	99.9832	1
Coleoptera	I	0.026	0.0008	99.9840	1
Chironomus staegeri	I	0.026	0.0008	99.9849	1
Chiridotea sp.	C	0.025	0.0008	99.9857	1
Palaemonetes paludosus	C	0.021	0.0007	99.9863	1
Neanthes sp.	P	0.019	0.0006	99.9869	1
Callinectes ornatus	C	0.019	0.0006	99.9875	1
Conchapelopia	I	0.018	0.0006	99.9881	1
Pisidium sp.	M	0.018	0.0006	99.9886	1

Organism	Taxa	Abundance ($n\ m^{-2}$)	Percent of total	Cumulative percent	# of stations that species occurs
Pagastiella sp.	I	0.017	0.0005	99.9892	1
Dicrotendipes	I	0.017	0.0005	99.9897	1
Cryptochironomus blarina	I	0.017	0.0005	99.9903	1
Tellina sybaritica	M	0.016	0.0005	99.9908	1
Tanaidacea	C	0.016	0.0005	99.9913	1
Apoprionospio pygmaea	P	0.016	0.0005	99.9919	1
Cucumaria pulcherrima	HO	0.016	0.0005	99.9924	1
Anachis obesa	M	0.016	0.0005	99.9929	1
Squilla empusa	C	0.016	0.0005	99.9934	1
Orbinia riseri	P	0.016	0.0005	99.9939	1
Leptochelia dubia	C	0.016	0.0005	99.9945	1
Pteriidae	M	0.016	0.0005	99.9950	1
Plumulariidae	CN	0.016	0.0005	99.9955	1
Genetyllis castanea	P	0.016	0.0005	99.9960	1
Ensis minor	M	0.016	0.0005	99.9966	1
Cliona celata	PO	0.016	0.0005	99.9971	1
Metapenaeopsis goodei	C	0.016	0.0005	99.9976	1
Tubulariidae	CN	0.016	0.0005	99.9981	1
Platyhelminthes	PL	0.015	0.0005	99.9986	1
Chiridotea stenops	C	0.012	0.0004	99.9990	1
Ampelisca verrilli	C	0.010	0.0003	99.9993	1
Parahesione luteola	P	0.008	0.0002	99.9996	1
Piscicolidae	HI	0.008	0.0002	99.9998	1
Tetrastemma elegans	N	0.005	0.0002	100.0000	1
Total		3134.624	100.0000		17