ASSESSING THE IMPACTS OF FLOATING DOCKS ON BOTTOM CHARACTER AND BENTHIC PRODUCTIVITY IN COASTAL GEORGIA

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Executive Summary

As part of a broad examination of the impact of private recreational docks on salt marsh habitat and productivity, we investigated the impacts of some structures associated with fixed docks (i.e., floating docks that rest on the bottom at low tide). These bottom-impacting structures are commonly found in the southeastern US, particularly in coastal Georgia and South Carolina, because of the high tidal range in the region (3 m at spring tide), the strong demand for water access and generous allowances for structure in the marsh to accommodate this desire. This examination is necessary because much of the understanding of impacts attributed to floating docks is based on research carried out in the Northeastern US where estuarine conditions differ significantly from those in our region.

The data from this preliminary study document that there are quantifiable effects on the benthic environment because of the presence of floating docks, which result in statistically significant changes in either benthic algal production (as measured by chl *a*), grain size, organic carbon or benthic macrofaunal distributions. One impact, the decrease in benthic algal production, is a simple, direct outcome of the structure's presence over the substrate. Other secondary impacts are a more complicated result of the interaction between the dock's structural elements and other physical forces in the environment (i.e., tidal flow). These secondary impacts do not appear to be statistically associated with the whole floating structure given our present dataset. The docks examined consisted of smaller, individual floats supporting a wooden platform. The impacts are observed at a statistically significant level in the open spaces between the floats and not in the areas directly under the small floats that support the floating platform. Flow acceleration, and the associated additional erosion and removal of finer, organic-rich materials between the smaller floats is a reasonable explanation for this observation. Thus, the

mechanism responsible for most impacts appears to be different than those suggested from work in the Northeastern US (i.e., wind-induced dock oscillation causing sediment resuspension or current removal of the organic-rich, fine-grained sediments stuck to the bottom of the dock).

The most obvious and direct effect of floating docks on benthic productivity is the loss of benthic diatom production (as measured by chl *a*) associated with dock shading of the substrate. Based on our data, total chl *a* content is decreased 57-73% under the floating dock. Because this impact results from shading of the substrate at all times under the dock, this impact would be felt under the complete footprint of the dock no matter the design of the dock (i.e., whether single or multiple floats support the dock).

Substrate sediment character and chemistry exhibit significant differences between the under-dock and control samples, with coarser sediments and lower organic carbon/nitrogen values observed under the docks. Where strong tidal flow is common, a flow-parallel, initial downstream fining and subsequent coarsening in grain size was observed, suggesting that bottom-impacting structures have greater effects on the benthic environment in regions where tidal velocities are more pronounced. Porosity profiles from dock and control cores suggests that the weight of the floats affects the density of at least the upper 1-2 centimeters of the seabed.

Biological data for macrofauna show that there are greater numbers of organisms and higher biomass by an order or magnitude in control sites when compared to float sites. The macrofaunal community was dominated by polychaete worms. Details of the macrofaunal distribution suggests that a predator-prey relationship may be structuring a portion of the polychaete community in our study.

In contrast, when comparing the effects of floats resting on the bottom at low tide on meiofauna, there are no obvious trends and it remains unclear if meiofauna are affected by this disturbance. In our study, the control sites had higher meiofaunal abundance and the under-dock samples lower abundance, although the differences were not statistically significant. Patchy distributions, rapid recruitment and reproductive response to disturbance of the substrate by currents and dock structures are all reasonable explanations for this lack of correlation. Meiofaunal communities in this study were dominated by nematodes, which made up 92% of the total organisms collected. Calculated meiofaunal biomass (0.16 g/m^2) is similar in magnitude to the macrofaunal biomass found in control areas in this study (0.18-0.23 g/m^2), highlighting the importance of meiofaunal as well as macrofaunal food resources in estuarine sediments. The distribution of these meiofaunal resources are apparently not significantly affected by dock groundings, in contrast to macrofaunal resources.

As with any biological system, the estuarine setting is complicated and requires large sample numbers, multiple replicates and repeated sampling to tease out the underlying relationships within the natural variability. Because the results presented here are based on a small number of sites, with similar types of dock construction, there need to be additional studies which examine a broader suite of samples from a greater diversity of study sites, with a more comprehensive biological sampling strategy and with greater replication among and between sites.

The three docks examined were all constructed using smaller floats under a larger wooden platform. It may be that the dominant zone of influence of a floating dock is at the interface between the float and the surrounding water (as suggested by the significant differences observed between control and interfloat sites in this study). Georgia's swift currents associated with a high tidal range may intensify the impact of floats when near the bottom. Comparative studies that examine the differences in the impacts associated with floating docks constructed on one large float and those constructed of numerous small floats could be profitably carried out to resolve what, if any, particular type of float minimizes the impact to the environment.

Combining results from a recent study of dock shading impacts on Spartina vegetation (Alexander and Robinson 2006) with results from this study characterizes the negative impact of dock and float shading on the saltmarsh ecosystem. Walkways shade the marsh, reducing biomass and carbon input by 21-37%. Adding a floating dock that rests on the bottom at low tide to the end of that walkway increases the impact of the structure by reducing the benthic algal production under the float by 57-73%. In addition, the terminal platform of the dock will shade the intertidal, non-vegetated mud-flat where benthic algae photosynthesize at lower stages of the tide, although the magnitude of the decrease from such high-standing structures was not quantified in this study and is expected to be less significant. When assessing impact to the ecosystem from docks and associated structures, both the decrease in carbon from the walkway and floating structures should be taken into account cumulatively.

1. Introduction

As part of a broad examination of the impact of private recreational docks on salt marsh habitat and productivity, we investigated the impacts of some structures associated with fixed docks (i.e., floating docks that rest on the bottom at low tide). These bottom-impacting structures are commonly found in the southeastern US, particularly in coastal Georgia and South Carolina, because of the high tidal range in the region (3 m at spring tide), the strong demand for water access and generous allowances for structure in the marsh to accommodate this desire. This study is the first to examine the impacts of these structures on benthic habitats and benthic primary productivity in the Southeastern US. This examination is necessary because much of the understanding of impacts attributed to floating docks is based on research carried out in the Northeastern US where estuarine conditions differ significantly from those in our region (Kelty and Bliven, 2003).

Several potential direct effects have been proposed for these structures, each of which will be described in the following section:

1) shading of substrate and reduction of benthic algal production;

2) altered grain size and organic matter content of under-float sediments;

3) altered substrate physical properties; and

4) increased turbidity in surrounding waters.

Dock structures in general, and floating docks specifically because of their proximity to the substrate, directly shade the substrate and suppress benthic algal primary productivity. Benthic algae produce base-of-food-chain primary productivity for higher trophic levels on intertidal mudflats within the marsh in addition to, but to a lesser extent than, the ubiquitous saltmarsh grasses (Pomeroy, 1959; Leach, 1970; Van Raalte et al., 1976; Cadée and Hegeman, 1974; Colijn and De Jorge, 1984; Fielding et al., 1988; Sullivan and Moncreiff, 1988; MacIntyre and Cullen, 1996; Underwood and Kromkamp, 1999; Webster et al., 2002). Given that some floats sit on the bottom for much of the tidal cycle, this productivity is diminished and cumulatively this effect may be important. Research from the Northeastern US suggests that bottom-resting floats may also compact the channel bottom sediments, potentially making the substrate more dense and less suitable to benthic macrofauna, thus reducing the food supply to animals that prey upon these infauna (M. Ludwig, pers. comm., 2003). In addition, the organic-rich, muddy sediments deposited during each slack high tide may adhere to the float during contact with the bottom on the subsequent low tide. As the tide rises, these sediments would be removed by tidal currents, selectively removing the most organic-rich portions of the sediment column and further decreasing the food available. Further, under the influence of wind-generated waves, floating docks have been suggested to experience high-frequency vertical movements that, when near the bottom, may resuspend and winnow finer-grained material. This winnowing has been hypothesized to coarsen bottom sediments and increase the turbidity in the tidal channel, decreasing light penetration through the water column and further decreasing benthic algal primary productivity (Kelty and Bliven, 2003). All these effects can reduce nutrients that are an important part of or contribute to the diet of many recreational and commercial species that have a juvenile stage within the salt marshes (e.g., penaeid shrimp and finfish).

We assessed these aspects of floating dock impacts by quantifying sediment grain size and porosity, chlorophyll *a* (to determine diatom abundance) and benthic infaunal abundance (both in the macrofaunal and meiofaunal communities) to infer the physical and biological parameters associated with floating docks at sites under, adjacent to and removed from end member configurations of dock structures. We did not attempt to assess float-induced variations in turbidity given the already highly turbid nature of estuarine waters of the southeastern US.

2. Study Locations

In the first year of our study (2004), we chose two community docks at locations that are significantly different to examine these parameters (Fig. 1).

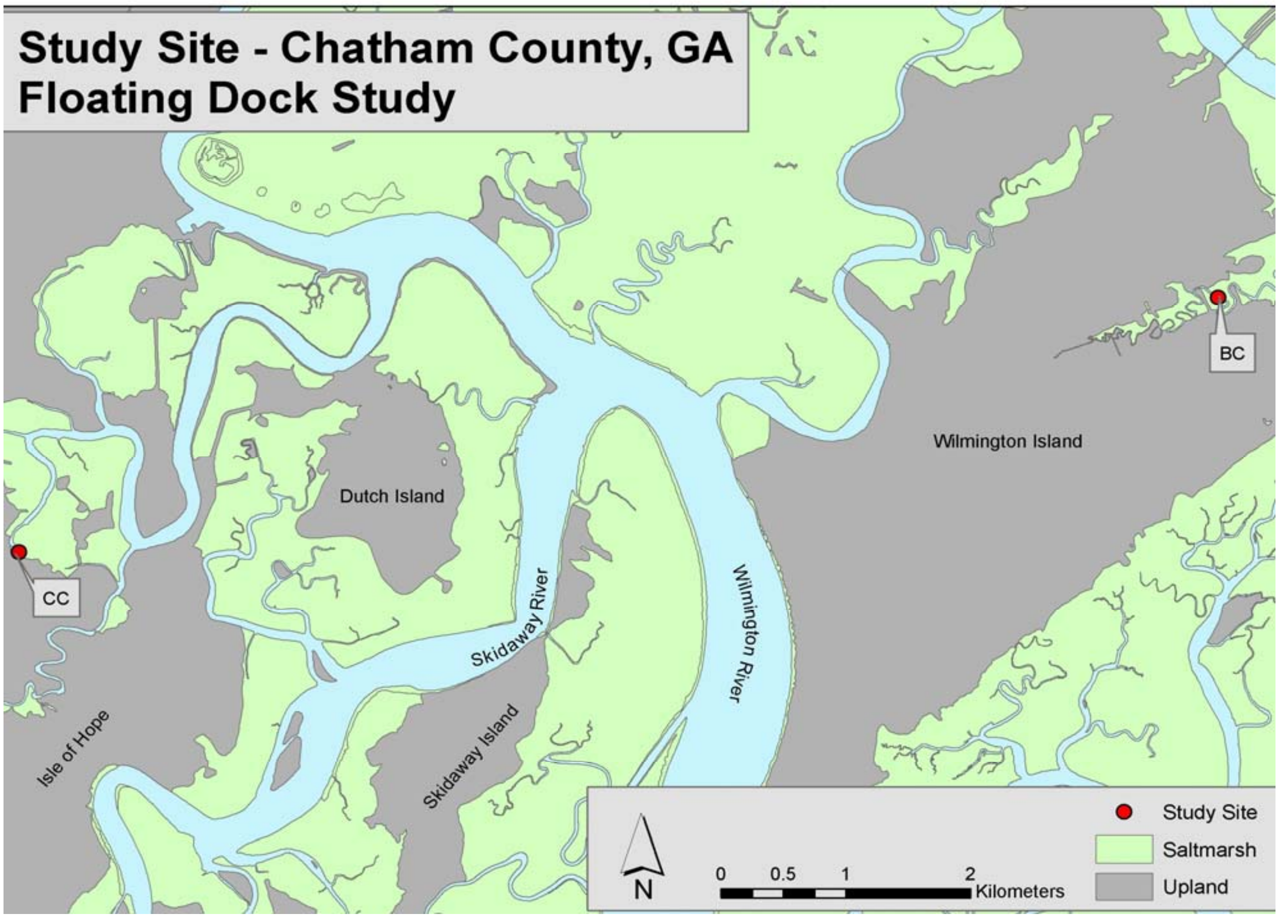

Figure 1. Map of study areas in Chatham County. Study location ChC in Beaufort, SC, is not shown.

The first location, which has low physical energy, very fine-grained sediments and where the tide rises and falls with relatively little current velocity near the dock, is a community dock on the Herb River (Location CC) near Isle of Hope (Fig. 2).

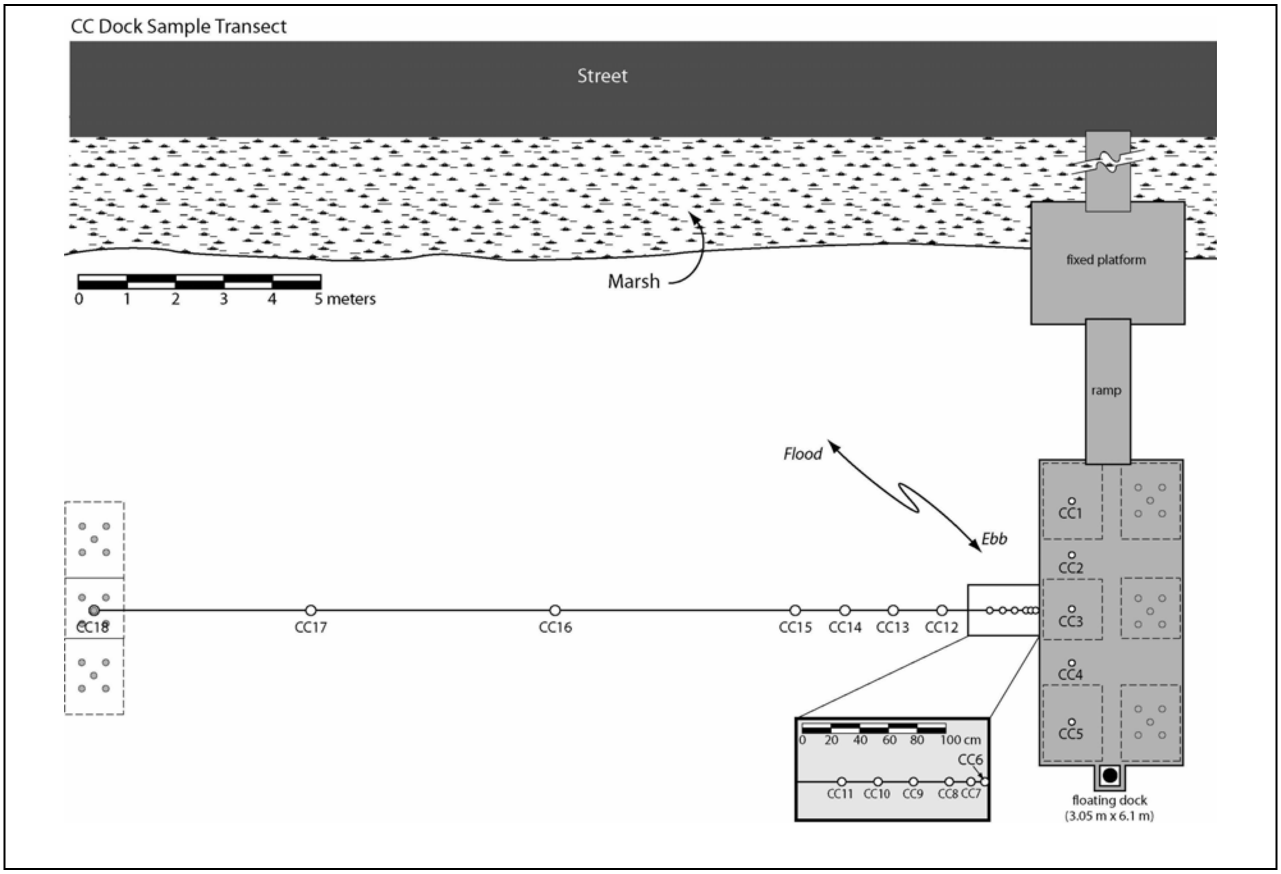

Figure 2. Study site CC. Note the six smaller floats comprising the larger floating dock, the transect orientation and control sites for the float macrofaunal samples at the and of the transect. Open circles: grain size, *chl a* and organic carbon/nitrogen samples. Closed circles: macrofaunal sample sites. Station names correspond to sites in Tables 1-4, 8-10.

Because of the low physical energy at this location, fine sediment is rapidly accumulating at rates of approximately 1 cm/year (Alexander, unpublished data). The second location, a community dock on Betz Creek (Location BC), has strong, ebb-dominant, along-channel tidal currents and a sediment composed of subequal quantities of sand and mud (Fig. 3).

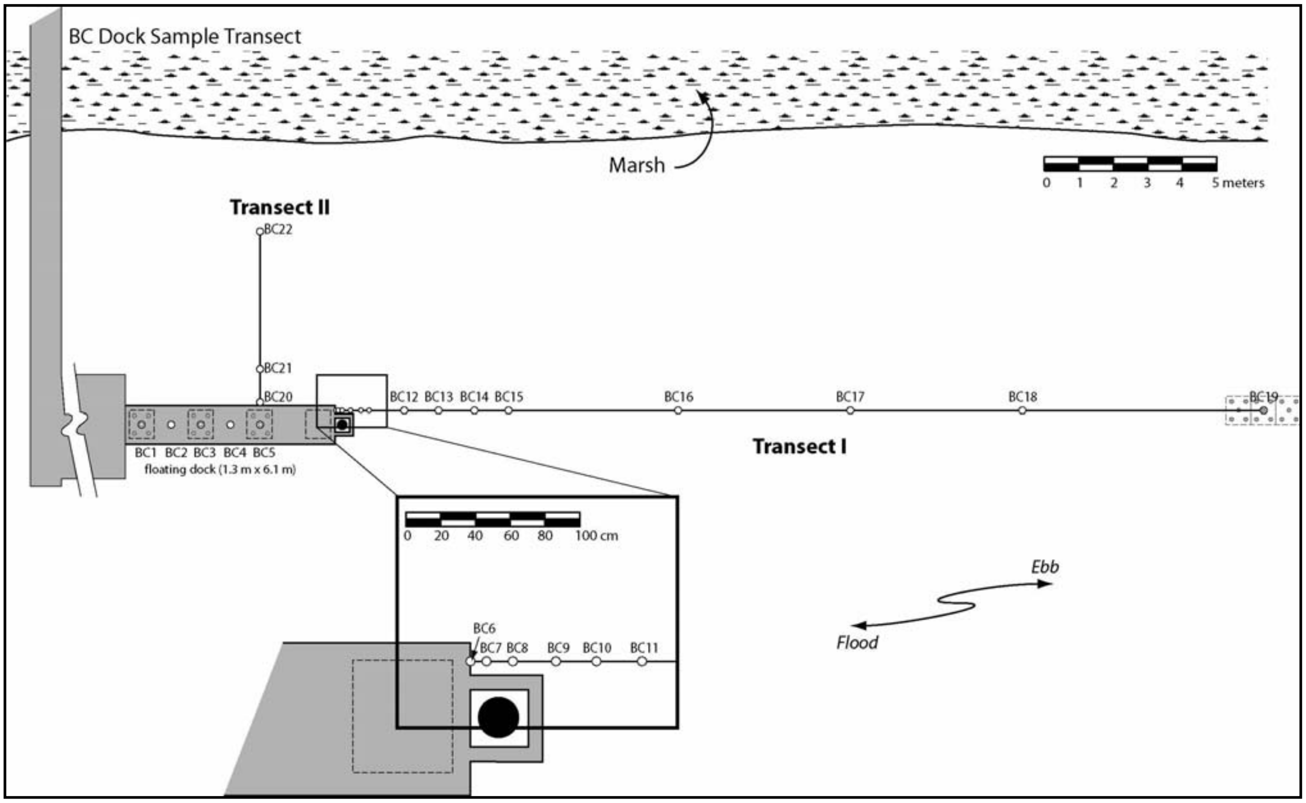

Figure 3. Study Location BC. Note that the narrow floating dock is only comprised of four floats, the two transect orientations and control sites for the float macrofaunal samples at the end of the transect. Open circles: grain size, *chl a* and organic carbon/nitrogen samples. Closed circles: macrofaunal sample sites. Station names correspond to sites in Tables 1-4, 8-10.

At both locations, the floating docks rest on the bottom at low tide, and the docks are comprised of smaller, rectangular floats supporting the main wooden dock platform. The Location CC platform is supported by smaller floats in a 3 x 2 configuration with the gaps between the floats oriented subparallel to tidal flow in a grid pattern; the Betz Creek dock is half as wide as the Herb River dock and consists of a single row of four floats with the gaps between the floats perpendicular to the direction of tidal flow. The first field season in 2004 included large-scale surveys of chlorophyll *a*, grain size, organic carbon/nitrogen under three smaller floats (float samples), between these floats (interfloat samples) and along a transect (transect samples) extending 19.5 m and 27 m away from the docks at Location CC and Location BC, respectively. The terminal stations of the transects were used as control sites (control samples) for the macrofaunal studies. At both sites, we collected a short (~30 cm) core for porosity (a measure of water content) measurements at the end of the major transect. At Location BC, we collected a second short transect from the dock oriented perpendicular to the flow direction that was not influenced as strongly by the presence of the floating dock. Benthic macrofauna were collected from float sites and at control sites (Figs. 2, 3).

From our first year's study of the two community docks, we found that grain size was strongly correlated to organic carbon/nitrogen content, indicating the need for an additional study location to represent sand-dominant environments. Consequently, for our second field season in 2005 we added an end-member location in Bluffton, SC (Location ChC), where the sediments are dominated by sand-sized material. The floating dock design was similar to that of Location CC, with a 3 x 2 configuration of smaller floats supporting a wooden platform, although oriented perpendicular to the dominant flow direction (Fig. 4).

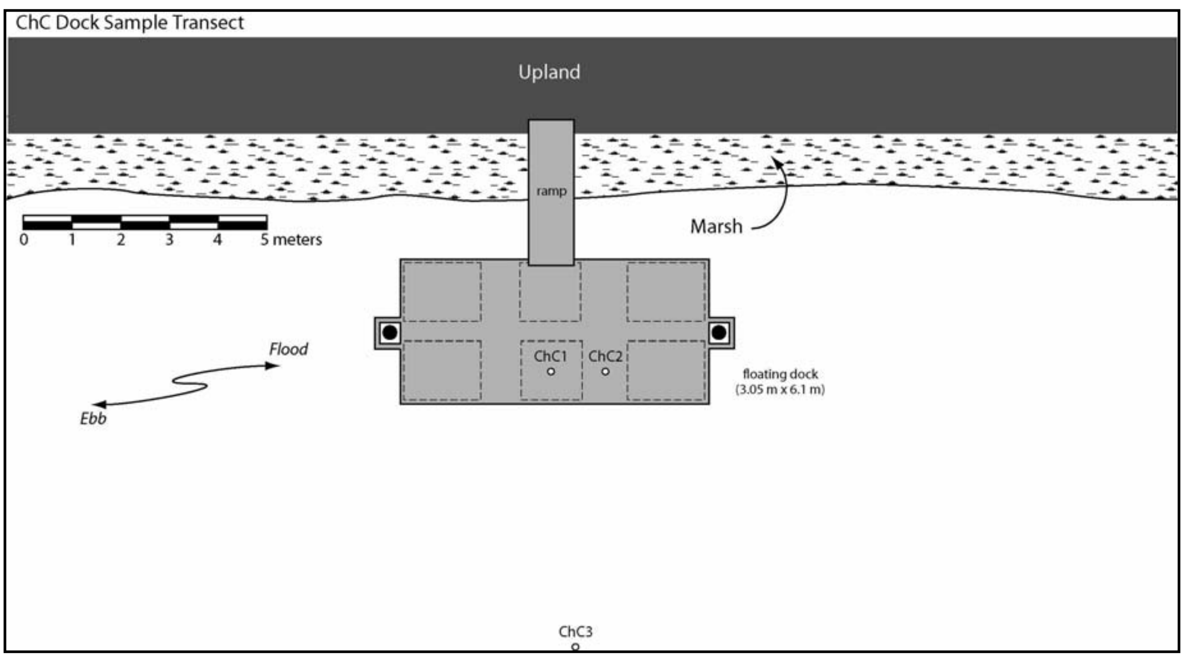

Figure 4. Sampling Location ChC. This dock, similar in design to Location CC, was added in the second year of sampling, after the fieldwork during which transect data were collected or *chl a*. Open circles: grain size, organic carbon/nitrogen and meiofauna samples. Station names correspond to sites in Tables 1-4, 8-10.

At each location in 2005, we examined grain size, organic carbon/nitrogen and benthic meiofaunal abundance to assess the relationship between these parameters. In addition, because we were examining meiofauna, which have rapid reproductive rates and high variability in recruitment, we investigated meiofaunal abundances on a monthly basis by sampling in May, June and July. Further, we attempted to assess the impact of individual dock groundings on meiofauna, organic carbon/nitrogen content and grain size by sampling prior to and after low tide (called before and after samples in subsequent data tables), although a complete, three month set of these samples was ultimately collected only at the ChC study location.

3. Methods

Samples for this study were collected by hand approximately one hour prior to dock grounding at Locations CC and BC in 2004. Samples at all three locations in 2005 were collected within an hour of dock grounding and subsequent refloating by the returning tide (Tables 1-4). Grain size samples (representing the upper 2 cm of the sediment column) were collected in whirl-pak plastic bags. Porosity cores were collected in PVC core barrels (50-cm long, 10-cm diameter), extruded and subsampled at 1-cm intervals. Organic carbon/nitrogen samples (representing the upper 5.0 mm of the sediment column) were collected in clean, pre-combusted glass vials and were kept frozen until analyzed. Chlorophyll *a* samples (representing the upper 2.5 mm of the sediment column to assure that all diatoms present were captured) were collected in pre-cleaned vials and were extracted and analyzed within two weeks to prevent loss of signal. Macrofaunal samples were collected in polybutyrate core tubes 5 cm in diameter to a depth of 10 cm. For macrofauna, five replicate cores were taken under each of three adjacent floats and at three similarly spaced areas in the control site at the end of each transect (Fig. 2 ,3). Meiofauna samples were collected with 5 cc (1.2-cm diameter) syringes to a depth of 3 cm.

Based on our results from year 1, we found that the number of macrofauna was not statistically different under the smaller, individual dock floats at any one location (see Results and Discussion) and therefore meiofauna were only collected from under one float, in the interfloat area between the sampled float and the adjacent float, and at a control site 5 m away from the dock (Tables 5-7, Figs. 2-4). Salinity was determined with a refractometer and temperature of the water at each study site was determined using a hand-held, laboratory thermometer (Tables 8-10).

The grain size, porosity, chlorophyll *a* and organic carbon/nitrogen analyses were carried out at the Skidaway Institute of Oceanography. Grain size was measured using 0.25-phi interval sieves for the sand fraction and a Sedigraph 5100ET for the silt and clay fraction; porosity was measured by water loss and corrected for variations in salinity (Alexander et al., 1986). Chlorophyll *a* was measured with a Turner 10AU spectrophotometer using a technique, modified for sediments, following Parsons et al. (1984). The organic carbon/nitrogen content was quantified using a Carlo-Erba CHNS analyzer. Organic carbon was determined in samples that had been acidified to remove inorganic carbon (i.e., carbonate). Nitrogen was determined on unacidified samples, as acidification is known to remove some fraction of the nitrogen, depending on sediment matrix.

For our study locations, acidification removed approximately 14% of the total nitrogen (Fig. 5). All faunal samples were sieved, preserved in formalin, stained with rose Bengal and identified to major taxa. The benthic macrofaunal samples were wet sieved at 500 um. Sample analysis was carried out on the greater than 500-um fraction of the biota using dissecting microscopes under the direction of Dr. Dionne Hoskins at Savannah State University. The benthic meiofaunal samples were wet sieved through a 500 um sieve onto a 63 um sieve.

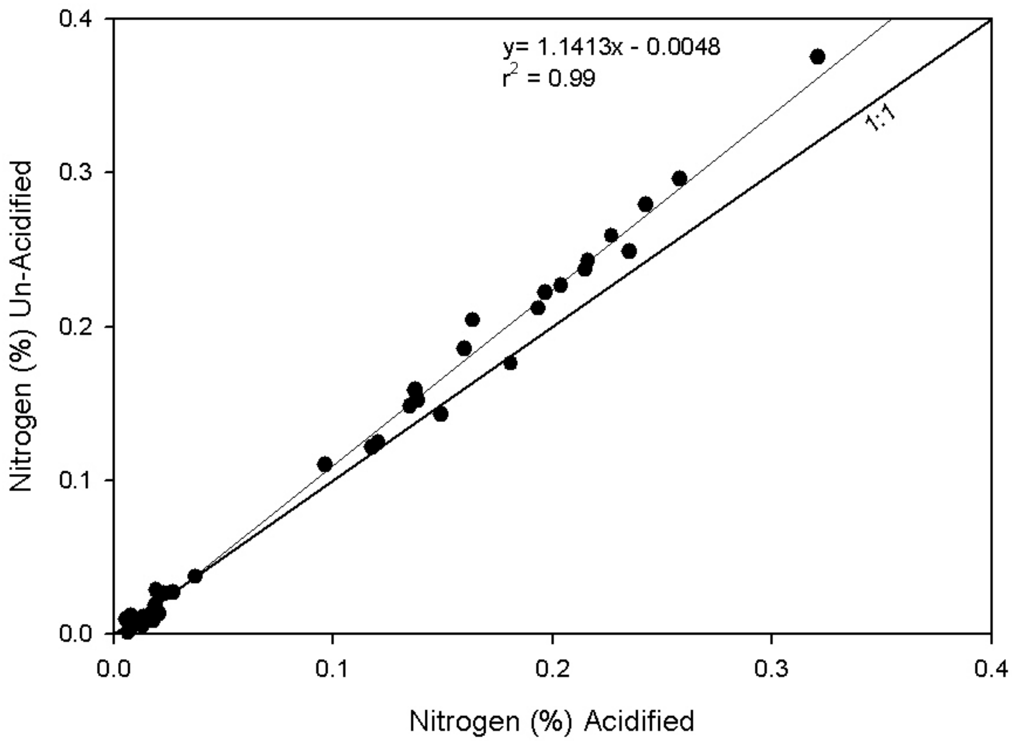

Figure 5. Nitrogen values from acidified versus non-acidified sediment samples from CC, BC and ChC. Note that the regression line falls above the 1:1 line, indicating that unacidified samples yield more nitrogen and indicating loss of nitrogen during the acidification process. The regression slope suggests a nitrogen loss of 14%.

Sample analysis was carried out on the 500 to 63 um fraction of the biota using binocular microscopes under the direction of Dr. Carla Curran at Savannah State University.

Grain size in this study is presented in Φ(phi) units, a size scale commonly used by geologists to efficiently handle the extremely wide range of sizes with which they must deal. Phi sizes are converted using the following formulas:

$$\textbf{size in } \Phi \textbf{ units} = \textbf{log}_2\textbf{(size in mm)} \text{ and thus } \textbf{size in mm} = \textbf{2}^{-(\text{size in } \Phi)}$$

Statistics were calculated using Sigmastat 3.1 by Systat Software, Inc. Means were compared using Student T-tests with significance determined at the 95% confidence level.

4. Results

4.1 Grain size and porosity

The mean grain size data from the three study locations show a range from fine sand to clay (Tables 1-4). The main components of the sediment samples (i.e., percent sand, silt and clay) are dominated by clay and sand sized particles, which make up to as much as 97% of an individual sample. There is a notable paucity of silt, which makes up an average of 14.6% and a maximum of 22% of any individual sample (Fig. 6).

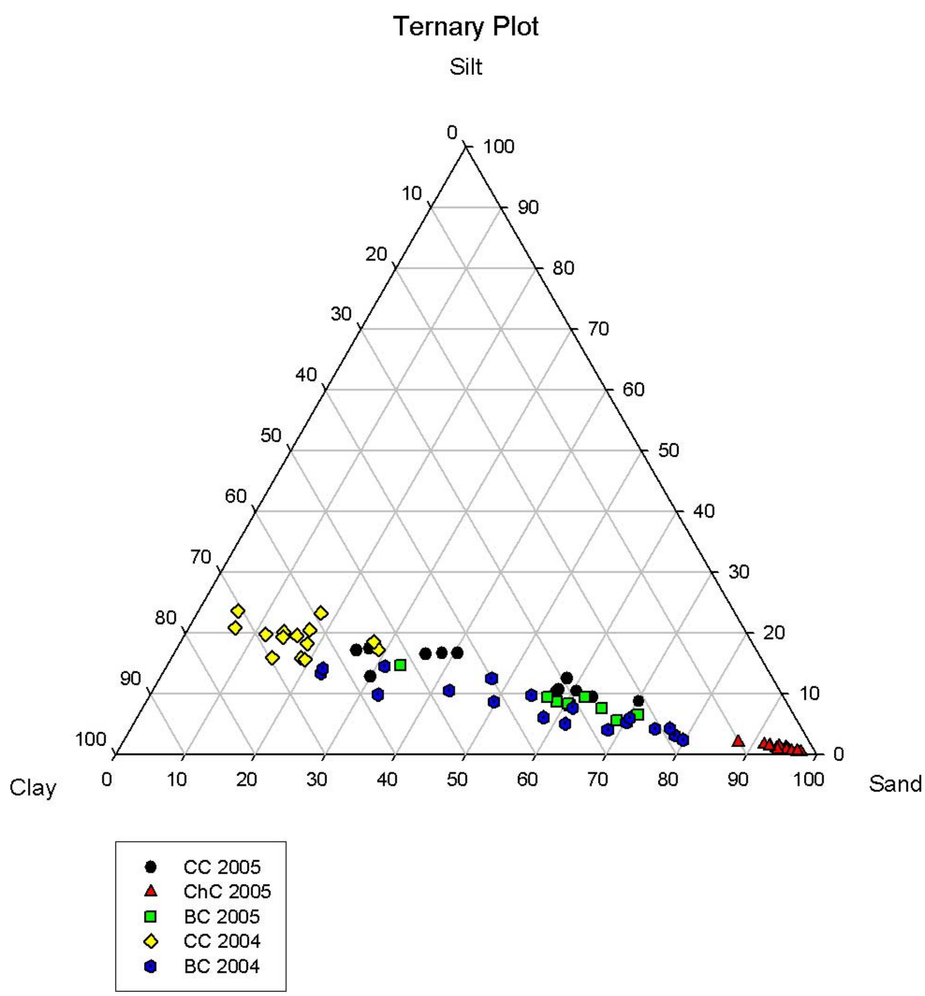

Figure 6. Ternary diagram showing the relative proportions of sand, silt and clay in the study location sediments. Note that the finest (most clay-rich) samples are from location CC whereas the coarsest are from location ChC and the relative lack of silt in all samples.

Location CC is the most muddy of our study areas, although there seems to be significant annual variability in the relative proportions of gravel, sand and clay (Table 2). The gravel component present at Location CC is comprised of calcareous fragments derived from the barnacles growing on the bottom of the floats and thus does not represent a sediment fraction brought into the site by physical processes. Comparing the 2004 average mean grain size from all under-dock samples with the average mean grain size along the transect shows that there is not a significant difference in these variables (p = 0.18; Fig. 7).

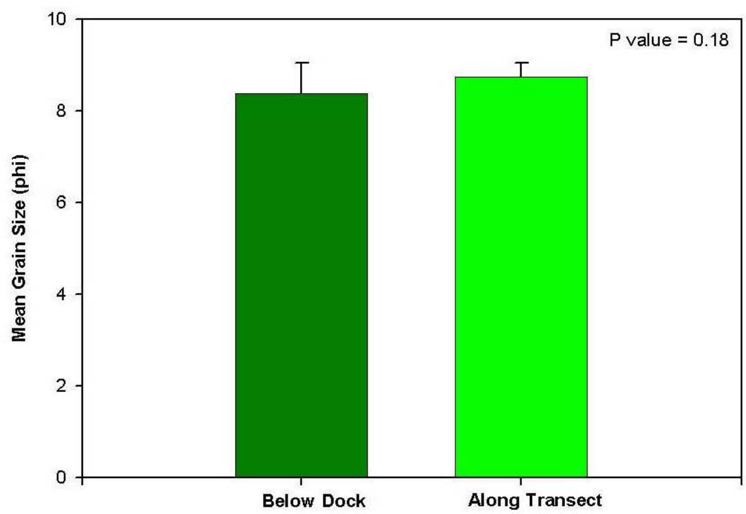

Figure 7. Comparison between mean grain size at under-dock and transect sites in 2004 at Location CC. No significant difference exists between the two sample sites.

The transect data from 2004 show the distribution of mean grain sizes with distance from the floating dock (Fig. 8). In all transects shown in this report, the data points on the left axis are the float and interfloat samples, whereas the transect samples begin at the edge of the wooden platform on the mud, at zero distance on the lower x-axis, and extend out perpendicular to the dock. There is an expansion in the distance axis after approximately 100 cm from the dock. At Location CC, note that the mean sizes are relatively constant and only become slightly finer

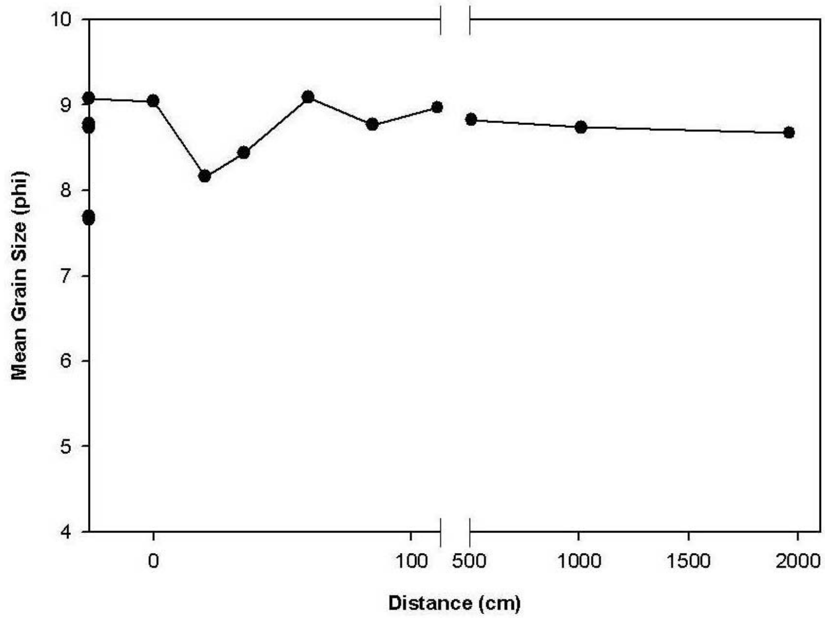

Figure 8. Distribution of mean grain size at under-dock and transect sites in 2004 at Location CC. The data points on the y-axis represent samples from float and interfloat sites, whereas the transect samples begin at 0 cm on the x axis and extend to the right. Note the change in scale after 100 cm on the x axis.

away from the dock. The percentages of sand, silt and clay are relatively uniform along the transect as well (Fig. 9A). If we compare the combined data from 2004 and 2005 in a similar fashion, we do see a significant difference between the under-dock samples and transect/control samples ($p = 0.013$). The source of this difference can be determined using a Kruskal-Wallace one-way ANOVA on ranks, which shows that there is no significant difference between either the float and interfloat samples, or between the float and transect/control samples. The significant difference lies between the interfloat samples and the transect/control samples ($p < 0.05$).

In contrast to Location CC, Location BC contains both sand and clay in subequal amounts and maintains its textural character between study periods (Table 3). Comparing the mean sizes along the two transects with the under dock samples shows that there is not a

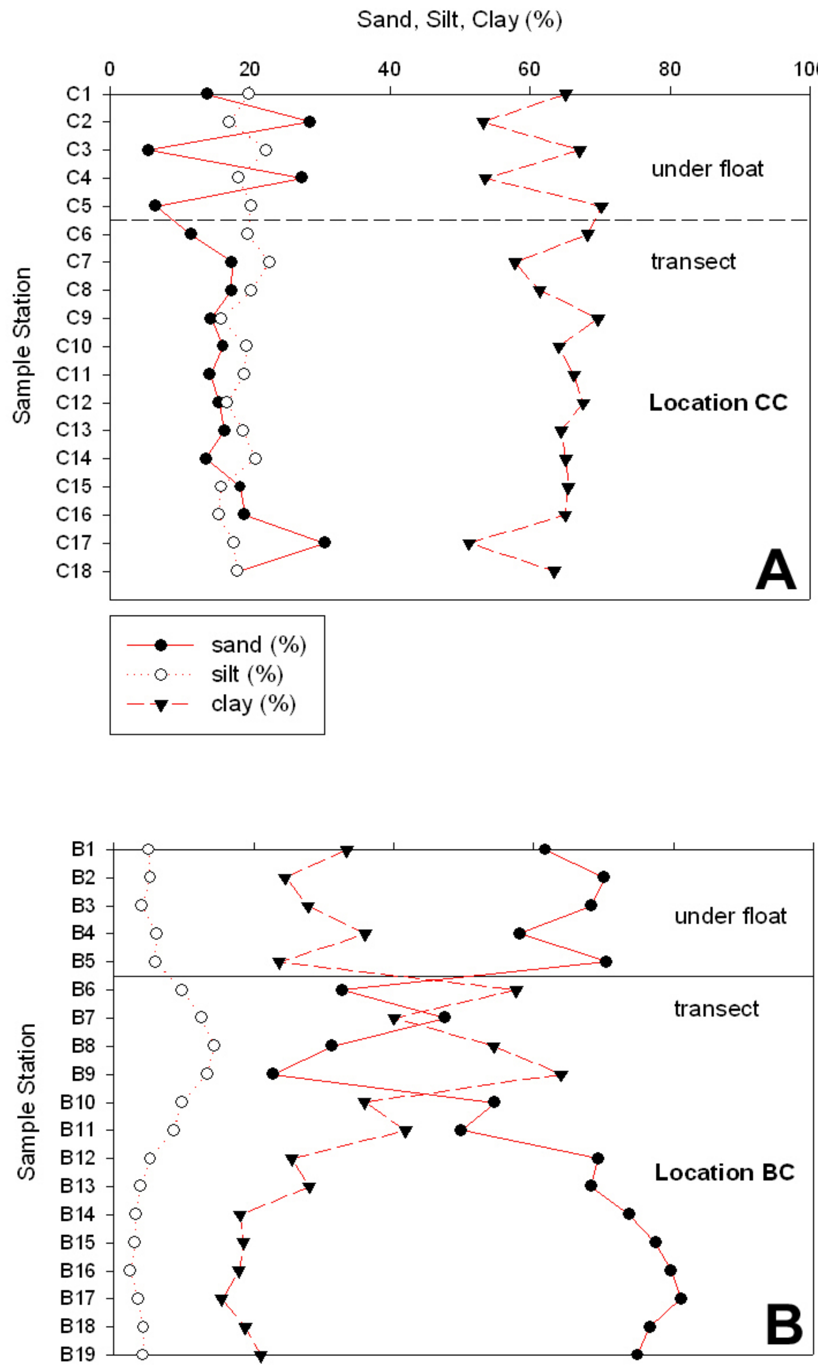

Figure 9. Percentages of sand, silt and clay in under-dock and transect/control sediments. A) Location CC exhibits compositional uniformity. Samples C1-C5 are located under the dock and C6-C18 extend away from the dock along the transect. Sand-rich samples under the dock (C2, C4) are interfloat sites. B) Location BC exhibits strong heterogeneity in textural components. Samples B1-B5 are located under the dock and C6-C18 extend away from the dock along the transect.

significant difference in mean grain size in the along-flow direction (p= 0.40) whereas there is a significant difference perpendicular to flow (p = 0.05) (Fig. 10).

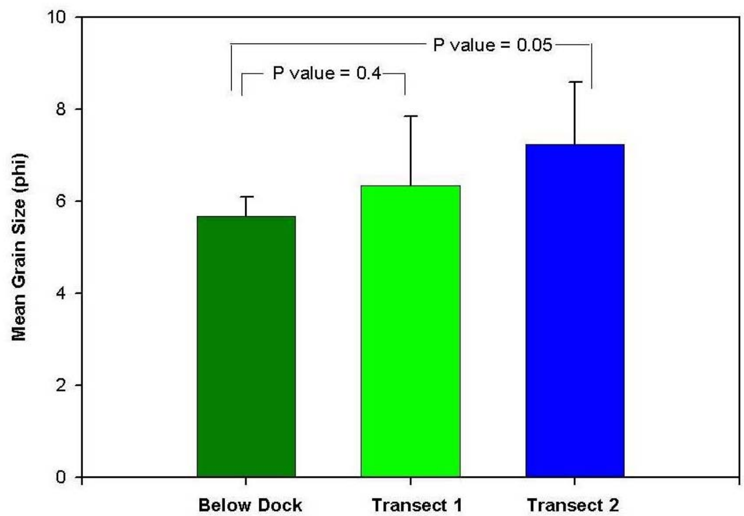

Figure 10. Comparison between mean grain size at under-dock and transect sites in 2004 at Location BC. Transect 1 extends downstream from the dock, parallel to flow and transect 2 extends from the dock perpendicular to flow. No significant difference exists between under-dock sites and transect 1, whereas a significant difference exists between under-dock samples and transect 2.

The 2004 under-dock data show that mean sizes at float and interfloat sites are coarse to medium silts (5.25-6.25 phi). The transect data exhibit a wide range in grain sizes (Fig. 11). In the transect oriented parallel to the current-flow direction, mean sizes from very fine silt to coarse clay (7-8.5 phi) are present from the edge of the wooden platform at zero distance out to about 75 cm distance whereafter sediments are coarser (mean sizes very fine sand to coarse silts; about 4.0-4.5 phi). The second transect, shown in red squares and oriented perpendicular to flow, exhibits similar characteristics, although sediments fine considerably at the end of the transect, near the marsh edge. Statistical testing of the combined 2004 and 2005 mean grain size or individual grain component data with float, interfloat or transect/control sites do not show significant relationships. Note that on the long, flow-parallel transect, the relative proportions of

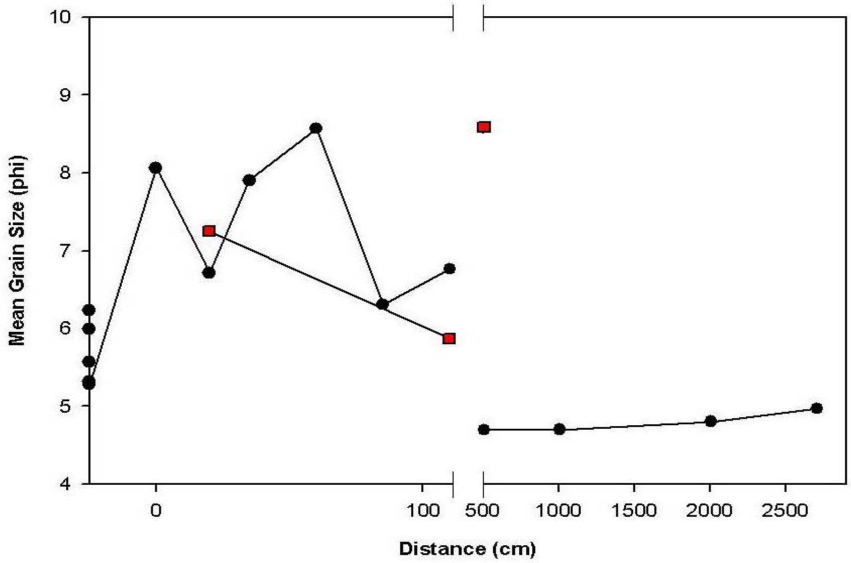

Figure 11. Distribution of mean grain size at under-dock and transect sites in 2004 at Location BC. Under-dock samples are coarser than sediments of both Transect 1 (black dots) and transect 2 (red squares) within a meter of the dock; farther along transect 1, sediments again coarsen. Transect 2 is 500 cm long and ends at the edge of the marsh. See Fig. 8 for explanation of graph.

sand, silt and clay change significantly (Fig. 9B). Sand and clay dominate the under-dock sites, silt and clay increase and sand decreases from the dock edge to about 75 cm along the transect and sand again dominates beyond that point, suggesting a hydrodynamic redistribution of material is occurring at this location.

Location ChC is dominated by sandy particles and contains little silt or clay (Table 4). Grain size data were only collected for Location ChC in 2005 and so transect data is not available. These discrete samples show that mean grain size of sediments at ChC are significantly coarser than at Locations CC or BC (medium sands compared to silts and clays). As at Location CC, mean grain size exhibits a significant difference between under-dock and control sites ($p = 0.007$). Further testing to identify the source of the significance shows that only the mean grain size from the control samples compared to the interfloat samples is significant ($p = 0.008$).

Porosity values are available for cores from float and control sites at locations CC and BC. Location CC sediments exhibit porosities decreasing with depth from 80% to 70% at the float site and from 88% to 60% at the control site (Fig. 12A). Location BC sediments exhibit porosities decreasing with depth from 67% to 55% at the float site and from 73% to 53% at the control site (Fig. 12B).

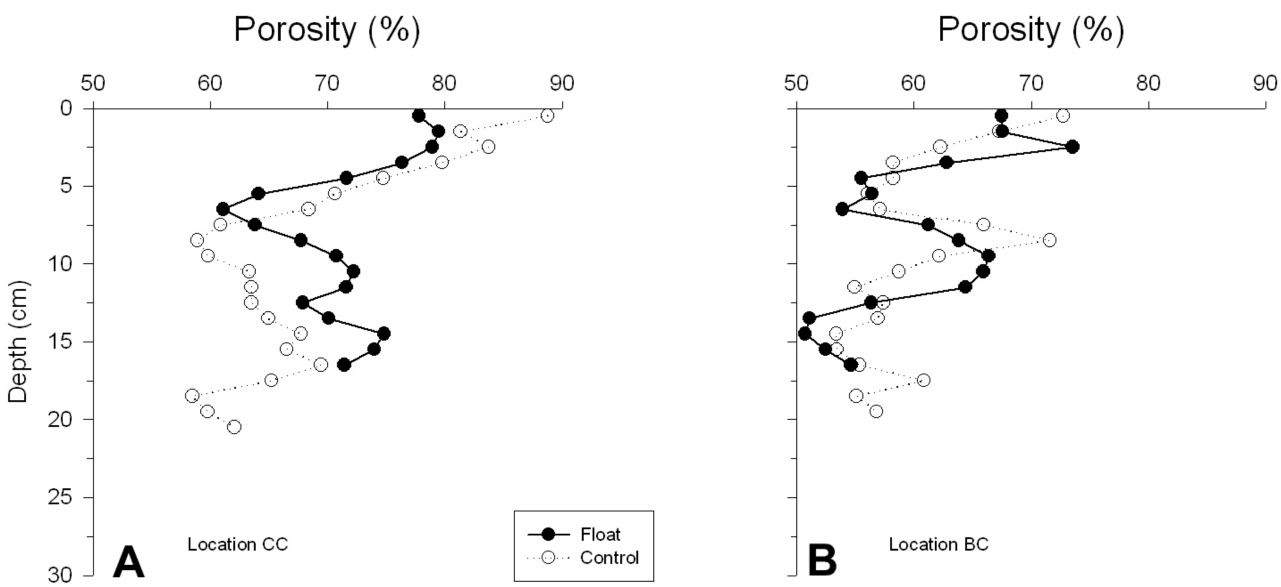

Figure 12. Porosity profiles in cores from Locations CC and BC comparing float and control sites. Note that the porosities are depressed in the upper 1-2 cms in float site cores. A) Location CC, which has fine-grained sediments (<20% sand) exhibits high porosities and an upward (toward 0 depth) shift in the porosity profile variations, suggesting a compaction of the sediment column under the float. B) Location BC, which has coarse-grained sediments (60-80% sand) does not show translocation of the variations in the float porosity profile. See text for discussion.

In both Locations CC and BC, the surface 1-cm interval has lower porosity at the float site when compared to the control site. There is a general similarity in the vertical structure of each pair of profiles from a location, although the profiles from Location CC appear to be offset in a consistent manner.

4.2 Organic carbon and nitrogen

Organic carbon values in the study areas ranged from 0.05 to 3.79 percent organic carbon by dry weight (% OC dw; Tables 1-4). When looking at all the data for both years, there is a good predictive relationship between organic carbon and both mean grain size (Fig. 13, $r^2 = 0.88$) and the individual grain size components (graphs not shown; sand, $r^2 = 0.87$; silt, $r^2 = 0.81$, clay, $r^2 = 0.88$ and mud, $r^2 = 0.88$), allowing the organic carbon content of sediments in our region to be estimated based on a simple textural analysis. Organic nitrogen values ranged from 0.00 to 0.39 % N dw and show a similar predictive relationship with both mean grain size (Fig. 14, $r^2 = 0.88$) and the individual grain size components (graphs not shown; sand, $r^2 = 0.90$; silt, $r^2 = 0.86$,

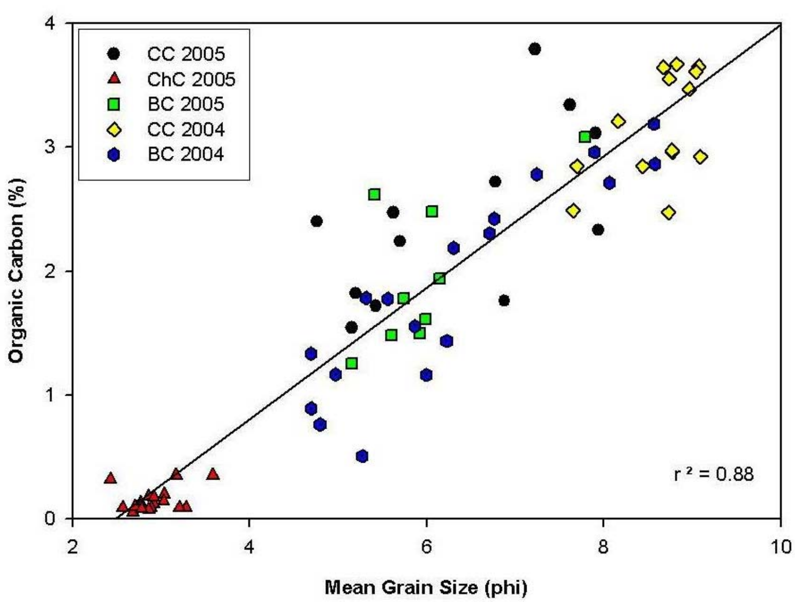

Figure 13. Mean grain size from 2004-2005 exhibits a strong relationship with organic carbon content in sediments from our region. Similar positive relationships between the grain size components (i.e., percent sand, silt, clay and silt+clay) are present, although sand is negatively correlated with organic carbon.

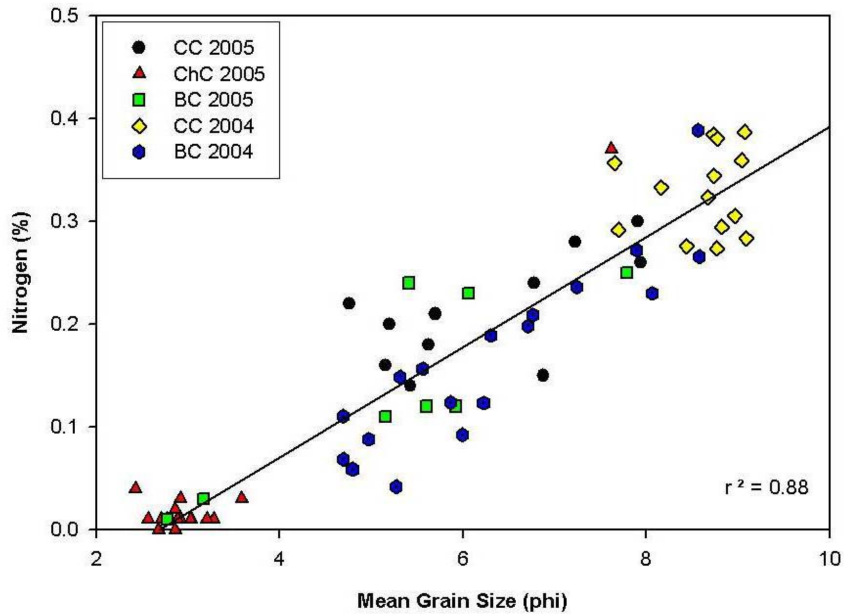

Figure 14. Mean grain size from 2004-2005 exhibits a strong relationship with nitrogen content in sediments from our region. Similar positive relationships between the grain size components (i.e., percent sand, silt, clay and silt+clay) are present, although sand is negatively correlated with nitrogen.

clay, r^2 = 0.89 and mud, r^2 = 0.90), allowing the organic nitrogen content to also be easily estimated. The regression equations for these relationships are given in Appendix A.

Location CC, being the muddiest site in our study, exhibits the highest organic carbon contents, ranging between 1.5 and 3.79 % OC dw (Table 2). There is great heterogeneity along the transect, causing a large standard deviation in the measurements. Thus, from the 2004 data there is no statistically significant difference between the organic carbon content in under-dock sites when compared to the transect/control stations at the 95% confidence level (Fig. 15; p = 0.07). However, as with mean grain size, when we examine the combined organic carbon data together for 2004 and 2005, there is a significant difference between the transect/control and under-dock samples (p = 0.019). Similar to grain size data, the significant difference lies between the transect/control data and interfloat samples (p = 0.015).

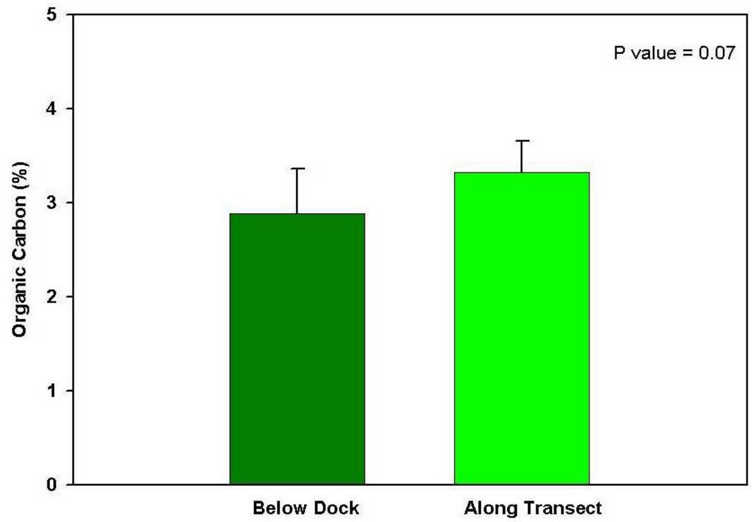

Figure 15. Comparison between organic carbon content at under-dock and transect sites in 2004 at Location CC. No significant difference exists between the two sample sites at the 95% confidence level.

Location BC, because of the large variability in grain size along the transect and the coarser sediments found at the study site, exhibits a greater range of organic carbon contents between 0.51 and 3.08 % OC dw (Table 3). The 2004 values do not show a statistically significant difference between the under-dock versus the transect/control site data (Fig. 16; p = 0.15 for transect 1; p = 0.05 for transect 2). However, as before, when examining the combined 2004 and 2005 data, a significant difference is present between samples from the transect/control site and the under-dock sites (p = 0.022); further testing does not reveal a significant difference between the transect/control data and specific under-dock samples (p = 0.096), as was observed at Location CC.

Location ChC, with coarse sediments and commensurately low organic carbon values (0.05-0.35 % OC dw) and nitrogen values (0.00-0.04 % N dw), did not exhibit any significant relationships between organic carbon or nitrogen and sampling site (Table 4).

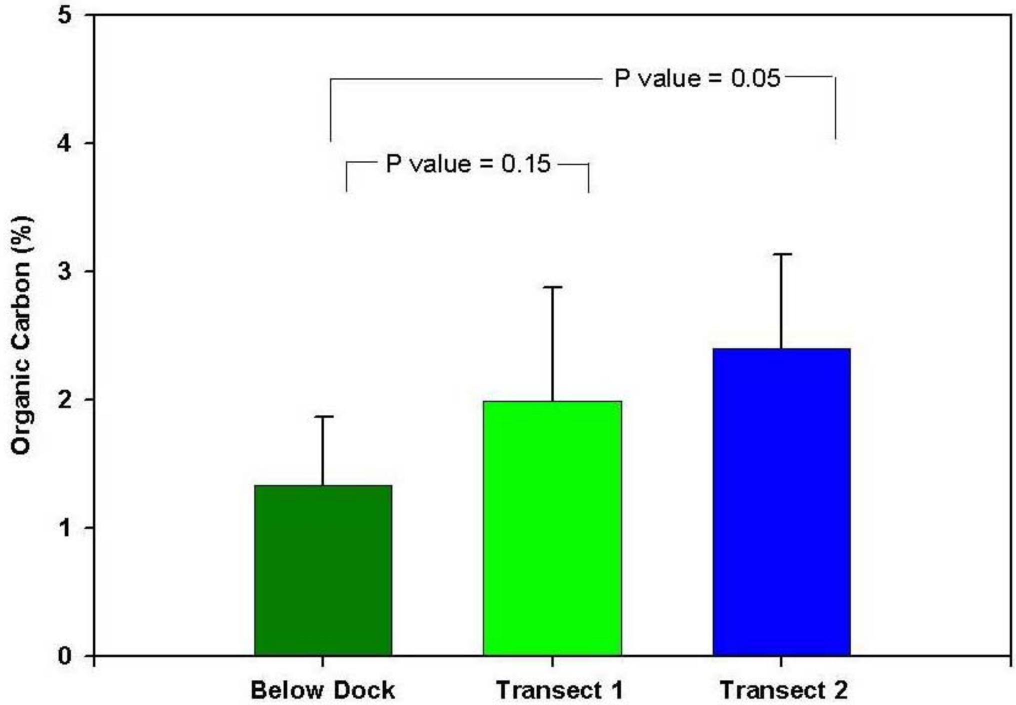

Figure 16. Comparison between organic carbon concentration at under-dock and transect sites in 2004 at Location BC. Transect 1 extends downstream from the dock, parallel to flow and transect 2 extends from the dock perpendicular to flow. No significant difference exists between under-dock sites and transect 1, whereas a significant difference exists between under-dock samples and transect 2.

4.3 Chlorophyll a

Chlorophyll *a* (chl *a*) data were only collected in the first sampling period in 2004, prior to the addition of Location ChC. Thus, transect/control and under-dock data are available for Locations CC and BC only (Tables 1-3).

At Location CC, the mean transect/control chl *a* concentration (110±38 ug/g) is significantly higher (approximately 3.7 x) than the mean value observed under the dock (30±14 ug/g; p = < 0.001; Fig. 17). Transect data also show that chl *a* is lowest under the dock, and higher, although highly variable, along the transect (Fig. 18).

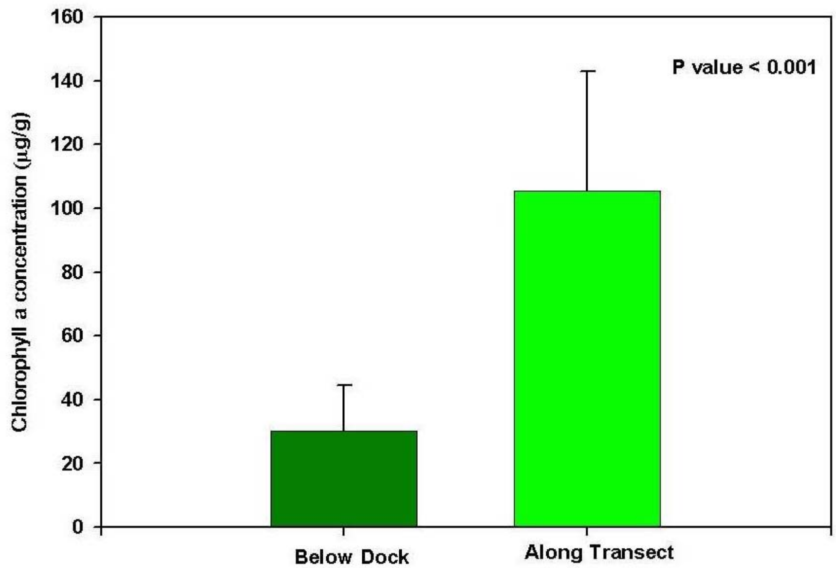

Figure 17. Comparison between Chlorophyll *a* concentrations at under-dock and transect sites in 2004 at Location CC. A significant difference exists between the two sample sites.

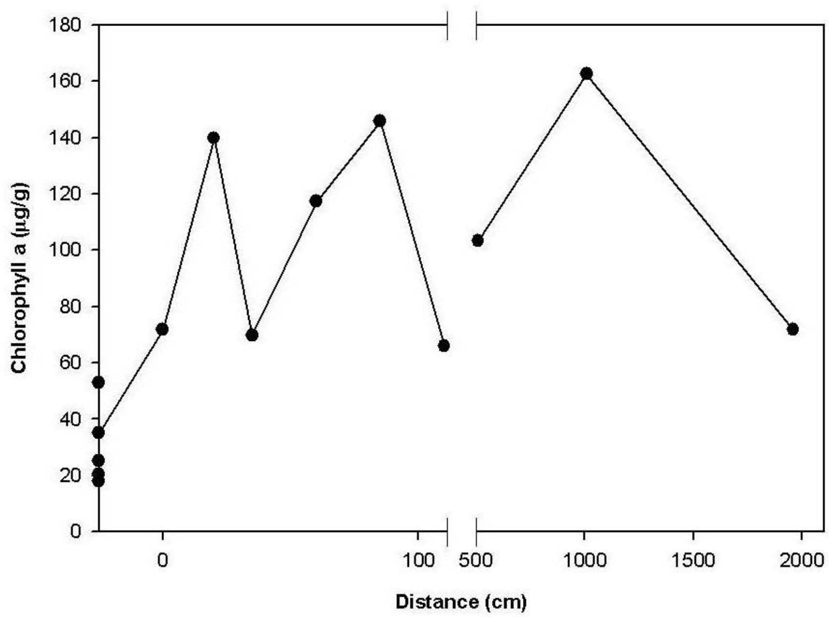

Figure 18. Distribution of Chlorophyll *a* at under-dock and transect sites in 2004 at Location CC. Even though there is large spatial heterogeneity along the transect, Chlorophyll *a* concentration is significantly lower under the dock compared to transect sites. See Fig. 8 for explanation of graph.

Phaeophytin *a*, an organic biomarker for dead or degraded chl *a*, does not show a significant difference in distribution between transect (54±7 ug/g) and under-dock (64±21 ug/g) sites ($p = 0.21$). However, the Phaeophytin *a*/Chl *a* ratio decreases from 2.3±0.7 at under-dock sites to 0.6±0.2 at transect/control sites, reflecting the significant decrease in Chl *a* concentration ($p < 0.001$; Tables 1, 2). As seen previously for mean grain size and organic carbon, the chl *a* contents are significantly different between the under-dock and control samples ($p = 0.003$); ANOVA testing shows that the significant difference exists between the transect/control and interfloat data ($p < 0.001$).

At Location BC, chl *a* contents are generally lower than those observed at CC, ranging between 10.3 and 77.2 ug/g (Tables 1, 3). Mean chl *a* content under the dock (14±3 ug/g) is lower by a factor of 2.1-2.9 compared to either Transect 1, oriented flow-parallel (30±18 ug/g;

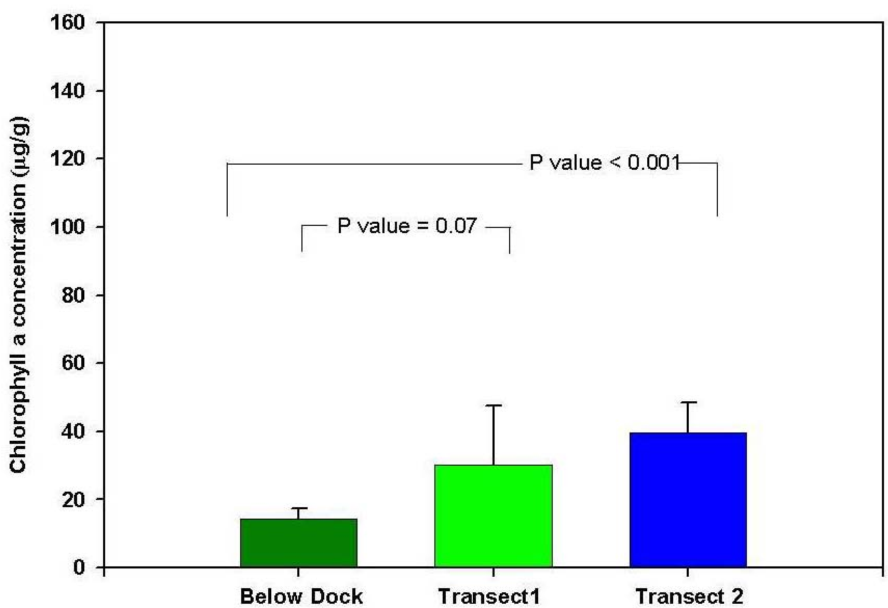

Figure 19. Comparison between chlorophyll *a* concentration at under-dock and transect sites in 2004 at Location BC. Transect 1 extends downstream from the dock, parallel to flow and transect 2 extends from the dock perpendicular to flow. No significant difference exists between under-dock sites and transect 1, whereas a significant difference exists between under-dock samples and transect 2.

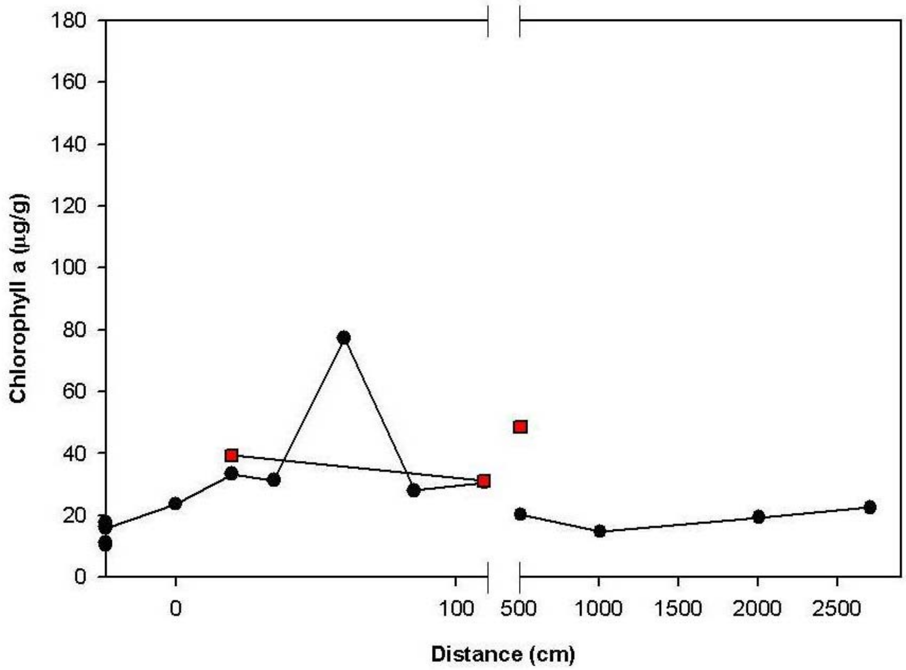

Figure 20. Distribution of chlorophyll *a* at under-dock and transect sites in 2004 at Location BC. Under-dock samples have lower chlorophyll concentrations than either Transect 1 (black dots) or transect 2 (red squares) within a meter of the dock; farther along transect 1, values decrease. Transect 2 is 500 cm long and ends at the edge of the marsh. See Fig. 8 for explanation of graph.

difference not significant, $p = 0.07$) or Transect 2, oriented flow-perpendicular (40±9 ug/g; difference significant, $p = < 0.001$) (Figs. 19, 20). Phaeophytin *a* does not show a significant difference in distribution between under-dock sites (44±12 ug/g) and transect 1 (43±17 ug/g; $p = 0.91$) or transect 2 (54±9 ug/g; $p = 0.26$) sites, as observed at Location CC. However, the Phaeophytin *a*/Chl *a* ratio decreases from 3.1±0.2 at under-dock sites to 1.5±0.3 and 1.4±0.4 along transects 1 and 2 sites, respectively, reflecting the significant decrease in Chl *a* concentration ($p < 0.001$ for either transect 1 and 2 samples compared to under-dock samples; Tables 1, 2). As observed previously at Location CC, the chl *a* contents are significantly different between the under-dock and transect/control samples ($p = 0.005$); ANOVA testing shows that the significant difference exists between the transect/control and interfloat data ($p = 0.017$).

4.4 Macrofauna

Macrofaunal organisms in our study areas were dominated by polychaete worms, which were identified down to genus, or species when possible (Figs 21, 22; Tables 5, 6).

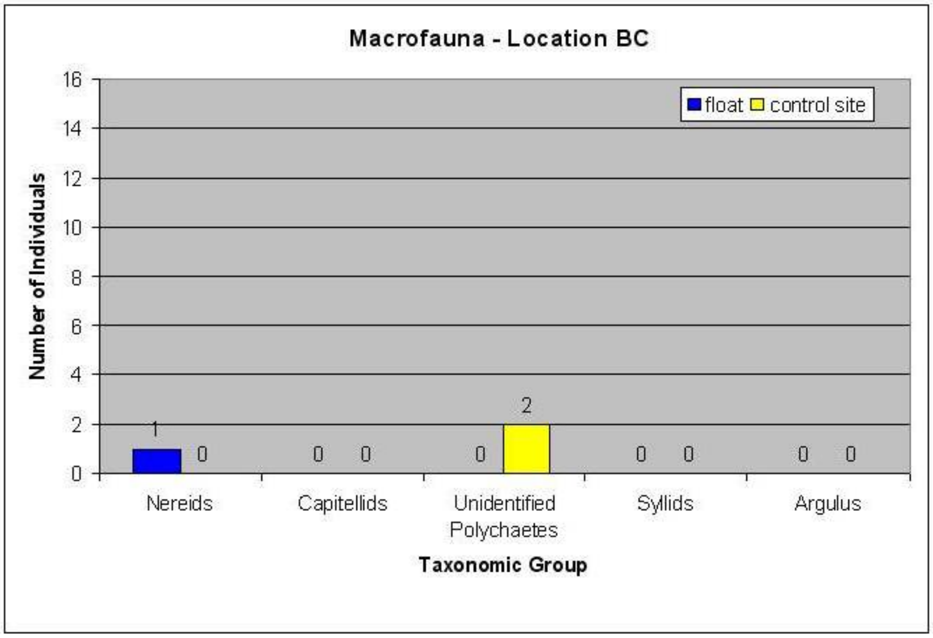

Figure 21. Macrofaunal organisms at Location CC are dominated by polychaetes.

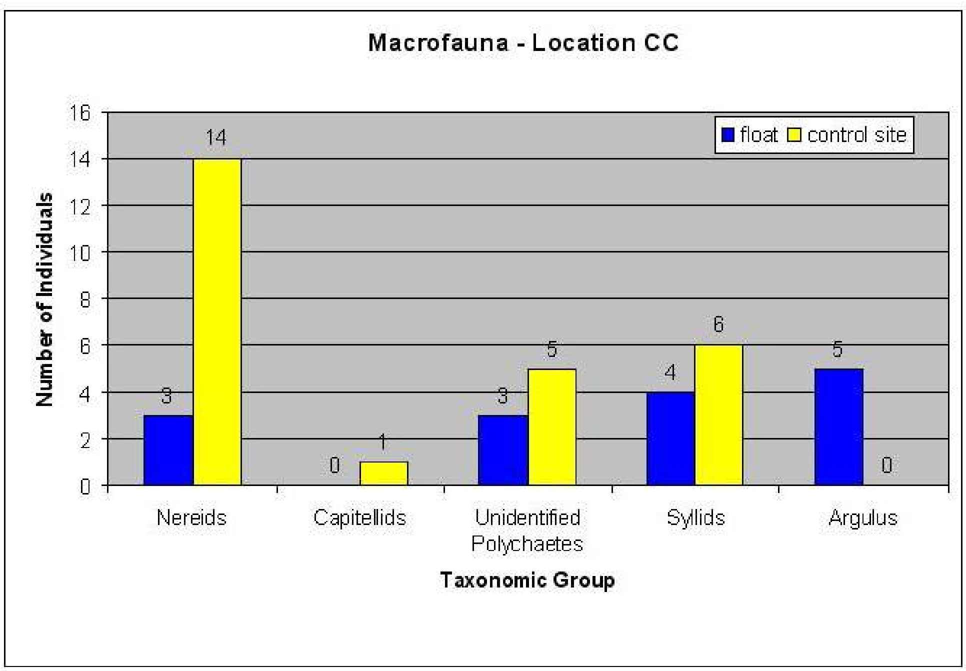

Figure 22. Macrofaunal organisms at Location BC are dominated by polychaetes but are few in number.

A statistical assessment of the within float and intrafloat variability (i.e., whether a significant difference in variability exists in the distribution of organisms within the five replicate samples under each float or among each of the three floats sampled) showed no significant differences, allowing us to pool our results from all three floats at each site.

The most commonly found macrofaunal organisms in our study were the Nereid worms. They were also the largest taxa observed in our samples and were up to 10 cm long. The majority of these worms are typically found in shallower waters but they can occupy all kinds of habitats and depth ranges (Rouse et al., 2001). They are found in stiff muddy sand, gravelly mud, coarse sand, shelly mud, and can even occur in soft, foul mud and are highly tolerant of salinity changes (Pettibone 1963; Gosner 1978). The Nereids found in this study were clam worms (*Nereis succinea*) and are strong predators that also feed on algae.

The Capitellid worms, which are burrowing polychaetes that are common in surficial and deep sediments, were also present. They are considered nonselective tube dwelling deposit feeders; however, some are motile and demonstrate some levels of selectivity (Fauchald and Jumars 1979). Some species like *Capitella capitata* have been cited as highly tolerant indicators of pollution, but because many groups in this family are opportunistic and can occur in high densities in unimpacted areas, they may be considered as simply tolerant of poor conditions (Gosner 1978; Reish 1979; Ewing 1984; Lopez and Levinton 1987). Capitellid fragments constituted the greatest portion of the unidentified polychaetes at the CC location.

The third group of polychaetes found were the Syllids. These worms are found mostly in areas of mud, gravel or sand but they are not sedentary tube builders. They are creeping worms that are thought to be predators that use a piercing-sucking technique (Pettibone 1963; Gosner

1978). They are probably the most migratory of the taxa we observed under the docks or in the control areas.

The only non-polychaete taxa found in our samples was a crustacean, the fish louse Argulus, that was found only at Location CC. It is an epibiotic parasite that can also swim free.

Statistical testing of organism distributions can provide insight into the processes that shape these distributions. Non-parametric ANOVA testing of the treatment effect (under-dock versus control) on taxa variability at each study site demonstrates that the treatment does account for a significant proportion of the distribution variability, but only for Nereid distributions ($p = 0.03$) and total polychaetes ($p = 0.04$) at Location CC. ANOVA of total taxa compared by study location shows a significant treatment effect (CC versus BC) on the distribution of Nereids ($p = 0.004$), unidentified polychaetes ($p = 0.002$) and syllids ($p = 0.029$). Similarly, a Chi-square test provides complimentary significance identification between study locations for Nereids ($p = 0.002$), unidentified polychaetes ($p = 0.003$) and Syllids ($p = 0.012$).

Biomass is a better measure of macrofaunal food resource productivity than is numbers of organisms, given the wide range of sizes contained within the definition of macrofauna (i.e., all organisms > 500 um). For Location CC, there is an order of magnitude difference in the biomass at the control site compared to under the dock; however, this difference is not statistically significant at the 95% confidence level ($p = 0.079$; Table 7, Fig. 23). The control site at Location BC had a similar amount of biomass at the control site to that at Location CC, but the under-dock samples were lost during the weighing process, so no statistical comparison can be made. The low number of organisms (1) and the type of organism at Location BC (Nereid, for which three organisms accounted for only 0.7 mg biomass at the CC location) at the

BC dock site suggests that the total under-dock biomass would have been significantly lower than the control site biomass value, similar to what was observed at the CC location.

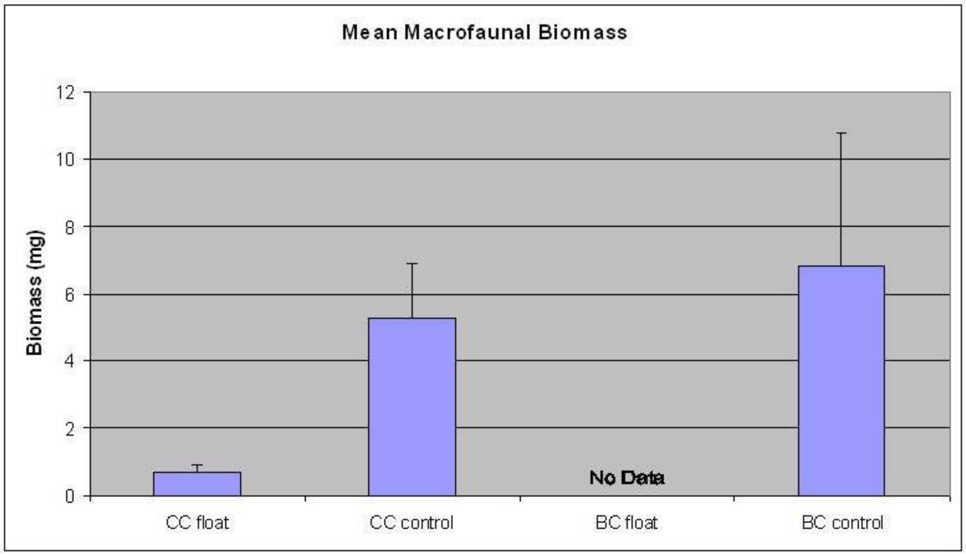

Figure 23. Macrofaunal biomass is lower by an order of magnitude at float sites when compared to control sites at Location CC. Location BC float data was lost during laboratory analysis but the larger and numerically greater organisms in the control site suggest that a similar trend exists at this study location.

4.5 Meiofauna

The total meiofaunal abundances and taxa for each subcore at all three study sites are given in Tables 8-10. Meiofauna were dominated by nematodes, which averaged 92.1% of the total number of organisms. Pooling all the data for meiofaunal abundance, there were more individuals in the controls sites (490 per 10 cm^2) than in float (390 per 10 cm^2) or interfloat (337 per 10 cm^2) locations, but ANOVA shows these differences are not statistically significant ($p = 0.15$) and could be the result of spatial variability in community distribution. Great variability characterized the total meiofaunal abundances at all study locations such that no characteristic patterns emerged from data collected to assess month-to-month, before-and-after low tide or intersite differences (Table 11). Graphical exploratory data analysis does not show any significant relationships between number of meiofaunal organisms and mean grain size, percent mud, organic carbon content or nitrogen content (Figs. 24-27).

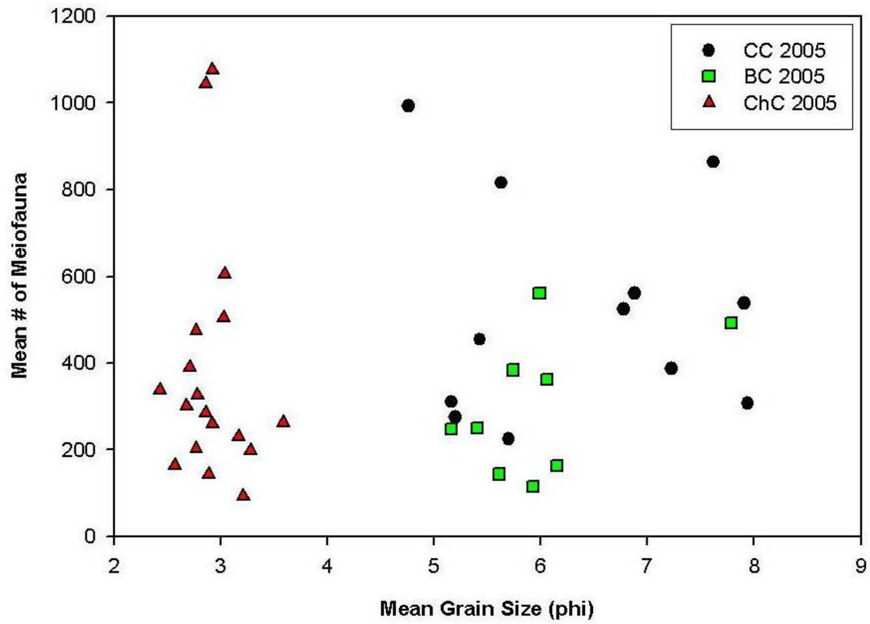

Figure 24. Comparison between mean number of meiofauna and mean grain size does not exhibit a significant relationship.

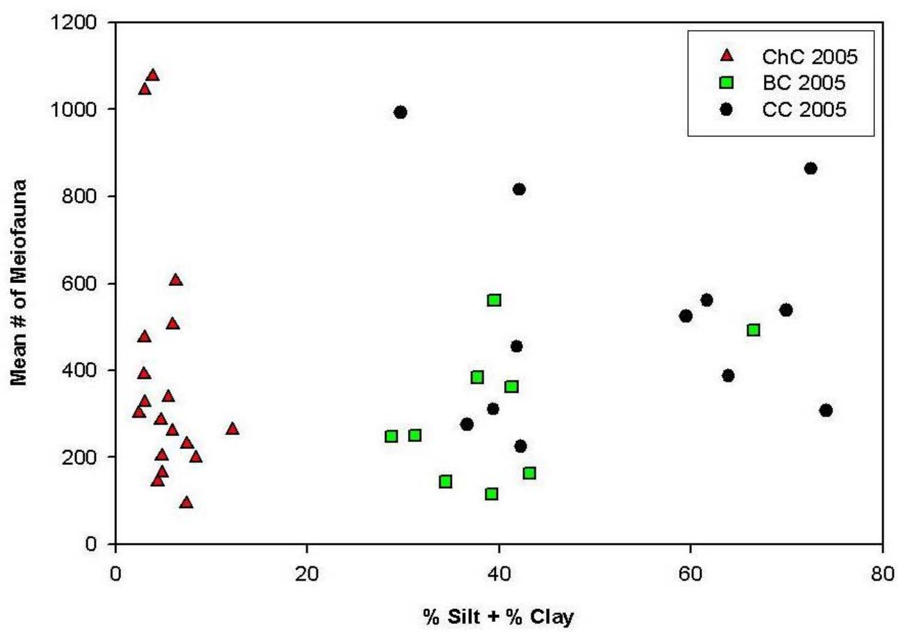

Figure 25. Comparison between mean number of meiofauna and percent mud (silt+clay) does not exhibit a significant relationship.

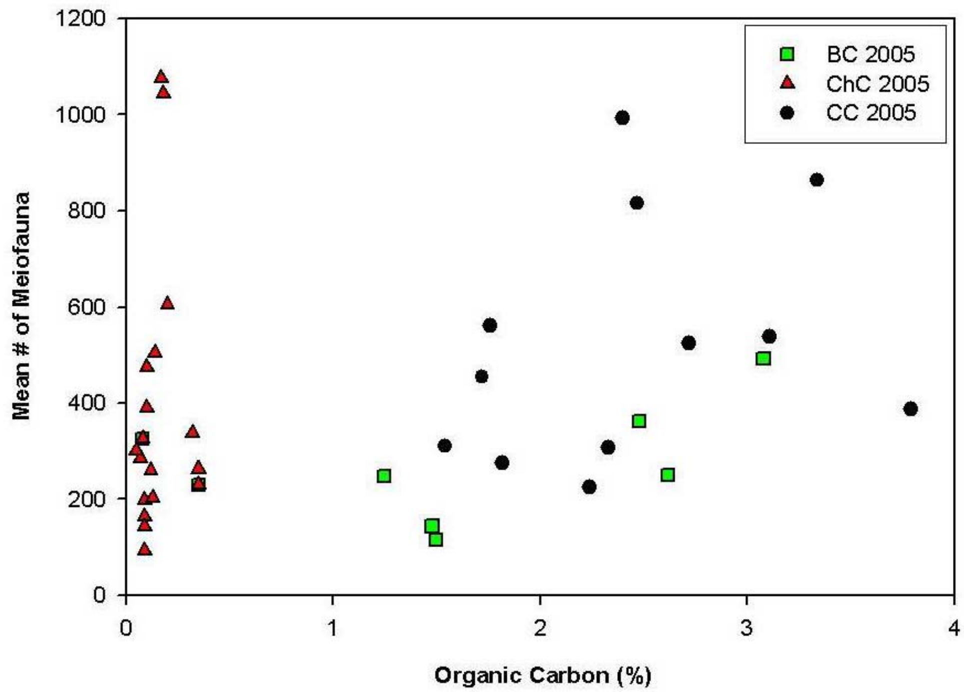

Figure 26. Comparison between mean number of meiofauna and percent organic carbon does not exhibit a significant relationship.

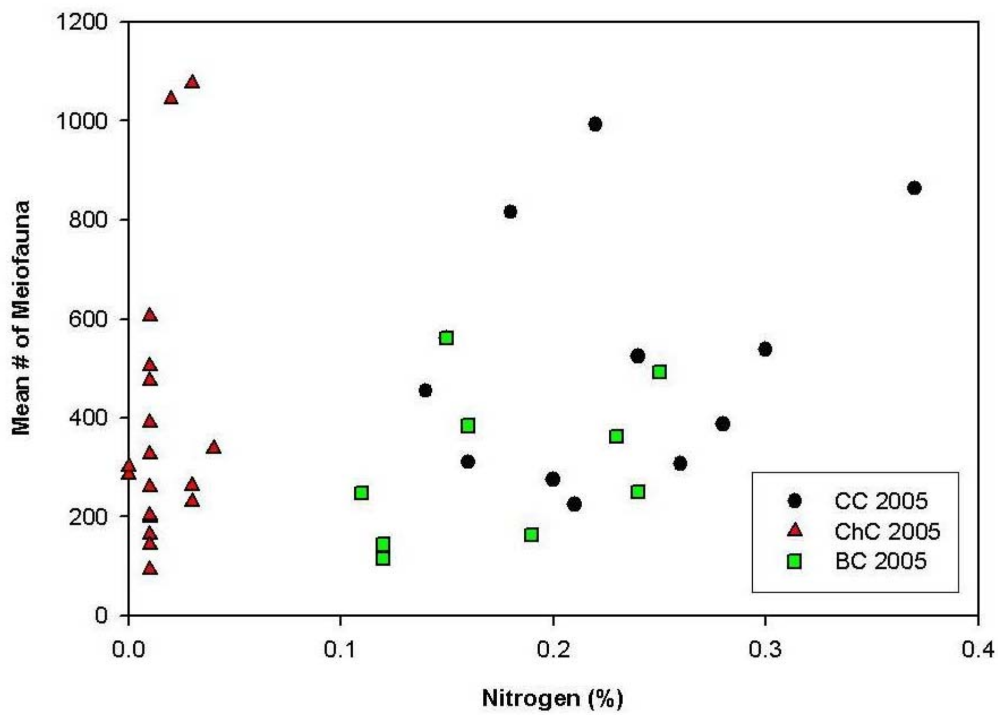

Figure 27. Comparison between mean number of meiofauna and percent nitrogen does not exhibit a significant relationship.

5. Discussion

Cataloging the Effects of Floating Docks on the Benthic Environment

The results of this preliminary study document that there are quantifiable effects on the benthic environment resulting from the presence of floating docks. At all three locations, we detected statistically significant changes in either benthic algal production (as measured by chl *a*), grain size, organic carbon or benthic macrofaunal distributions. One impact, the decrease in benthic algal production, is a simple, direct outcome of the structure's presence over the substrate. Other secondary impacts are a more complicated result of the interaction between the dock's structural elements and other physical forces in the environment (i.e., tidal flow). These secondary impacts do not appear to be statistically associated with the whole floating structure given our present dataset. These changes were typically associated with only a portion of the area occupied by the floating dock. The docks examined consisted of smaller, individual floats supporting a wooden platform. The open spaces between the floats (interfloat sites) are where the impacts are observed at a statistically significant level, and not in the areas directly under the small floats that support the floating platform. Flow acceleration, and the associated additional erosion and removal of finer, organic-rich materials, between the smaller floats is a reasonable explanation for this observation. Thus, the mechanism responsible for most impacts appears to be different than those suggested from work in the Northeastern US (i.e., wind-induced dock oscillation causing sediment resuspension or current removal of the organic-rich, fine-grained sediments stuck to the bottom of the dock).

5.1 Is there a Significant Effect on Primary Productivity (Chl a)?

Yes. The most obvious and direct effect of floating docks on benthic productivity is the loss of benthic diatom production (as measured by chl *a*) associated with dock shading of the substrate. Based on our data, total Chl *a* content is decreased 57-73% under the floating dock, with statistically significant differences observed when control sites are compared to interfloat sites. Flow acceleration between the floats might be expected to enhance the removal of any benthic productivity that is produced over each high tidal cycle. Because this impact results from shading of the substrate at all times under the dock, (e.g., not only when the dock is near the bottom as appears to be the case with changes in sediment physical properties), this impact would be felt under the complete footprint of the dock no matter the design of the dock (i.e., whether single or multiple floats support the dock).

The great variability in chl *a* concentration along the transects at both locations creates a large standard deviation in the data, effectively masking a similarly strong relationship between the transect/control and float data. At each location, using Dunn's Method for pairwise multiple comparisons, control data compared to float data exhibit large, but non-statistically significant differences in ranks (6.5-7.3), within 90% of the significant difference in ranks between control and interfloat data (7.3-7.9), whereas float data compared to interfloat data exhibits small differences in rank (0.7-0.8), showing the close similarity in the float and interfloat sites.

5.2 Is there a significant effect on sediment grain size or physical parameters?

Yes. Significant differences were observed between the under-dock and control samples for Locations CC and ChC, with coarser sediments observed under the docks. Sediments collected from our study locations show a range of sedimentary components; therefore a range of grain sizes exists for transport and redistribution if such processes are occurring in the vicinity of the floating dock structure. We detected limited amounts of silt in most samples, as has been demonstrated in several other studies of Georgia coastal sediments (Mayou, 1973; Alexander et al., 1997).

Significant coarsening between the individual floats was detected at Locations CC and ChC. At location BC, no significant difference in mean grain size was observed when comparing the under-dock and transect/control sites. However, the pronounced along-transect variability in mean size at Location BC may mask relationships between means that may be present.

In Location BC, where strong tidal flow is common, an initial downstream fining and subsequent coarsening in grain size was observed along the main transect. This pattern represents deposition and accumulation of finer sediments in the lee of the floating platform during prolonged ebb tides and suggests that bottom-impacting structures have greater effects on the benthic environment in regions where tidal velocities are greater.

Comparing porosity profiles from dock and control cores at both study locations CC and BC suggests that the weight of the floats is affecting the density of the upper 1-2 centimeters of the seabed (Fig. 12). The porosity is decreased in this upper zone in both the float cores, whereas the control porosity profiles show a monotonic decrease with depth in the surface sediments, as is typical of undisturbed sediments. The effect may be more pronounced in the muddy sediments similar to those at Location CC, as the high-porosity peaks in the profile, which probably represent zones of finer grain size, are consistently shifted upward toward the sediment-water interface, as would be expected if the sediments were being compacted by some weight bearing down and squeezing out interstitial fluids. The same pattern is not obvious in the Location BC cores. However, sand-sized particles, which make up 60-80% of the sediments at Location BC dock and control sites, form less-compressible deposits, being that sand grains form a self-supporting matrix within which the pore fluids are contained. Sands make up less than 20% of the particles at Location CC (Fig. 9).

5.3 Is there a Significant Effect on Organic Carbon/Nitrogen Content?

Yes. Because there is a strong relationship between grain size and organic carbon/nitrogen, the results for organic carbon/nitrogen are similar to those derived for grain size. At locations CC and BC, there is a statistically significant difference between the under-dock and transect/control values, with less organic carbon/nitrogen found under the dock. At Location ChC, no significant relationship was observed, but this site uniformly exhibits coarse sediments, with less than 10% fine-grained material and extremely low organic carbon/nitrogen values. This widespread lack of organic material suggests that there is little potential for any signal to manifest.

5.4 Is there a Significant Effect on Benthic Macrofauna?

Apparently yes, based on the present dataset. Our data show that there are greater numbers of organisms and that biomass may be an order or magnitude higher in control sites when compared to float sites. The macrofaunal community was dominated by polychaete worms. Details of the macrofaunal distribution suggests that a predator-prey relationship may be structuring a portion of the polychaete community in our study. Only the distribution of Nereids and total polychaetes between dock and control was significant at Location CC in our study. While we do not have enough data to be certain, it is possible that the relatively high number of predatory Nereids at the Location CC control site may have been a response to the greater density of other polychaetes. It is reasonable to speculate that a predatory species like *Nereis succinea* would be distributed positively relative to prey species.

When examining macrofaunal distributions between study Locations (CC vs BC), a significant difference exists for Nereids, unidentified polychaetes, syllids and total polychaetes.

These differences may represent the response of organisms to the increased energy at Location BC or to the difference in grain size between the two locations.

5.5 *Is there a Significant Effect on Benthic Meiofauna?*

No. When comparing the effects of floats resting on the bottom at low tide on meiofauna at all locations and sampling sites, there is no obvious trend and it remains unclear if meiofauna are affected by this disturbance. At all three locations (CC, BC, and ChC), the control sites had higher meiofaunal abundance and the under-dock samples taken together the lower, although the differences were not statistically significant. Location BC exhibited the greatest meiofaunal abundance in the control site and the least meiofaunal abundance at float sites. Locations CC and ChC exhibited greatest meiofaunal abundance in the control sites and the least meiofaunal abundance in interfloat sites. Patchy distributions, rapid recruitment and reproductive response to disturbance of the substrate by currents and dock structures are all reasonable explanations for this lack of correlation (Sherman and Coull, 1980; Schratzberger and Warwick, 1998). Although we may see predation controls on macrofaunal abundances in our study, most research in recent years has demonstrated that top down predation control does not structure the meiofaunal community (e.g., Coull 1999), and so it is not surprising that we do not see any significant relationship between the macrofaunal and meiofaunal data.

Meiofaunal communities in this study were dominated by nematodes. These results are similar to previous studies of meiofaunal abundance in estuarine, coastal and marine settings which document nematodes comprising between 80-100% of the meiofauna (e.g., Wieser 1960; Vanaverbeke at al., 1997; Coull 1999; Cross and Curran, 2000; Lampadariou and Tselepides 2006). We know that nematodes make up 92% of the individuals observed in this study. If we assume that the dominant nematodes represent the bulk of the biomass, a back-of-the-envelope assessment of the total meiofaunal biomass contained in muddy Georgia estuarine sediments can be made using average nematode dry weight values from the literature and an average of abundance data from the present study. Widbom (1980) gives the average dry weight of nematodes in the 40-500 um size fraction as 0.37 ug dw/organism. The average abundance observed in our study was 425 organisms/10 cm^2 in the Georgia study locations. Thus the calculated meiofaunal biomass is 157,250 ug dw/m^2 or 0.16 g dw/m^2 [(425 organisms/10 cm^2) * (0.37 ug/organism) * (10^4 cm^2/1 m^2)] and is similar to values reported by Weiser (1960) for nematode biomass in Buzzards Bay, MA (0.19 g dw/m^2). This value is similar in magnitude to the macrofaunal biomass found in control areas in this study (Table 7) and highlights the importance of meiofaunal as well as macrofaunal food resources in estuarine sediments. The distribution of these meiofaunal resources are apparently not significantly affected by dock groundings, in contrast to macrofaunal resources.

6. Suggestions for Additional Research

As with any biological system, the estuarine setting is complicated and requires large sample numbers, multiple replicates and repeated sampling to tease out the underlying relationships within the natural variability. Given the limited amount of funding available for this work, this study is, of necessity, only a first step toward quantifying the impacts of floating docks on the benthic environment. Because the results presented here are based on a small number of sites, with similar types of dock construction, there need to be additional studies which examine a broader suite of samples from a greater diversity of study sites, a more comprehensive biological sampling strategy and greater replication among and between sites. Some tentative conclusions presented here (e.g., the significant difference in macrofaunal biomass between dock and control sites) require larger datasets to provide greater confidence in the result.

One issue that might be pertinent to coastal management merits discussion. The three docks examined were all constructed using smaller floats under a larger wooden platform. It may be that the dominant zone of influence of a floating dock is at the interface between the float and the surrounding water (as suggested by the significant differences observed between control and interfloat sites in this study). Georgia's swift currents associated with a high tidal range may intensify the impact of floats when near the bottom. Comparative studies that examine the differences in the impacts associated with floating docks constructed on one large float and those constructed of numerous small floats could be profitably carried out to resolve what, if any, particular type of float minimizes the impact to the environment.

Combining results from a recent study of dock shading impacts on Spartina vegetation (Alexander and Robinson 2006) with results from this study characterizes the negative impact of dock and float shading on the saltmarsh ecosystem. Walkways shade the marsh, reducing biomass and carbon input by 21-37%. Adding a floating dock that rests on the bottom at low tide to the end of that walkway increases the impact of the structure by reducing the benthic algal production under the float by 57-73%. In addition, the terminal platform of the dock will shade the intertidal, non-vegetated mud-flat where benthic algae photosynthesize at lower stages of the tide, although the magnitude of the decrease from such high-standing structures was not quantified in this study and is expected to be less significant. In conclusion, when assessing impact to the ecosystem from docks and associated structures, both the decrease in carbon from the walkway and floating structures should be taken into account cumulatively.

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APPENDIX A

Regression Equations for Textural Parameters versus % Organic Carbon and Nitrogen (see Figs. 13 and 14).

Textural Parameters versus % Organic Carbon

Mean Grain Size vs. organic carbon:	C org = 0.5313*(phi mean size) – 1.3190
%sand vs. organic carbon:	C org = -0.0389*(% sand) + 4.0049
%silt vs. organic carbon:	C org = 0.1593*(% silt) + 0.3255
%clay vs. organic carbon:	C org = 0.0505*(% clay) + 0.1030
%silt + %clay vs. organic carbon:	C org = 0.0392*(%silt+clay) +0.1201

Textural Parameters versus % Nitrogen

Mean Grain Size vs. nitrogen:	Nitrogen = 0.537*(mean size phi) – 0.1445
%sand vs. nitrogen:	Nitrogen = -0.0040*(%sand) + 0.3985
%silt vs. nitrogen:	Nitrogen = 0.0166*(%silt) + 0.0174
%clay vs. nitrogen:	Nitrogen = 0.0052*(%clay) – 0.0028
%silt + %clay vs. nitrogen:	Nitrogen = 0.0040*(%silt+clay) – 0.0017

Table 1. Range data for physical, chemical and biological parameters at Locations CC and BC. Location ChC was not a part of this study when this dataset was collected.

Site Location	gravel (%)	sand (%)	silt (%)	clay (%)	Mean Grain Size (phi)	Sorting (phi)	Organic Carbon (%)	Carbonate (%)	Nitrogen (%)	C:N Ratio (AT:AT)	Chlorophyll a (ug/g)	Phaeophytin a (ug/g)
2004 data												
CC float	1.21 - 5.11	5.46 - 13.84	19.85 - 22.36	65.10 - 70.20	8.73 - 9.08	3.37 - 3.54	2.47 - 3.65	0.16 - 0.42	0.38 - 0.39	12.93 - 13.08	17.85 - 35.01	36.89 - 92.69
CC interfloat	0.55 - 1.07	27.46 - 28.58	17.04 - 18.38	53.31 - 53.61	7.66 - 7.70	3.81 - 3.90	2.49 - 2.85	0.15 - 0.36	0.29 - 0.36	12.81 - 13.38	20.36 - 53.06	52.50 - 62.34
CC control	0.07 - 2.01	11.54 - 19.23	15.52 - 22.73	57.90 - 69.69	8.16 - 9.04	3.18 - 3.60	2.85 - 3.67	0.11 - 0.16	0.27 - 0.36	13.29 - 17.23	66.05 - 162.58	44.85 - 66.68
BC float	0.00 - 0.14	61.60 - 70.43	4.01 - 5.92	23.65 - 33.26	5.28 - 6.00	3.55 - 3.93	0.51 - 1.77	0.04 - 0.12	0.04 - 0.16	14.77 - 15.52	10.26 - 16.24	29.86 - 54.80
BC interfloat	0.07 - 0.23	57.99 - 70.10	5.21 - 6.04	24.46 - 35.90	5.32 - 6.23	3.60 - 3.92	1.44 - 1.78	0.06 - 0.07	0.12 - 0.15	14.49 - 15.06	11.20 - 17.64	32.11 - 52.22
BC control	0.00 - 0.98	22.56 - 79.71	2.35 - 14.43	17.88 - 63.90	4.70 - 8.58	3.12 - 3.99	0.76 - 3.19	0.03 - 0.37	0.06 - 0.39	14.43 - 15.69	14.76 - 48.49	22.05 - 79.18
2005 data												
CC2	7.48 - 14.7	33.60 - 53.97	8.02 - 14.57	23.31 - 39.56	5.20 - 6.88	3.75 - 3.96	1.72 - 2.24	0.85 - 1.80	0.14 - 0.21	17.03 - 28.79	--	--
											--	--
CC3	14.49 - 30.11	19.21 - 44.04	7.55 - 13.78	21.1 - 46.13	5.16 - 7.94	3.95 - 3.99	1.54 - 3.34	1.17 - 3.89	0.16 - 0.37	14.05 - 28.00	--	--
											--	--
CC15	0.09 - 15.14	29.67 - 70.2	6.68 - 16.58	21.03 - 56.59	4.76 - 7.91	3.44 - 3.93	2.40 - 3.79	0.15 - 1.31	0.22 - 0.30	12.84 - 16.14	--	--
											--	--
BC1	0.26 - 0.66	56.68 - 60.39	8.00 - 9.42	30.98 - 33.64	5.93 - 6.15	3.76 - 3.77	1.50 - 2.48	0.05 - 0.37	0.12 - 0.23	13.41 - 14.53	--	--
											--	--
BC2	0.04 - 0.74	60.45 - 70.99	6.48 - 8.24	22.20 - 31.27	5.16 - 5.99	3.37 - 3.77	1.25 - 1.61	0.07 - 0.11	0.11 - 0.15	14.23 - 14.85	--	--
											--	--
BC15	0.24 - 0.73	33.32 - 68.54	5.57 - 14.59	25.61 - 51.85	5.41 - 7.79	3.60 - 3.83	1.78 - 3.08	0.06 - 0.23	0.16 - 0.25	13.16 - 15.54	--	--
											--	--
ChC1	0.06 - 3.75	91.39 - 97.00	0.41 - 1.17	2.54 - 6.17	2.57 - 3.17	1.56 - 2.22	0.09 - 0.35	0.00 - 0.14	0.01 - 0.03	15.16 - 23.30	--	--
											--	--
ChC2	0.16 - 9.87	84.63 - 97.58	0.32 - 1.2	2.10 - 4.3	2.43 - 2.86	1.42 - 2.29	0.05 - 0.32	0.01 - 0.45	0.00 - 0.04	9.25 - 123.92	--	--
											--	--
ChC3	0.05 - 0.28	87.73 - 96.77	0.37 - 1.95	2.68 - 10.27	2.86 - 3.59	1.56 - 2.74	0.09 - 0.35	0.00 - 0.07	0.01 - 0.03	9.78 - 16.14	--	--

Table 2. Location CC 2004 and 2005 physical, chemical and biological field data.

Site Location	Sample Site Location or Distance from Dock (cm)	gravel (%)	sand (%)	silt (%)	clay (%)	Mean Grain Size (phi)	Sorting (phi)	Organic Carbon (%)	Carbonate (%)	Nitrogen (%)	C:N Ratio (AT:AT)	Chlorophyll a (ug/g)	Phaeophytin a (ug/g)	Phaeo a:Chl a
2004														
CC1_0704	float	1.21	13.84	19.85	65.10	8.73	3.54	2.47	0.42	0.38	12.93	25.13	74.26	3.0
CC2_0704	interfloat	1.07	28.58	17.04	53.31	7.66	3.90	2.49	0.36	0.36	12.81	53.06	62.34	1.2
CC3_0704	float	5.11	5.46	22.36	67.08	8.78	3.53	2.96	0.30	0.38	13.01	17.85	36.89	2.1
CC4_0704	interfloat	0.55	27.46	18.38	53.61	7.70	3.81	2.85	0.15	0.29	13.38	20.36	52.50	2.6
CC5_0704	float	3.13	6.50	20.17	70.20	9.08	3.37	3.65	0.16	0.39	13.08	35.01	92.69	2.6
CC6_0704	0	0.59	11.54	19.63	68.25	9.04	3.18	3.61	0.14	0.36	13.54	71.67	55.75	0.8
CC7_0704	20	2.01	17.36	22.73	57.90	8.16	3.60	3.21	0.15	0.33	13.29	139.80	51.50	0.4
CC8_0704	35	1.15	17.27	20.19	61.39	8.44	3.56	2.85	0.12	0.28	13.60	69.78	46.90	0.7
CC9_0704	60	0.02	14.41	15.88	69.69	9.09	3.30	2.92	0.16	0.28	14.30	117.34	53.59	0.5
CC10_0704	85	0.35	16.12	19.43	64.10	8.77	3.37	2.97	0.12	0.27	14.41	145.80	62.31	0.4
CC11_0704	110	0.19	14.28	19.22	66.31	8.97	3.30	3.47	0.13	0.31	15.28	66.05	55.16	0.8
CC12_0704	210	0.20	15.56	16.68	67.56	8.96	3.40	--	--	--	--	--	--	
CC13_0704	310	0.24	16.29	19.01	64.46	8.81	3.41	--	--	--	--	--	--	
CC14_0704	410	0.48	13.65	20.73	65.14	8.90	3.36	--	--	--	--	--	--	
CC15_0704	510	0.10	18.59	15.81	65.50	8.82	3.57	3.67	0.16	0.29	17.23	103.23	66.68	0.6
CC16_0704	1010	0.18	19.23	15.52	65.07	8.74	3.54	3.55	0.14	0.34	13.92	162.58	44.85	0.3
CC17_0704	1510	0.42	30.64	17.64	51.31	7.56	3.90	--	--	--	--	--	--	
CC18_0704	1960	0.07	18.21	18.23	63.49	8.67	3.51	3.64	0.11	0.32	14.70	71.64	51.18	0.7
2005														
CC2_before_0505	float	7.48	53.40	9.43	29.69	5.70	3.95	2.24	0.85	0.21	17.03	--	--	--
CC3_before_0505	interfloat	19.17	20.92	13.78	46.13	7.94	3.98	2.33	3.89	0.26	28.00	--	--	--
CC15_before_0505	500	1.14	29.67	12.60	56.59	7.91	3.84	3.11	0.15	0.30	12.84	--	--	--
CC2_before_0605	float	10.60	51.98	11.14	26.28	5.43	3.75	1.72	1.80	0.14	28.79	--	--	--
CC3_before_0605	interfloat	27.31	44.04	7.55	21.10	5.16	3.98	1.54	1.17	0.16	20.02	--	--	--
CC15_before_0605	500	0.27	40.41	16.58	42.74	6.78	3.79	2.72	0.36	0.24	14.83	--	--	--
CC2_after_0605	float	12.28	33.60	14.57	39.56	6.88	3.96	1.76	1.61	0.15	25.97	--	--	--
CC3_after_0605	interfloat	14.49	49.51	9.07	26.93	5.63	3.95	2.47	1.18	0.18	24.23	--	--	--
CC15_after_0605	500	0.09	70.20	6.68	21.03	4.76	3.44	2.40	1.31	0.22	13.53	--	--	--
CC2_after_0705	float	14.70	53.97	8.02	23.31	5.20	3.86	1.82	1.78	0.20	20.55	--	--	--
CC3_after_0705	interfloat	30.11	19.21	12.17	38.51	7.62	3.99	3.34	1.18	0.37	14.05	--	--	--
CC15_after_0705	500	15.14	30.60	14.01	40.25	7.23	3.93	3.79	0.07	0.28	16.14	--	--	--

Table 3. Location BC 2004 and 2005 physical, chemical and biological field data.

Site Location	Sample Site Location or Distance from Dock (cm)	gravel (%)	sand (%)	silt (%)	clay (%)	Mean Grain Size (phi)	Sorting (phi)	Org C (%)	Carbonate (%)	Org N (%)	C:N Ratio (AT:AT)	Chlorophyll a (ug/g)	Phaeophytin a (ug/g)	Phaeo a:Chl a
2004														
BC1_0704	float	0.14	61.6	5	33.26	6.00	3.93	1.16	0.05	0.09	15.52	16.24	54.80	3.4
BC2_0704	interfloat	0.23	70.1	5.21	24.46	5.32	3.60	1.78	0.07	0.15	15.06	17.64	52.22	3.0
BC3_0704	float	0.04	68.18	4.01	27.78	5.57	3.70	1.77	0.12	0.16	14.96	10.26	29.86	2.9
BC4_0704	interfloat	0.07	57.99	6.04	35.9	6.23	3.92	1.44	0.06	0.12	14.49	11.20	32.11	2.9
BC5_0704	float	0	70.43	5.92	23.65	5.28	3.55	0.51	0.04	0.04	14.77	15.76	49.89	3.2
BC6_0704	0	0.13	32.59	9.78	57.50	8.07	3.95	2.71	0.08	0.23	14.97	23.58	43.95	1.9
BC7_0704	20	0.09	47.37	12.48	40.05	6.71	3.95	2.30	0.09	0.20	14.82	33.29	48.77	1.5
BC8_0704	35	0.08	31.21	14.43	54.27	7.90	3.88	2.96	0.13	0.27	14.54	31.27	47.01	1.5
BC9_0704	60	0.08	22.73	13.29	63.90	8.57	3.63	3.19	0.37	0.39	15.13	77.23	79.18	1.0
BC10_0704	85	0.02	54.44	9.67	35.87	6.31	3.86	2.19	0.08	0.19	14.62	27.94	50.35	1.8
BC11_0704	110	0	49.68	8.58	41.73	6.76	3.97	2.42	0.08	0.21	14.78	30.63	52.57	1.7
BC12_0704	210	0.15	69.18	5.20	25.47	5.30	3.54	--	--	--	--	--	--	
BC13_0704	310	0.06	68.20	3.80	27.94	5.56	3.74	--	--	--	--	--	--	
BC14_0704	410	5.03	73.71	3.20	18.06	4.49	3.38	--	--	--	--	--	--	
BC15_0704	510	0.98	77.48	3.03	18.51	4.70	3.21	1.33	0.05	0.11	14.8	20.19	27.48	1.4
BC16_0704	1010	0.05	79.71	2.35	17.88	4.70	3.12	0.89	0.03	0.07	15.69	14.76	24.36	1.7
BC17_0704	1510	0.09	81.09	3.41	15.41	4.53	3.01	--	--	--	--	--	--	
BC18_0704	2010	0.34	76.65	4.22	18.79	4.80	3.27	0.76	0.04	0.06	15.66	19.20	22.05	1.1
BC19_0704	2710	0.00	74.83	4.16	21.01	4.97	3.25	1.16	0.04	0.09	16.08	22.45	33.55	1.5
BC20_0704	20	0.23	42.30	10.41	47.06	7.25	3.99	2.78	0.10	0.24	15.31	39.36	63.70	1.6
BC21_0704	110	0.12	61.37	7.62	30.89	5.87	3.74	1.55	0.06	0.12	15.57	31.08	49.89	1.6
BC22_0704	510	0.03	22.56	14.09	63.32	8.58	3.54	2.86	0.13	0.27	14.43	48.49	47.23	1.0
2005														
BC1_before_0505	float	0.66	58.27	8.57	32.49	6.06	3.77	2.48	0.12	0.23	13.41	--	--	--
BC2_before_0505	interfloat	0.33	70.99	6.48	22.2	5.16	3.37	1.25	0.10	0.11	14.23	--	--	--
BC15_before_0505	500	0.29	68.54	5.57	25.61	5.41	3.60	2.62	0.06	0.24	13.16	--	--	--
BC1_before_0705	float	0.63	60.39	8	30.98	5.93	3.76	1.50	0.05	0.12	14.53	--	--	--
BC2_before_0705	interfloat	0.74	65.06	7.53	26.67	5.61	3.65	1.48	0.07	0.12	14.85	--	--	--
BC15_before_0705	500	0.24	33.32	14.59	51.85	7.79	3.83	3.08	0.23	0.25	15.54	--	--	--
BC1_after_0705	float	0.26	56.68	9.42	33.64	6.15	3.77	1.94	0.37	0.19	14.51	--	--	--
BC2_after_0705	interfloat	0.04	60.45	8.24	31.27	5.99	3.77	1.61	0.11	0.15	13.53	--	--	--
BC15_after_0705	500	0.73	61.77	9.31	28.2	5.74	3.64	1.78	0.15	0.16	14.16	--	--	--

Table 4. Location ChC 2005 physical, chemical and biological field data.

Site Location	Sample Site Location or Distance from Dock (cm)	gravel (%)	sand (%)	silt (%)	clay (%)	Mean Grain Size (phi)	Sorting (phi)	Organic Carbon (%)	Carbonate (%)	Nitrogen (%)	C:N Ratio (AT:AT)	Chlorophyll a (ug/g)	Phaeophytin a (ug/g)	Phaeo a:Chl a
ChC1_before_0505	float	3.75	91.39	1.03	3.83	2.57	2.05	0.09	0.00	0.01	18.08	--	--	--
ChC2_before_0505	interfloat	9.87	84.63	1.20	4.30	2.43	2.29	0.32	0.45	0.04	24.04	--	--	--
ChC3_before_0505	500	0.28	91.36	1.58	6.77	3.28	2.33	0.09	0.00	0.01	10.85	--	--	--
ChC1_after_0505	float	2.81	91.44	1.15	4.60	2.92	2.03	0.12	0.02	0.01	15.16	--	--	--
ChC2_after_0505	interfloat	8.30	87.29	0.84	3.57	2.77	1.91	0.13	0.04	0.01	13.99	--	--	--
ChC3_after_0505	500	0.05	87.73	1.95	10.27	3.59	2.74	0.35	0.00	0.03	15.47	--	--	--
ChC1_before_0605	float	2.42	93.87	0.89	5.24	3.04	2.14	0.20	0.02	0.01	19.97	--	--	--
ChC2_before_0605	interfloat	1.46	93.89	0.69	3.96	2.86	1.88	0.07	0.02	0.00	31.23	--	--	--
ChC3_before_0605	500	0.88	95.64	0.63	3.74	2.89	1.80	0.09	0.01	0.01	14.16	--	--	--
ChC1_after_0605	float	1.08	93.02	0.71	5.20	3.03	2.10	0.14	0.02	0.01	15.63	--	--	--
ChC2_after_0605	interfloat	0.32	97.58	0.32	2.10	2.68	1.42	0.05	0.07	0.00	123.92	--	--	--
ChC3_after_0605	500	0.16	92.46	1.34	6.04	3.21	2.15	0.09	-0.01	0.01	16.14	--	--	--
ChC1_before_0705	float	0.06	97.00	0.41	2.54	2.71	1.56	0.10	0.08	0.01	23.30	--	--	--
ChC2_before_0705	interfloat	0.16	96.83	0.38	2.64	2.77	1.55	0.10	0.06	0.01	21.21	--	--	--
ChC3_before_0705	500	0.19	96.77	0.37	2.68	2.86	1.56	0.18	-0.01	0.02	10.86	--	--	--
ChC1_after_0705	float	1.24	91.42	1.17	6.17	3.17	2.22	0.35	0.14	0.03	21.66	--	--	--
ChC2_after_0705	interfloat	1.17	95.83	0.47	2.53	2.78	1.56	0.08	0.01	0.01	9.25	--	--	--
ChC3_after_0705	500	0.11	96.01	0.53	3.34	2.92	1.70	0.17	0.07	0.03	9.78	--	--	--

Table 5. Macrofaunal abundance (per 0.03 m^2) at Location CC under the floats and in the control area.

Taxa (by genus)	**Float**	**Control**	**p-value**
Nereids	1	0	0.34
Capitellids	0	0	1.00
Unidentified Polychaetes	0	2	0.31
Syllids	0	0	1.00
Total Polychaetes	*1*	*2*	*0.5*
Argulus	0	0	1.00

Table 6. Macrofaunal abundance (per 0.03 m^2) at Location BC under the floats and in the control area.

Taxa (by genus)	**Float**	**Control**	**p-value**
Nereids	3	14	0.03
Capitellids	0	1	0.33
Unidentified Polychaetes	3	5	0.43
Syllids	4	6	0.66
Total Polychaetes	*10*	*26*	*0.04*
Argulus	5	0	0.32

Table 7. Macrofaunal biomass (in g/m^2) at both study locations under the floats and in control areas.

Study Location	**Float**	**Control**	**p-value**
CC	0.022 ± 0.008	0.18 ± 0.05	0.08
BC	no data	0.23 ± 0.13	------

Table 8. Meiofauna data for Location CC.

Site CC 2005 Meiofauna Data			Note : all organism numbers are per 10 cm^2										
Site Location	**Date**	**Temperature**	**Salinity**	**Replicate**	**Nematodes**	**Copepods**	**Ostracods**	**Polychaetes**	**Oligochaetes**	**Nauplii**	**Forams**	**Total Meiofauna**	**% Nematodes**
CC2_before	5/23/2005	26.0	15.0	1	298.2	0.0	0.0	0.0	0.0	0.0	0.0	298.2	100.0
CC2_before	5/23/2005	26.0	15.0	2	269.4	28.9	0.0	0.0	0.0	0.0	0.0	298.3	90.3
CC2_before	5/23/2005	26.0	15.0	3	57.7	9.6	0.0	0.0	0.0	0.0	0.0	67.3	85.7
CC3_before	5/23/2005	26.0	15.0	1	548.3	0.0	0.0	0.0	0.0	19.2	0.0	567.5	96.6
CC3_before	5/23/2005	26.0	15.0	2	86.6	0.0	0.0	0.0	0.0	0.0	0.0	86.6	100.0
CC3_before	5/23/2005	26.0	15.0	3	269.4	0.0	0.0	0.0	0.0	0.0	0.0	269.4	100.0
CC15_before	5/23/2005	26.0	15.0	1	471.4	28.9	0.0	0.0	0.0	9.6	0.0	509.9	92.4
CC15_before	5/23/2005	26.0	15.0	2	529.1	38.5	9.6	0.0	0.0	0.0	0.0	577.2	91.7
CC15_before	5/23/2005	26.0	15.0	3	481.0	19.2	9.6	0.0	0.0	0.0	0.0	509.8	94.4
CC2_before	6/24/2005	30.0	17.0	1	1065.6	9.6	9.6	0.0	0.0	0.0	0.0	1084.8	98.2
CC2_before	6/24/2005	30.0	17.0	2	192.0	0.0	0.0	0.0	0.0	0.0	0.0	192.0	100.0
CC2_before	6/24/2005	30.0	17.0	3	76.8	9.6	0.0	0.0	0.0	0.0	0.0	86.4	88.9
CC3_before	6/24/2005	30.0	17.0	1	307.2	0.0	0.0	0.0	0.0	0.0	0.0	307.2	100.0
CC3_before	6/24/2005	30.0	17.0	2	528.0	0.0	0.0	0.0	0.0	0.0	0.0	528.0	100.0
CC3_before	6/24/2005	30.0	17.0	3	96.0	0.0	0.0	0.0	0.0	0.0	0.0	96.0	100.0
CC15_before	6/24/2005	30.0	17.0	1	662.4	0.0	0.0	0.0	0.0	9.6	0.0	672.0	98.6
CC15_before	6/24/2005	30.0	17.0	2	259.2	0.0	9.6	0.0	0.0	0.0	0.0	268.8	96.4
CC15_before	6/24/2005	30.0	17.0	3	614.4	0.0	9.6	0.0	0.0	0.0	0.0	624.0	98.5
CC2_after	6/24/2005	28.0	18.0	1	240.0	9.6	0.0	0.0	0.0	0.0	0.0	249.6	96.2
CC2_after	6/24/2005	28.0	18.0	2	1094.4	28.8	0.0	9.6	0.0	57.6	0.0	1190.4	91.9
CC2_after	6/24/2005	28.0	18.0	3	230.4	9.6	0.0	0.0	0.0	0.0	0.0	240.0	96.0
CC3_after	6/24/2005	28.0	18.0	1	1324.8	28.8	0.0	0.0	0.0	0.0	0.0	1353.6	97.9
CC3_after	6/24/2005	28.0	18.0	2	777.6	19.2	0.0	0.0	0.0	0.0	0.0	796.8	97.6
CC3_after	6/24/2005	28.0	18.0	3	288.0	9.6	0.0	0.0	0.0	0.0	0.0	297.6	96.8
CC15_after	6/24/2005	28.0	18.0	1	1248.0	19.2	0.0	0.0	9.6	0.0	0.0	1276.8	97.7
CC15_after	6/24/2005	28.0	18.0	2	1286.4	28.8	9.6	0.0	0.0	0.0	0.0	1324.8	97.1
CC15_after	6/24/2005	28.0	18.0	3	345.6	19.2	0.0	0.0	0.0	9.6	0.0	374.4	92.3
CC2_after	7/29/2005	33.5	17.0	1	249.6	0.0	0.0	0.0	0.0	9.6	0.0	259.2	96.3
CC2_after	7/29/2005	33.5	17.0	2	374.4	0.0	0.0	0.0	0.0	0.0	0.0	374.4	100.0
CC2_after	7/29/2005	33.5	17.0	3	192.0	0.0	0.0	0.0	0.0	0.0	0.0	192.0	100.0
CC3_after	7/29/2005	33.5	17.0	1	758.4	0.0	0.0	0.0	0.0	0.0	0.0	758.4	100.0
CC3_after	7/29/2005	33.5	17.0	2	1094.4	0.0	0.0	0.0	0.0	0.0	0.0	1094.4	100.0
CC3_after	7/29/2005	33.5	17.0	3	739.2	0.0	0.0	0.0	0.0	0.0	0.0	739.2	100.0
CC15_after	7/29/2005	33.5	17.0	1	566.4	0.0	0.0	0.0	0.0	0.0	0.0	566.4	100.0
CC15_after	7/29/2005	33.5	17.0	2	326.4	0.0	0.0	0.0	0.0	0.0	0.0	326.4	100.0
CC15_after	7/29/2005	33.5	17.0	3	268.8	0.0	0.0	0.0	0.0	0.0	0.0	268.8	100.0

Table 9. Meiofauna data for Location BC.

Site BC 2005 Meiofauna Data			Note : all organism numbers are per 10 cm^2										
Site Location	Date	Temperature	Salinity	Replicate	Nematodes	Copepods	Ostracods	Polychaetes	Oligochaetes	Nauplii	Forams	Total Meiofauna	% Nematodes
BC1_before	5/23/2005	24.9	10.0	1	134.7	48.1	19.2	0.0	0.0	28.9	0.0	230.9	58.3
BC1_before	5/23/2005	24.9	10.0	2	654.2	0.0	9.6	0.0	0.0	28.9	0.0	692.7	94.4
BC1_before	5/23/2005	24.9	10.0	3	96.2	0.0	9.6	0.0	0.0	0.0	0.0	105.8	90.9
BC2_before	5/23/2005	24.9	10.0	1	490.6	67.3	57.7	0.0	28.9	0.0	0.0	644.5	76.1
BC2_before	5/23/2005	24.9	10.0	2	38.5	9.6	0.0	0.0	0.0	0.0	0.0	48.1	80.0
BC2_before	5/23/2005	24.9	10.0	3	38.5	0.0	0.0	0.0	0.0	0.0	0.0	38.5	100.0
BC15_before	5/23/2005	24.9	10.0	1	48.1	19.2	9.6	0.0	0.0	9.6	0.0	86.5	55.6
BC15_before	5/23/2005	24.9	10.0	2	67.3	9.6	19.2	0.0	9.6	28.9	0.0	134.6	50.0
BC15_before	5/23/2005	24.9	10.0	3	452.1	28.9	9.6	0.0	0.0	19.2	0.0	509.8	88.7
BC1_before	7/22/2005	32.0	15.0	1	240.0	0.0	0.0	0.0	0.0	0.0	0.0	240.0	100.0
BC1_before	7/22/2005	32.0	15.0	2	67.2	0.0	0.0	0.0	0.0	0.0	0.0	67.2	100.0
BC1_before	7/22/2005	32.0	15.0	3	38.4	0.0	0.0	0.0	0.0	0.0	0.0	38.4	100.0
BC2_before	7/22/2005	32.0	15.0	1	134.4	0.0	0.0	0.0	0.0	0.0	0.0	134.4	100.0
BC2_before	7/22/2005	32.0	15.0	2	249.6	0.0	0.0	0.0	0.0	0.0	0.0	249.6	100.0
BC2_before	7/22/2005	32.0	15.0	3	48.0	0.0	0.0	0.0	0.0	0.0	0.0	48.0	100.0
BC15_before	7/22/2005	32.0	15.0	1	633.6	0.0	0.0	0.0	0.0	0.0	0.0	633.6	100.0
BC15_before	7/22/2005	32.0	15.0	2	288.0	0.0	0.0	0.0	0.0	0.0	0.0	288.0	100.0
BC15_before	7/22/2005	32.0	15.0	3	556.8	0.0	0.0	0.0	0.0	0.0	0.0	556.8	100.0
BC1_after	7/22/2005	31.0	15.0	1	211.2	9.6	0.0	0.0	0.0	0.0	0.0	220.8	95.7
BC1_after	7/22/2005	31.0	15.0	2	105.6	0.0	0.0	0.0	0.0	0.0	0.0	105.6	100.0
BC1_after	7/22/2005	31.0	15.0	3	144.0	0.0	19.2	0.0	0.0	0.0	0.0	163.2	88.2
BC2_after	7/22/2005	31.0	15.0	1	624.0	19.2	0.0	0.0	0.0	0.0	0.0	643.2	97.0
BC2_after	7/22/2005	31.0	15.0	2	172.8	0.0	0.0	0.0	0.0	0.0	0.0	172.8	100.0
BC2_after	7/22/2005	31.0	15.0	3	854.4	9.6	0.0	0.0	0.0	0.0	0.0	864.0	98.9
BC15_after	7/22/2005	31.0	15.0	1	595.2	9.6	0.0	0.0	9.6	0.0	0.0	614.4	96.9
BC15_after	7/22/2005	31.0	15.0	2	470.4	0.0	0.0	0.0	0.0	0.0	0.0	470.4	100.0
BC15_after	7/22/2005	31.0	15.0	3	57.6	0.0	0.0	0.0	0.0	9.6	0.0	67.2	85.7

Table 10. Meiofauna data for Location ChC.

Site ChC 2005 Meiofauna Data			Note : all organism numbers are per 10 cm^2										
Site Location	**Date**	**Temperature**	**Salinity**	**Replicate**	**Nematodes**	**Copepods**	**Ostracods**	**Polychaetes**	**Oligochaetes**	**Nauplii**	**Forams**	**Total Meiofauna**	**% Nematodes**
ChC1_before	5/25/2005	24.5	30.0	1	202.0	0.0	9.6	0.0	0.0	0.0	0.0	211.6	95.5
ChC1_before	5/25/2005	24.5	30.0	2	125.1	0.0	0.0	0.0	0.0	0.0	0.0	125.1	100.0
ChC1_before	5/25/2005	24.5	30.0	3	115.4	0.0	9.6	28.9	0.0	0.0	0.0	153.9	75.0
ChC2_before	5/25/2005	24.5	30.0	1	288.6	19.2	0.0	19.2	0.0	0.0	0.0	327.0	88.3
ChC2_before	5/25/2005	24.5	30.0	2	288.6	9.6	19.2	9.6	0.0	19.2	0.0	346.2	83.4
ChC2_before	5/25/2005	24.5	30.0	3	307.8	0.0	0.0	9.6	0.0	19.2	0.0	336.6	91.4
ChC3_before	5/25/2005	24.5	30.0	1	279.0	0.0	19.2	0.0	0.0	9.6	0.0	307.8	90.6
ChC3_before	5/25/2005	24.5	30.0	2	134.7	9.6	0.0	0.0	0.0	0.0	0.0	144.3	93.3
ChC3_before	5/25/2005	24.5	30.0	3	105.8	19.2	9.6	9.6	0.0	0.0	0.0	144.2	73.4
ChC1_after	5/25/2005	25.5	32.5	1	230.9	9.6	0.0	0.0	0.0	0.0	0.0	240.5	96.0
ChC1_after	5/25/2005	25.5	32.5	2	288.6	19.2	9.6	0.0	0.0	0.0	0.0	317.4	90.9
ChC1_after	5/25/2005	25.5	32.5	3	182.8	9.6	0.0	28.9	0.0	0.0	0.0	221.3	82.6
ChC2_after	5/25/2005	25.5	32.5	1	86.6	9.6	0.0	0.0	0.0	0.0	0.0	96.2	90.0
ChC2_after	5/25/2005	25.5	32.5	2	182.8	19.2	9.6	0.0	0.0	0.0	0.0	211.6	86.4
ChC2_after	5/25/2005	25.5	32.5	3	288.6	0.0	9.6	0.0	0.0	0.0	0.0	298.2	96.8
ChC3_after	5/25/2005	25.5	32.5	1	269.4	9.6	0.0	0.0	0.0	0.0	0.0	279.0	96.6
ChC3_after	5/25/2005	25.5	32.5	2	250.1	28.9	19.2	0.0	0.0	0.0	0.0	298.2	83.9
ChC3_after	5/25/2005	25.5	32.5	3	173.2	19.2	19.2	0.0	0.0	0.0	0.0	211.6	81.9
ChC1_before	6/19/2005	28.0	30.0	1	375.2	38.5	0.0	9.6	0.0	9.6	0.0	432.9	86.7
ChC1_before	6/19/2005	28.0	30.0	2	307.2	0.0	19.2	0.0	0.0	19.2	0.0	345.6	88.9
ChC1_before	6/19/2005	28.0	30.0	3	67.2	9.6	0.0	0.0	0.0	0.0	0.0	76.8	87.5
ChC2_before	6/19/2005	28.0	30.0	1	57.7	0.0	0.0	9.6	0.0	9.6	0.0	76.9	75.0
ChC2_before	6/19/2005	28.0	30.0	2	182.4	0.0	9.6	0.0	0.0	0.0	0.0	192.0	95.0
ChC2_before	6/19/2005	28.0	30.0	3	163.2	0.0	0.0	0.0	0.0	0.0	0.0	163.2	100.0
ChC3_before	6/19/2005	28.0	30.0	1	625.3	0.0	0.0	0.0	0.0	19.2	0.0	644.5	97.0
ChC3_before	6/19/2005	28.0	30.0	2	604.8	9.6	9.6	9.6	0.0	0.0	0.0	633.6	95.5
ChC3_before	6/19/2005	28.0	30.0	3	508.8	9.6	0.0	9.6	0.0	9.6	0.0	537.6	94.6
ChC1_after	6/19/2005	27.0	30.0	1	413.7	38.5	9.6	0.0	9.6	0.0	0.0	471.4	87.8
ChC1_after	6/19/2005	27.0	30.0	2	211.6	0.0	9.6	9.6	0.0	0.0	0.0	230.8	91.7
ChC1_after	6/19/2005	27.0	30.0	3	192.4	0.0	0.0	0.0	9.6	0.0	0.0	202.0	95.2
ChC2_after	6/19/2005	27.0	30.0	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ChC2_after	6/19/2005	27.0	30.0	2	96.2	0.0	0.0	9.6	0.0	9.6	0.0	115.4	83.4
ChC2_after	6/19/2005	27.0	30.0	3	144.3	0.0	9.6	0.0	9.6	0.0	0.0	163.5	88.3
ChC3_after	6/19/2005	27.0	30.0	1	173.2	9.6	0.0	0.0	0.0	0.0	0.0	182.8	94.7
ChC3_after	6/19/2005	27.0	30.0	2	644.5	9.6	19.2	19.2	0.0	9.6	0.0	702.1	91.8
ChC3_after	6/19/2005	27.0	30.0	3	606.1	9.6	0.0	9.6	0.0	0.0	0.0	625.3	96.9
ChC1_before	7/27/2005	31.5	31.0	1	480.0	0.0	19.2	0.0	0.0	0.0	0.0	499.2	96.2
ChC1_before	7/27/2005	31.5	31.0	2	153.6	0.0	0.0	19.2	19.2	0.0	0.0	192.0	80.0
ChC1_before	7/27/2005	31.5	31.0	3	460.8	0.0	0.0	9.6	0.0	9.6	0.0	480.0	96.0
ChC2_before	7/27/2005	31.5	31.0	1	307.2	0.0	0.0	0.0	0.0	0.0	0.0	307.2	100.0
ChC2_before	7/27/2005	31.5	31.0	2	624.0	0.0	0.0	9.6	0.0	0.0	0.0	633.6	98.5
ChC2_before	7/27/2005	31.5	31.0	3	470.4	0.0	0.0	0.0	0.0	9.6	0.0	480.0	98.0
ChC3_before	7/27/2005	31.5	31.0	1	124.8	9.6	28.8	9.6	0.0	19.2	0.0	192.0	65.0
ChC3_before	7/27/2005	31.5	31.0	2	2160.0	28.8	9.6	9.6	0.0	0.0	0.0	2208.0	97.8
ChC3_before	7/27/2005	31.5	31.0	3	710.4	0.0	9.6	0.0	0.0	9.6	0.0	729.6	97.4
ChC1_after	7/27/2005	32.5	34.0	1	28.8	0.0	0.0	0.0	0.0	0.0	0.0	28.8	100.0
ChC1_after	7/27/2005	32.5	34.0	2	201.6	0.0	19.2	0.0	28.8	28.8	0.0	278.4	72.4
ChC1_after	7/27/2005	32.5	34.0	3	364.8	19.2	0.0	0.0	0.0	0.0	0.0	384.0	95.0
ChC2_after	7/27/2005	32.5	34.0	1	249.6	0.0	0.0	0.0	0.0	0.0	0.0	249.6	100.0
ChC2_after	7/27/2005	32.5	34.0	2	489.6	0.0	9.6	9.6	0.0	9.6	0.0	518.4	94.4
ChC2_after	7/27/2005	32.5	34.0	3	211.2	0.0	0.0	0.0	0.0	0.0	0.0	211.2	100.0
ChC3_after	7/27/2005	32.5	34.0	1	1180.8	0.0	9.6	0.0	0.0	19.2	0.0	1209.6	97.6
ChC3_after	7/27/2005	32.5	34.0	2	1046.4	9.6	0.0	0.0	0.0	9.6	0.0	1065.6	98.2
ChC3_after	7/27/2005	32.5	34.0	3	921.6	0.0	9.6	0.0	0.0	19.2	0.0	950.4	97.0

Table 11. Average total number of meiofauna (per 10 cm^2) for the three study locations before and after low tide in May, June and July 2005. ND – no data.

A. Total meiofauna at Locations CC, BC and ChC before and after low tide May 2005.

Location	**Float**		**Interfloat**		**Control**	
	Before	After	Before	After	Before	After
CC	307 ± 140	ND	221 ± 77	ND	532 ± 22	ND
BC	343 ± 178	ND	243 ± 200	ND	244 ± 134	ND
ChC	163 ± 25	259 ± 29	336 ± 6	202 ± 59	199 ± 55	263 ± 26

B. Total meiofauna at Locations CC, BC and ChC before and after low tide June 2005.

Location	**Float**		**Interfloat**		**Control**	
	Before	After	Before	After	Before	After
CC	310 ± 124	816 ± 305	454 ± 317	560 ± 315	522 ± 127	992 ± 309
BC	ND	ND	ND	ND	ND	ND
ChC	605 ± 34	503 ± 162	285 ± 107	301 ± 85	144 ± 35	93 ± 49

C. Total meiofauna at Locations CC, BC and ChC before and after low tide July 2005.

Location	**Float**		**Interfloat**		**Control**	
	Before	After	Before	After	Before	After
CC	ND	864 ± 115	ND	275 ± 53	ND	387 ± 91
BC	115 ± 63	163 ± 33	144 ± 58	560 ± 204	493 ± 105	384 ± 164
ChC	390 ± 99	230 ± 105	474 ± 94	326 ± 97	1043 ± 603	1075 ± 75