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Amber C. Metallo
Nova Southeastern University, am2486@nova.edu

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HALMOS COLLEGE OF NATURAL SCIENCES AND
OCEANOGRAPHY

A Comparison of Macroinfaunal Community Structure between Artificial Concrete Boulder Reefs and Adjacent Natural Reefs in Broward County, Florida

By: Amber C. Metallo

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Masters of Science: Marine Biology and Coastal Zone Management

Amber C. Metallo
Nova Southeastern University
Halmos College of Natural Sciences and Oceanography

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Approved: Thesis Committee

Major Professor :______________________________ Charles Messing, Ph.D.

Committee Member :______________________________Amy Hirons, Ph.D.

Committee Member :____________________________Christopher Blanar, Ph.D.

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Abstract

Relatively little is known about either the biological (i.e., predation) or physical (i.e., current, sedimentation) effects that artificial reefs may have on surrounding benthic infaunal communities. Following deployment of artificial reefs (concrete boulders) between the first and second reefs off Fort Lauderdale, Florida, on 30 October 2009, sediment cores were taken at 4 distances along three replicate 10-m transects on 13 and 26 September 2013, and 24 and 25 May 2014 at each of four artificial reef sites and four of their adjacent natural reef sites using SCUBA. Infauna (>0.5mm) were extracted from the sediment and identified to the lowest possible taxonomic level. Statistical analysis (PRIMER, PERMANOVA, SIMPER) focused on four main variables: type of reef, year, site, and distance. Type of reef, year, and site was significantly different between samples, while distance did not affect density. There is a clear separation of communities between the artificial and natural reefs. From 2013 to 2014, a slight shift occurred between communities suggesting the artificial reef community composition became slightly more similar to the natural reef. All four artifical reef sites were more taxonomically distinct at the phylum and class level then the natural reef, which had higher diversity, higher species richness and more low-density taxa. This two year study provides insight on infauna communities four and five years out from deployment, but follow up monitoring in 3-5 years could shed light on whether these patterns of shift to more similar assemblages between reefs will continue as the artificial reef matures. Environmental data collection including longer time-series datasets, longer transects, and physical and geological data could provide more knowledge of how the artificial reef infaunal communities are changing over time.

KEYWORDS: Infauna, Taxa, Artificial Reef, Natural Reef, Broward County, Florida, Community Ecology

Introduction

Artificial reefs are widely deployed tools for resource management and ecosystem protection and rehabilitation, because coastal ecosystems are vulnerable to damage by storms or other natural occurrences, as well as an array of anthropogenic impacts (Bohnsack and Sutherland 1985; Hueckel et al. 1989; Bohnsack et al.1994; Pickering et al. 1998; Pinnegar et al. 2000; Svane and Petersen 2001; Spieler et al. 2001; Perkol-Finkel et al. 2006; Walker and Schlacher 2014). These structures provide barriers or habitats that attempt to increase the health and biomass of affected areas (Pickering et al. 1998; Bohnsack 1989). Artificial reefs not only help the underwater communities, but can also contribute to tourism and revenue as sites for recreational diving and sport fishing (Chang 1985; Milon 1989; Santos and Monteiro 1997; Bortone et al. 1998; Pickering et al. 1998; Krohling et al. 2006).

Although artificial reefs have been deployed for centuries to improve fishing yields (Baine 2001), experimental investigations were first begun in the Mediterranean Sea in the 1970s to counter lost fishery resources and overfishing pressure (Ardizzone 1989; Bombace 1989). By 2000, eight European Union countries (Finland, France, Greece, Italy, Portugal, Spain, Netherlands, and United Kingdom) had implemented artificial reef research programs (Jensen 2002). The European Artificial Reef Research Network (EARRN) was set up to recommend to the European Commission the direction of future artificial reef research (Jensen 2002). EARRN defined an artificial reef as a submerged structure deliberately placed on the seafloor to mimic a natural reef. Artificial reefs have been deployed in Europe to prevent trawling, in Japan to increase fisheries yield and production, and in the United States for recreational diving (Baine 2001). Artificial reefs are usually constructed on extensive sand plains to attract fish and sessile organisms to increase local biomass and provide hard surfaces for larval settlement (Ambrose and Anderson 1990; Shahbudin et al. 2011). Although artificial reefs may not recreate the entire community of a natural reef, they can improve habitat complexity on the local scale (Wilding and Sayer 2002).

These structures disturb underlying and surrounding infaunal communities (Davis et al. 1982; Ambrose and Anderson 1990). Divers and tourists view reef fish, sharks, and macroinvertebrates as signs of a healthy reef, but the infauna, the organisms living within the sediment on the seafloor, are often overlooked (Relini et al. 1994; Danovaro et al. 2002). Infaunal organisms range from bacteria to large mollusks, worms and echinoderms. Those large enough to be retained on a 0.5-mm sieve are treated as macrofauna and are the most studied (Brenchley 1982; Davis et al. 1982; Fitzhardinge and Bailey-Brock 1989; Ambrose and Anderson 1990; Jensen et al. 1994; Posey and Ambrose 1994; Barros et al. 2001; Fabi et al. 2002; People et al. 2006). However, few studies have investigated relationships between infaunal assemblages in the sediment and adjacent reefs and associated fish fauna (Davis et al. 1982; Wendt et al. 1989; Bombace et al. 1994; Cummings 1994; Spieler et al. 2001; Hirons et al. 2015).

Artificial reefs vary in size, material, and purpose. They range from single structures, such as a ship or plane, to arrays of separate units (Pickering et al. 1998). Location, purpose and available materials affect the size of the reef. Materials range from concrete block to rubber, depending on the purpose of the reef and where it is constructed (Fitzhardinge and Bailey-Brock 1989; Jensen et al. 1994; Pickering et al. 1998; Sherman et al. 2002). Automotive tires have been used in some areas, such as Australia, Jamaica, and the Philippines (Pickering et al. 1998; Collins et al. 2002), but are avoided in Europe because they are a potential source of polluting leachate (Pickering et al. 1998). Used car tires were deployed one mile offshore Fort Lauderdale, Florida, in an attempt to create the world’s largest artificial reef while simultaneously removing tires from landfills. However, this idea proved to be a disaster after a hurricane strewed the tires across the seafloor (Finkl and Makowski 2010). Oil-ash concrete is another popular material because of its durability, but because the levels of metal in the concrete could affect larval settlement, more studies are needed (Nelson et al. 1994; Vose and Nelson 1998). Planes, cars and boats that are properly prepared for submersion are used to enhance recreational diving opportunities. Preparation includes emptying fluids and removal of materials such as upholstery, which will break down in the water. The shell remains intact and serves as a refuge for many organisms and a hard surface for colonization by sessile invertebrates (Pickering et al. 1998).

Artificial reefs are regarded in a positive light because of the species they attract from surrounding communities. It remains uncertain, however, whether they only attract fish from other areas or whether biomass increases with the artificial reef becoming self-sustaining like adjacent natural reefs (Bohnsack and Sutherland 1985; Scarborough Bull and Kendall 1994; Perkol-Finkel and Benayahu 2007). Also, their deployment kills the organisms directly beneath them by either crushing or smothering. Additional studies are needed in order to fully understand how these structures function and affect surrounding seafloor communities.

Zajac and Whitlatch (1982) defined disturbance as any stochastic event initiating a change in a species' population from density-independent mortality or a change in the resource base of the community, or both. Artificial reefs can affect existing species abundance and distribution patterns as well as predator-prey interactions, sedimentation rates, and sediment organic content and grain-size distribution (Ambrose and Anderson 1990). Ambrose and Anderson (1990) and Carter et al. (1985) studied the Pendelton Artificial Reef (PAR) in San Diego County, California, and its influence on the surrounding infaunal community. PAR consists of eight rock piles on a sand-rock substrate at 13 m depth. These studies recorded a total of 121 taxa, 57% of which were polychaetes. Densities of some taxa were reduced within 10 m of the artificial reef and increased from 10 to 20 m away. Ambrose and Anderson (1990) determined that changes in seafloor physical characteristics between the modules, mainly sediment size, organic content of the sediment, and water movement, resulted lower infaunal densities then at the 20 m distances. Such reductions in densities can decrease food sources for upper trophic levels and lead to reduced biomass on the artificial reef. Polychaetes were the most abundant infaunal component in the PAR study likely due to their wide adaptive and reproductive capabilities (Gravina et al. 1989; Hutchings 1998).

Brooks et al. 2006 produced a literature synopsis of benthic faunal resources along the eastern U.S. and described dominant taxa found in 46 different studies. Of the 46 studies, 31 highlighted polychaetes as the dominant taxa. Four studies found amphipods and four studies found nematodes as the dominant taxa. Bivalves were the dominant taxa in two of the studies. By region, only three papers conducted infauna collection in the southeastern U.S. Of those three papers, one highlighted polychaetes, one highlighted archiannelids, and one highlighted bivalves as the dominant infaunal taxa (Brook et al. 2006).

Hughes et al. (1984) proposed a model concerning the structure and dynamics of benthic invertebrate communities that stated that disturbance and space availability, instead of food, were the two factors controlling diversity. Somaschini et al. (1997) used this model in a 10-year study of a polychaete community on an artificial substrate in the Mediterranean Sea. Their results indicated that the first two years of colonization (including other sessile invertebrates) followed Hughes model, but disturbance eventually led to a decline in community diversity. Gravina et al. (1989) found that polychaete communities were the least affected of invertebrates. They can adapt to physical environmental changes faster than other infaunal species and can opportunistically switch prey if their normal prey abundance is negatively impacted by environmental changes. The low diversity of some benthic species (i.e. crustaceans, gastropods) following deployment of an artificial reef can be correlated with the introduction of new predators (i.e. reef associated fish and predatory crustaceans) that are attracted to the artificial reef structures (Posey and Ambrose 1994).

Fabi et al. (2002) determined that artificial reefs increased organic matter accumulation in the surrounding infaunal community by changing and slowing water movement, which increased deposition of suspended particles. Suspended organic particles provide food to sessile organisms on the reef, but also increase the food supply to the surrounding community and increase species diversity. Sediment grain size also affects organism abundances. Changes in water movements by artificial structures lead to changes in sediment grain sizes near the reef (Barros et al. 2001). As water flows between the structures, it may increase in velocity and pick up larger sediment particles, or decrease, depositing suspended particles. Larger particle sizes may result in a decrease in sediment organic content, meaning less food availability. Smaller particle sizes near reefs may result in increased organic content and, perhaps, greater infaunal diversity (Fabi et al. 2002). Both burrowing infauna (i.e. Terebellidae, Cardiidae) and tube builders (Sabellidae, Serpulidae, Onuphidae) can be variously affected by changes in sediment grain size (Brenchley 1982; Gallagher et al. 1983).

Reef communities are often considered self-sustaining, but evidence suggests that the reef may just supply refuge, while fish and other predators get their nourishment from lower trophic-level organisms living in the surrounding sediment. Building artificial reefs in fairly undisturbed areas can greatly alter benthic community diversity once predators become established on the reef. Posey and Ambrose (1994) predicted that increased predator-prey interactions predict areas of decreased prey abundance near predator refugia. They targeted intermediate predators such as small fish and invertebrates in the middle of the trophic pyramid for study, because they forage on areas adjacent to the reef so they can hide from higher trophic level predators. Infauna samples were collected at four distances along the transect (1, 10, 25, 75m). The 1 and 10m distances showed low diversity, which is supported by the off-reef foraging distance of 5m-10m by reef-associated predators described in previous studies (Ambrose and Anderson 1990; Posey at al. 1992). Polychaetes, bivalves, isopods, scaphopods and total fauna were most abundant at the 75m distance (Posey and Ambrose 1994). Traveling only short distances from the reef to forage is beneficial for safety purposes, but generates lower infaunal diversity areas adjacent to reefs.

Danovaro et al. (2002) found that total meiofaunal densities significantly decreased within reef areas and between the individual reef boulders on two separate artificial reefs, one in the Adriatic Sea and one in the Tyrrhenian Sea. Many of the thriving taxa that did not previously have natural predators nearby decreased in abundance. Without these sand-bottom communities, the upper trophic level species may not have an alternate food source and would have to move to another refuge.

The current research project investigated patterns of macroinfaunal community composition and distribution relative to distance from a series of artificial and adjacent natural reefs in Broward County, Florida. Moyer et al. (2003) found that reefs in this area, which are among the northernmost along the southeast Florida coast, yielded similar Caribbean fauna species among the four inshore-offshore corridors that they sampled across the shore-parallel hard-substrate environments: ridge complex, inner, middle, and outer reef, but community structure differed from that of reefs elsewhere in the tropical western Atlantic (e.g., Bahamas, Florida Keys). These reef corridors are susceptible to fresh water input from runoff, sewage effluent, and varying substratum type between the ridge complex and outer reef. These reefs are also negatively impacted by recurring hurricanes and tropical storms (Moyer et al. 2003). Moyer et al. 2003 used Primer v.5 to create a multivariate statistical model comparing coral cover, species diversity, richness, spatial patterns and within-group similarities among the four corridors. The varying benthic community found between different reef locations could be attributed to the environmental and anthropogenic effects impacting nearshore waters in Broward County. In addition, Port Everglades' proximity to the Florida Department of Transportation (FDOT) manufactured concrete boulder reefs could be a driving factor in benthic infauna composition.

For the current study area, land-based pollution may represent a major problem due to shoreline development and the proximity of the Florida reef tract to Broward County's Port Everglades inlet. In 2012, Port Everglades had 4,000 ship calls and moved 5,944,513 tons of containerized cargo, not including smaller commercial and recreational boats that use the inlet (Cernak 2012). Dredging to keep the inlet open leads to sedimentation, and ships stir up the bottom, re-distributing heavy metals into the water column. The tides carry this polluted water out to the reef where suspended solids settle out and may enter the food web via primary consumers. Pinnegar et al. 2000). This is by no means just a local problem, e.g., Edinger and Risk (2000) described the effects of land-based pollution on nearshore reefs in Indonesia from untreated sewage, agricultural runoff, effluent from aquaculture and shrimp hatcheries, and sedimentation that resulted in low species diversity and high coral mortality.

Materials and Methods

Sample Sites

Samples were taken adjacent to a series of 12 artificial reefs consisting of piles of concrete boulders deployed on 30 October 2009 by the Florida Department of Transportation (FDOT) on sediment at an average depth of 17 m between the inner and middle reef tracts ~1.43-1.53 km offshore of Fort Lauderdale, Florida, and adjacent to the nearby natural inner and middle reefs (Figures 1, 2). The natural reefs consist of rubble at an average depth of ~11 (inner reef) and 18 m (outer reef).

Of the 12 artificial reefs, two close to the inner reef and two close to the middle reef were chosen for comparison with each other and with four corresponding sites adjacent to the natural inner and middle reefs at the same latitudes (Figures 2 and 3; Table 1). Sites are identified by number and letter combinations established by Florida

Fish and Wildlife Conservation Commission (FFWCC) during deployment: A or B for artificial reef sites and AN or BN for natural reef sites. Corresponding sites 3A and 3AN were 305 m apart, and sites 1A and 1AN, 5B and 5BN, and 6A and 6AN were each 275 m apart (Figure 4).

Table 1. Site location coordinates for the artificial and natural reef sites.

Artificial Reef Sites			Natural Reef Sites		
Site Name	Latitude	Longitude	Site Name	Latitude	Longitude
3A	26°09.1887	80°05.1449	3AN	26°09.1889	80°05.3373
6A	26°09.1148	80°05.1703	6AN	26°09.1158	80°05.3379
1A	26°09.1914	80°05.0944	1AN	26°09.1903	80°04.9324
5B	26°09.1201	80°05.0958	5BN	26°09.1190	80°04.9330

Three, 10-m-long parallel transects extending east to west, 2 m apart and designated north, middle and south, were established at each of the four sites, with transects at corresponding pairs of natural and artificial sites extending towards each other (e.g., west to east from natural site 3AN and east to west from artificial site 3A) (Figure 3). Transects at natural reef sites extended along an east-west orientation towards the adjacent manufactured concrete boulder sites. Ends of transect lines were marked with rebar hammered into the sediment by SCUBA divers. A sediment sample for infauna was taken at four distances from the hard substrate (0, 1, 3, and 7 m) along each of the three transect lines (north, middle and south) for a total of 12 infauna samples per site. Eight sites were sampled per year resulting in a collection of 96 infauna samples annually. A total of 192 infauna core samples were analyzed in this study.

The corer was composed of steel and measured 7 inches in height and 4 inches in diameter. Core samples varied in sediment volume due to the presence of coral rubble in the substrate. In 2014, separate sediment cores were taken directly to the right of the infauna core to provide sediment volumes for density calculations.

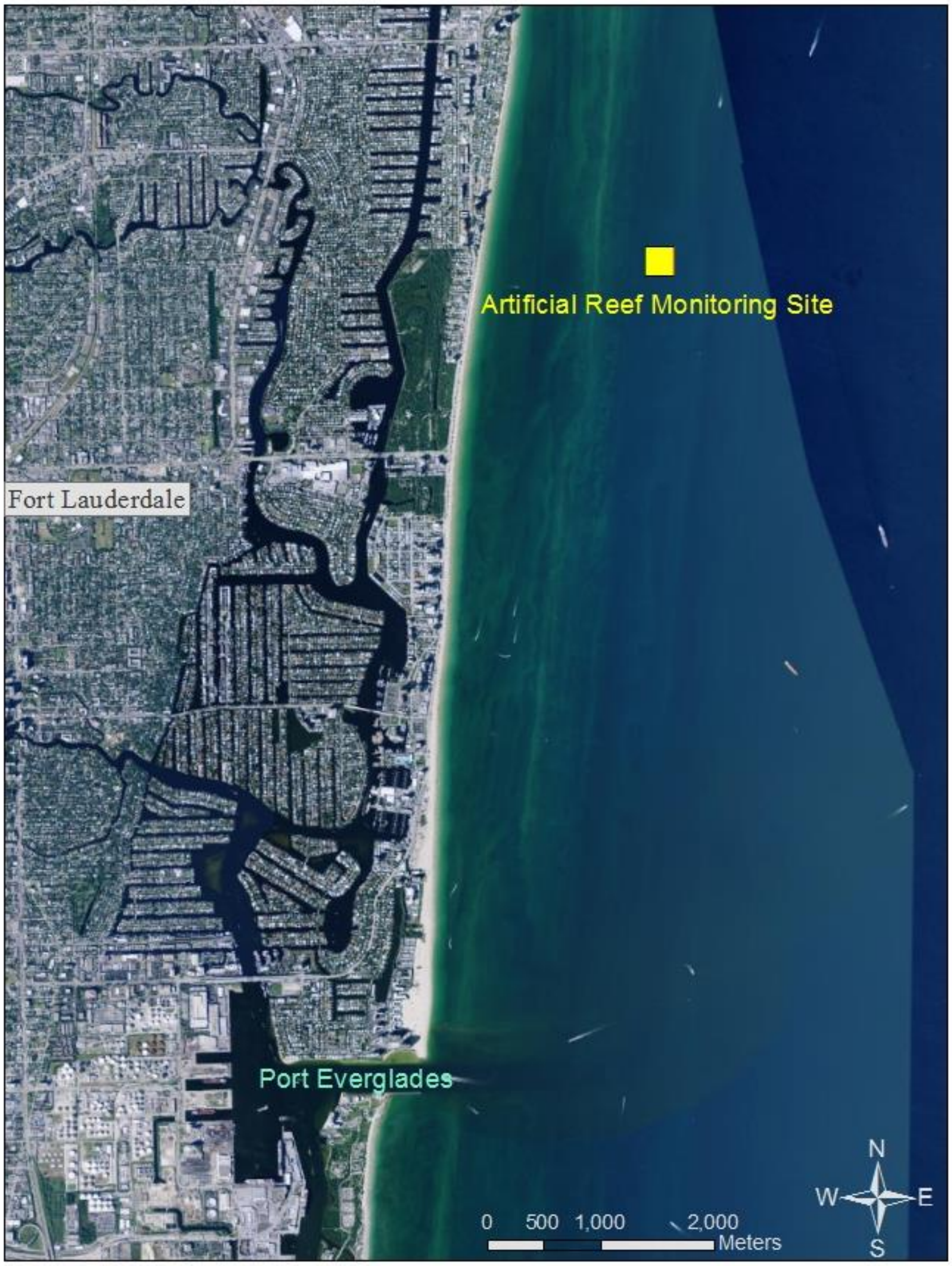

Figure 1. Map of artificial reef sampling site offshore Broward County, Florida (center of the reef: 26 09.195’N, 80 05.112’W).

Sampling of infauna

A total of 192 core samples were taken on 13 and 26 September 2013, and 24 and 25 May 2014. Divers first imbedded rebar immediately adjacent to hard substrate and 10 m distant and connected the two with transect tape. Individual core samples were taken adjacent to the tape by pressing a cylindrical metal push core, 10 cm across and 18 cm long, as far as it would penetrate into the substrate. Each sample was transferred on the seafloor from the core into a 1-gallon plastic Ziploc bag; bags were transported to the surface using ten-pound lift bags. On the boat, seawater was decanted from each bag and replaced with a 10% formalin/rose Bengal solution to 2.5 cm (1 inch) above the sediment layer. The sample was then thoroughly kneaded to mix the solution throughout the sediment. Rose Bengal is a biologic indicator that stains organism soft tissues and is used to improve contrast between organisms and sediment during sorting and identification at the laboratory. After 48 hours, samples were gently drained onto a 0.5-mm Nalgene screen and washed repeatedly with freshwater; the contents retained on the screen were then stored in glass jars with 70% ethanol.

Sieved samples were analyzed under a dissecting microscope. Sediment was removed a tablespoon at a time and spread out on a watch glass with enough 70% ethanol to keep the sediment wet. Fine tweezers were used to push 0.5-cm lines of sediment aside while looking for specimens. Specimens, including fragments, were removed from the sediment using forceps and placed in small vials filled with 70% ethanol. The vials were placed in jars labeled by site location, distance along transect, and year, and were stored until the specimens were examined for identification to lowest practical taxonomic level.

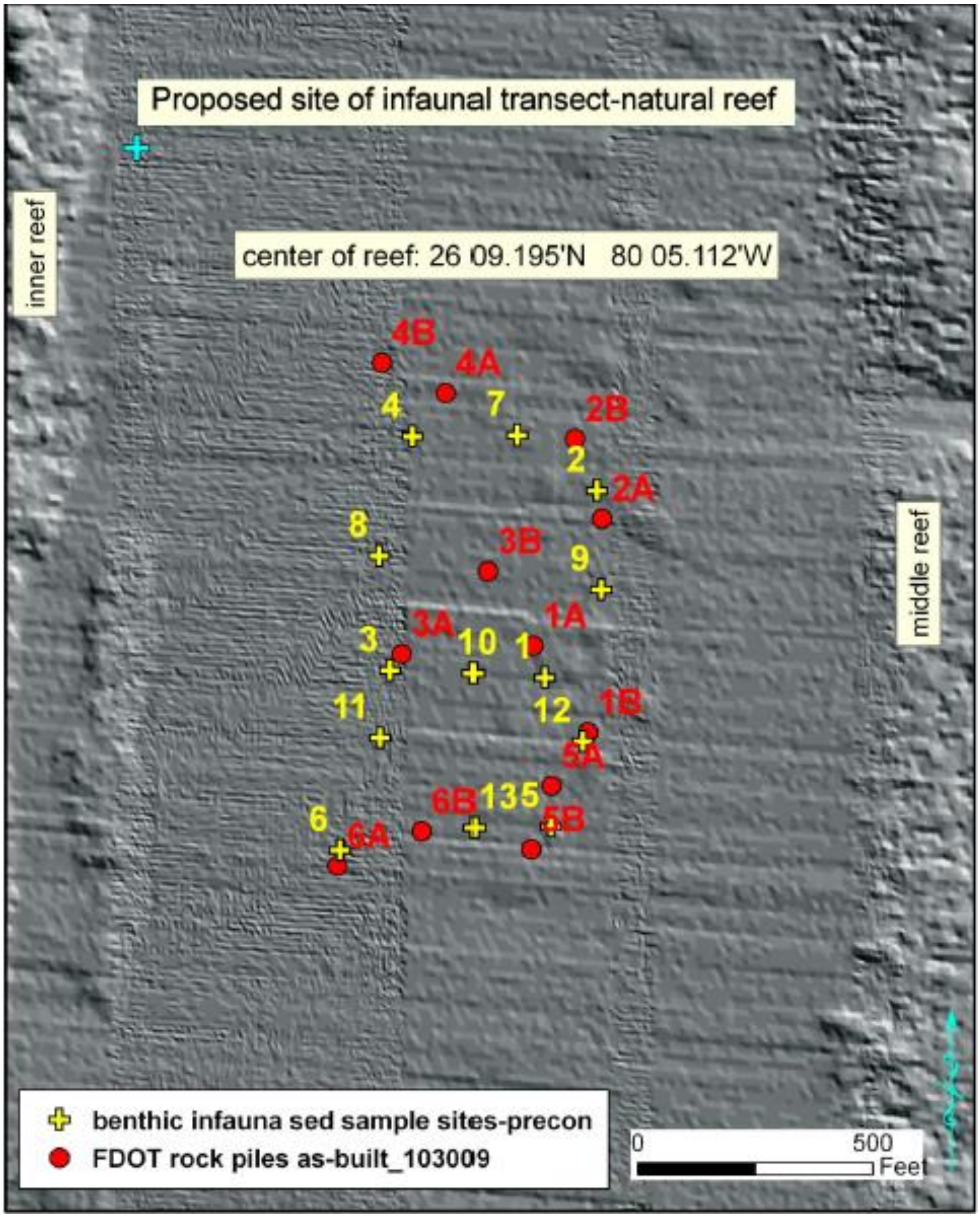

Figure 2. Study area between the inner (left) and middle reef (right) showing FDOT artificial reef concrete boulders deployed 30 October 2009 (red dots and labels), and locations of pre-construction infaunal sediment samples (yellow + signs and labels) (Hirons et al. 2015)

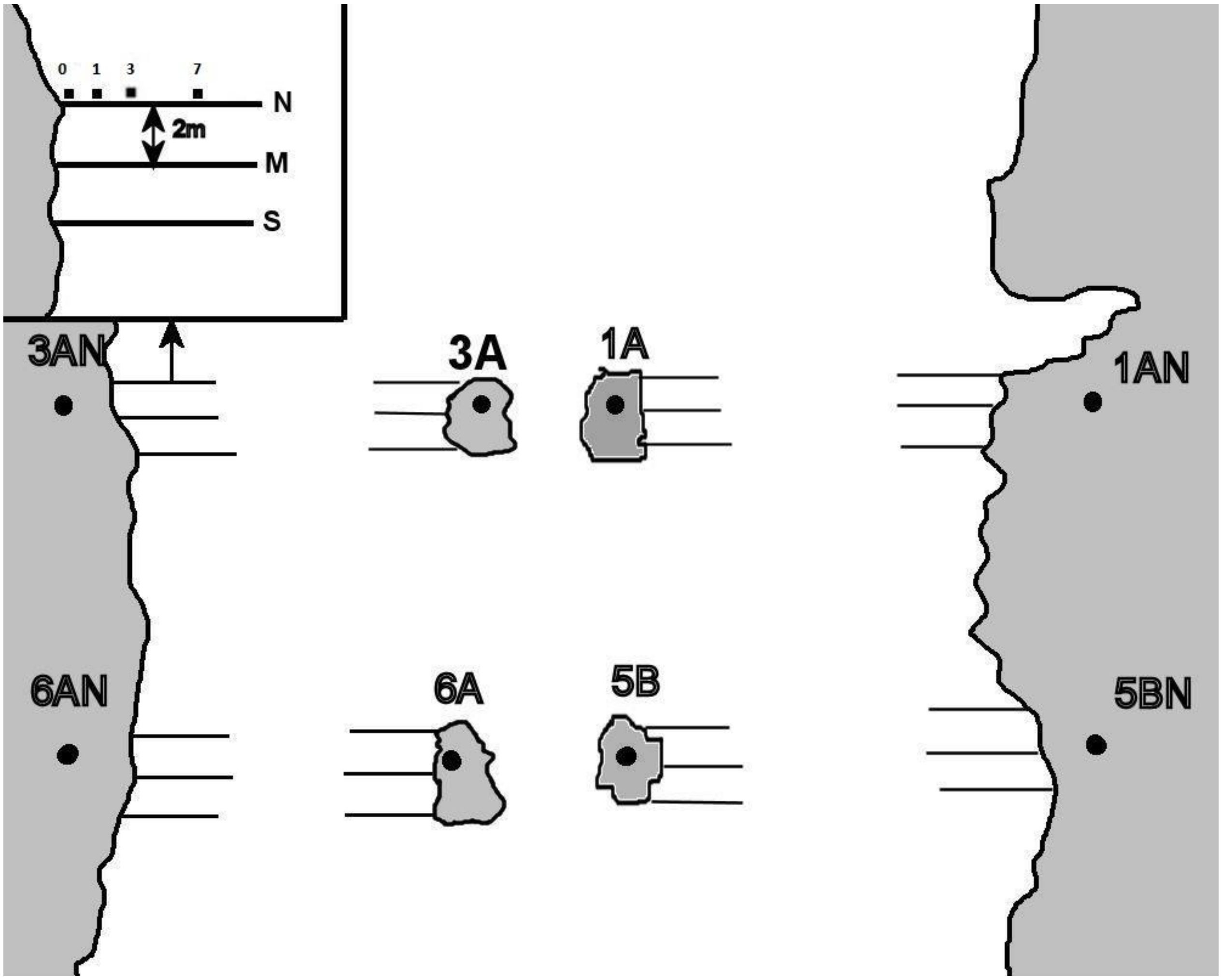

Figure 3. Layout of transects and core positions. Insert at upper left shows an enlarged view of site 3AN identifying the north (N), middle (M) and south (S) transects, and indicating the locations and distances of core samples along transects. Not drawn to scale.

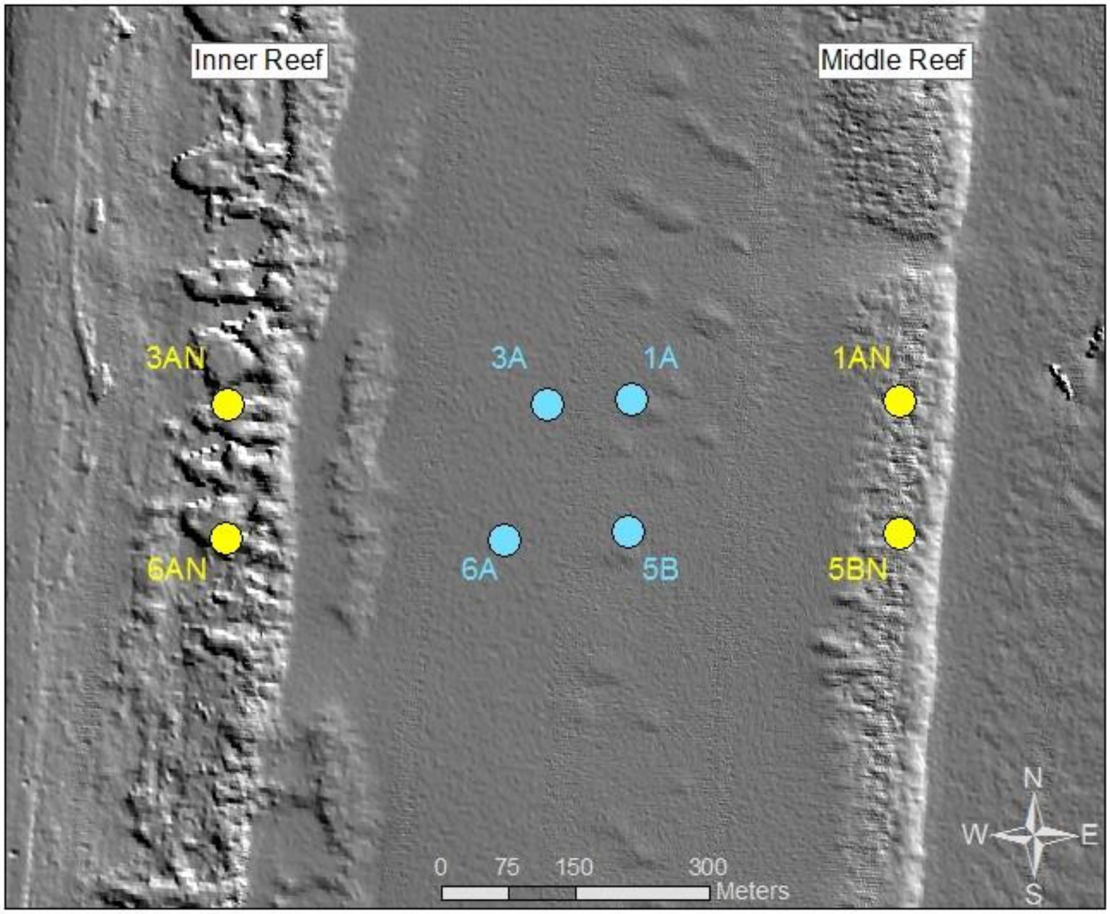

Figure 4. Location of artificial reef (blue dots) and adjacent natural reef sites (yellow dots) between the inner and middle reef tract. The distance between 1A and 1AN, 5B and 5BN, and 6A and 6AN is 275m. The distance between 3A and 3AN is 305m due to the inability to hammer the rebar into the substrate closer to the artificial site.

Sediment Collection

Sediment cores were taken during the 2014 sampling period (24 and 25 May 2014) along the North and South transects at each of the eight sites at four distances (0, 1, 3, and 7 m) for a total of eight samples per site and 64 samples for the year. Sediment samples were placed in a drying oven at 80° C for at least 24 hours. Dry weight of sediment was used to calculate density. The dry weight of the middle transect was calculated using the average of the North and South dry weights at each distance. Density was calculated for individual taxa of each sample as abundance of a given taxon/total grams of dry sediment at in core sample x 1000 = organism number kg^{-1} dry weight.

Dry weight of sediment ranged from 224.07 to 543.76 g for samples adjacent to natural reef and 240.93 to 844.16 g for artificial reef samples (Table 2). The smaller range and lower weights of the former were due to generally more abundant coral rubble immediately adjacent to the natural reefs and difficulty driving the core tube into the substrate. However, sediment volume showed no obvious pattern with distance along transects.

Taxonomic Treatment

The majority of mollusks and crustaceans were identified to genus and species. However, the majority of polychaetes were identified to family due to limited availability of taxonomic expertise. Fragments and specimens destroyed by the transport and washing process were identified to class if possible or discarded if they could not be identified.

Statistical Analysis

This study applied multivariate statistical analyses using the Plymouth Routines In Multivariate Ecological Research (PRIMER) to compare macroinfaunal diversity, richness, and density in post-construction sediment cores collected 13 and 26 September 2013 with those collected 24 and 25 May 2014 at each site, location along the transect, inner vs. middle reef, artificial vs. natural reef and sampling years (2013-2014). At each site, the three samples taken at the same distance from the hard substrate (e.g., 7-m samples from the three transects at 1AN) were treated as replicates. Thus, each of the two sampling years had 32 samples of three replicates each. Taxon richness, diversity and density were determined for all core samples and sites. Diversity is here referred to as taxon diversity as not all taxa were identified to species level. All cores were treated as individual samples.

Univariate tests on community richness and evenness

Community indices were calculated using the DIVERSE procedure to generate standard diversity indices: taxon diversity (S), and Pielou's evenness (J'). Average Phylogenetic Diversity (AVPD, or Phi+) was calculated to show the taxonomic structure of the communities at the class and phylum level. SPSS was used to design a General Linear Model (GLM) to test for effects due to type of reef, year, site, and distance.

Taxon diversity (S) applies to number of species. There are other species diversity type indices, but they all attempt to correct for difference in sampling effort or sampling size. This is pre-standardized by using density; therefore, S was used. Pielou's evenness (*J'*) determines the relative similarity in number of each taxon in a community. Pielou's evenness falls between zero and one; the less variation in numbers of different taxa in a community, the closer *J'* is to one. Pielou's evenness can be calculated using the following equation:

$$J' = \left(- \sum_{J=1}^{S} P_i ln P_i \right) / lnS$$

Average Phylogenetic Diversity (Phi+) determines how the densities of the different taxa are distributed, and how they are distributed among higher taxonomic levels (class and phylum). Phi+ is used in diversity studies in order to incorporate species differences and to give insight into community structure (Vellend et al. 2011).

Multivariate tests on community similarity

Bray Curtis similarities were calculated among all samples. The values range from 0-100% with Bray Curtis of 100% indicating two communities that have exactly the same taxa in the exact same densities. Conversely, values approaching zero designate few taxa in common with very different densities. This index is more useful than S or J' because it provides information on what taxa are present and their relative densities.

A PERMANOVA (permutational multivariate analysis of variance) was run to test for differences in the Bray Curtis similarities using type of reef, year, site, and distance as fixed factors in the analysis. The advantage of PERMANOVA is that it allows complex ANOVA and MANOVA type designs, but uses permutations of the data set to establish the null model. The test makes no assumptions, so the distribution of the data doesn't matter. Therefore, it is completely independent of the statistical distribution of the samples. PERMANOVA and MANOVA are similar (F statistics replaced by Pseudo-F) and can be used as a measure of effect size so factors can be ranked by how much effect they have on community structure.

Two-dimensional non-parametric multidimensional scaling (nMDS) figures were used to visualize the differences identified in the PERMANOVA analysis. SIMPER (similarity percentage) identifies the taxa that differ the most between levels of the factors (type of reef, year, site, and distance). SIMPER produces a ranked list of taxa that are represented on the nMDS as vectors. This process was repeated using summed densities by class and phylum. Distance from hard substrate was found not statistically significant and was not included in the two-dimensional non-parametric multidimensional scaling (nMDS) figures.

Results

A total of 226 taxa were identified at the artificial and natural reef sites in 2013 and 2014 (Appendix A1). Taxa were identified to the lowest taxon possible and included 6 phyla, 15 classes, 35 orders, 93 families, 92 genera, and 123 species. Of these, 9 were identified only to class, 4 to order, 50 to family, and 40 to genus. Figures 5 and 6 compare percentages of major taxa (≥5%) for each year at all sites (adjacent to both artificial and natural reefs). Table 2 shows the percentages for each major taxon by site and year. Malacostraca and Polychaeta were the two most abundant taxa at both artificial and natural reef sites. Bivalvia was relatively more abundant at artificial reef sites, while Oligochaeta and Gastropoda were more abundant at natural reef sites. Ranges of relative contributions of major taxa per site were: Bivalvia 2-21%, Oligochaeta 0-17%, Gastropoda 0-12%, Malacostraca 3-28%, and Polychaeta 34-68%. Other taxa ranged from 3-18% and included Echinoidea, Ostracoda, Leptocardii, Ophiuroidea, Holothuroidea, Scaphapoda, Cephalocarida, and Pycnogonida. Polyplacophora (0-5%) was a major taxon only at natural reef sites. Phascolosomatidea (0-23%) was a major taxon only at artificial reef sites. (Phascolosomatidea is a class in the former phylum Sipuncula, recently included within Annelida [Stuck *et al.* 2007]. It is maintained as a separate clade herein pending taxonomic revision.)

Two sites had low percentages of polychaetes and high percentages of malacostracans uncharacteristic of the other sites: natural reef site 3AN in 2013 (polychaetes 34% and malacostracans 28%), and artificial site 5B in 2014 (polychaetes 39% and malacostracans 18%). In 2014, artificial reef site 3A had an unusually high percentage of Phascolosomatidea (23%), and natural reef site 1AN was the only natural site to not yield any Oligochaeta.

Organism density at all sites and in both years ranged from 0.77 to 4.36 organisms kg^{-1} dry weight (dw). In 2013, mean densities ranged from 1.70 to 2.30 kg^{-1} dw at all distances, whereas in 2014, values were lower: 1.19-1.79 individuals kg^{-1} dw. Highest densities for a given distance from hard substrate were 2.78 kg^{-1} dw (0 m, site 5BN), 3.19 kg^{-1} dw (1 m, site 5BN), 4.36 kg^{-1} dw (3 m, site 3AN), 1.97 kg^{-1} dw (7 m, site 3AN).

Results of the General Linear Model analysis (GLM) found that taxon diversity (*S*) differed significantly as a function of type of reef, year, and site, but not distance (Table 3). Full GLM analysis of taxon diversity (*S*) between-subjects effects can be found in Appendix A2.

A boxplot of reef type by year shows that diversity was consistently lower at all artificial and natural reef sites in 2014 (Figure 7). Figure 8 shows that all four artificial reef sites for both years recorded significantly lower species than their adjacent natural reef sites. Pielou's evenness (*J'*) only showed significant differences among year and site, but not type of reef or distance (Table 3). Appendix A3 gives the full GLM analysis of Pielou's evenness between-subjects effects.

Data based on Pielou's evenness show that evenness increased in 2014 while species diversity and richness decreased (Figures 9, 10). Figure 9 shows no difference among means of each site when compared by reef type. This effect of reef type disappearing using Pielou's evenness means that the artificial and natural communities are equally even in terms of density distribution among taxa. However, when a comparison of reef type means by year found a significantly higher evenness for both reef types in 2014 (Figure 10). There is no pattern to the outliers on the boxplots and these outliers change depending on the graphing scale and representation.

Average Phylogenetic Diversity (Phi+) showed significant differences between reef type and years at the phylum and class level, but not among sites or distances (Table 3). Appendix A4 lists the full GLM analysis of Phi+ between-subjects effects. Taxonomic distinctness returned as higher on artificial reef sites, meaning that the taxa were not as closely related to each other phylogenetically at the phylum and class level as on the natural reef sites.

Table 2. Percentages of major infaunal taxa at all eight sites during 2013-2014.

Reef Type	Site	Year	Bivalvia	Oligochaeta	Gastropoda	Malacostraca	Phascolosomatidea	Polychaeta	Other	Total%
Artificial	1A	2013	11	2	1	9	5	64	9	100
	1A	2014	21	0	2	11	12	51	3	100
	3A	2013	12	4	0	8	5	61	11	100
	3A	2014	17	0	1	9	23	45	6	100
	5B	2013	15	3	2	7	0	62	11	100
	5B	2014	18	0	0	18	11	39	13	100
	6A	2013	9	4	1	3	5	68	11	100
	6A	2014	8	0	0	11	22	42	18	100
	Site	Year	Bivalvia	Oligochaeta	Gastropoda	Malacostraca	Polyplacophora	Polychaeta	Other	
Natural	1AN	2013	13	2	6	10	1	63	6	100
	1AN	2014	9	0	7	8	0	64	11	100
	3AN	2013	2	6	12	28	5	34	11	100
	3AN	2014	8	17	8	7	0	55	6	100
	5BN	2013	12	3	6	5	2	66	6	100
	5BN	2014	8	7	6	14	0	56	8	100
	6AN	2013	9	11	6	17	0	51	5	100
	6AN	2014	10	13	5	7	0	60	6	100

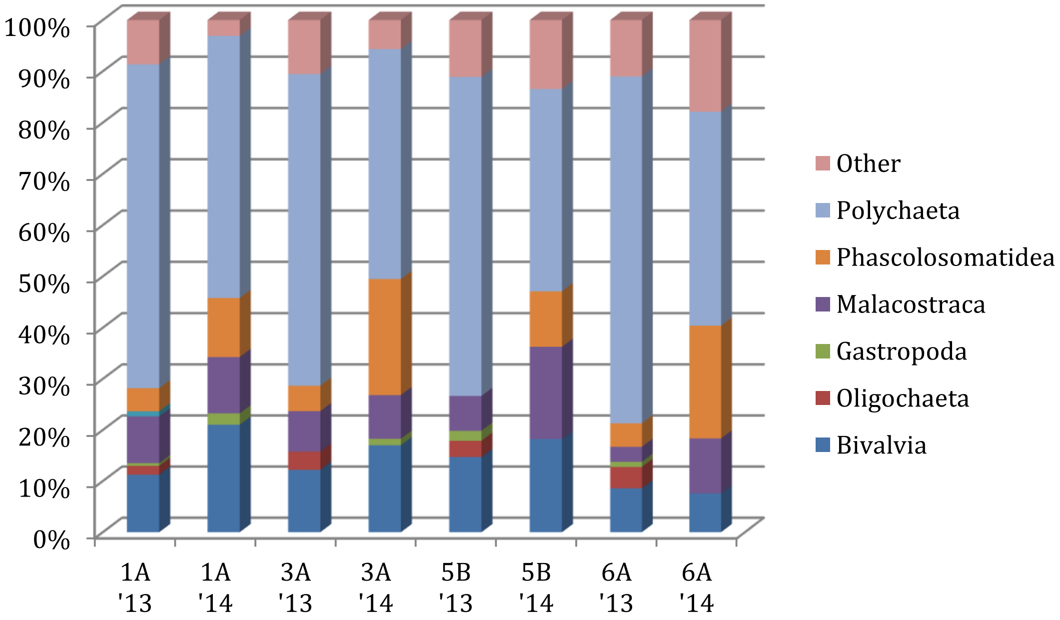

Figure 5. Percent distribution of major infaunal taxa from four artificial reef sites in 2013 and 2014.

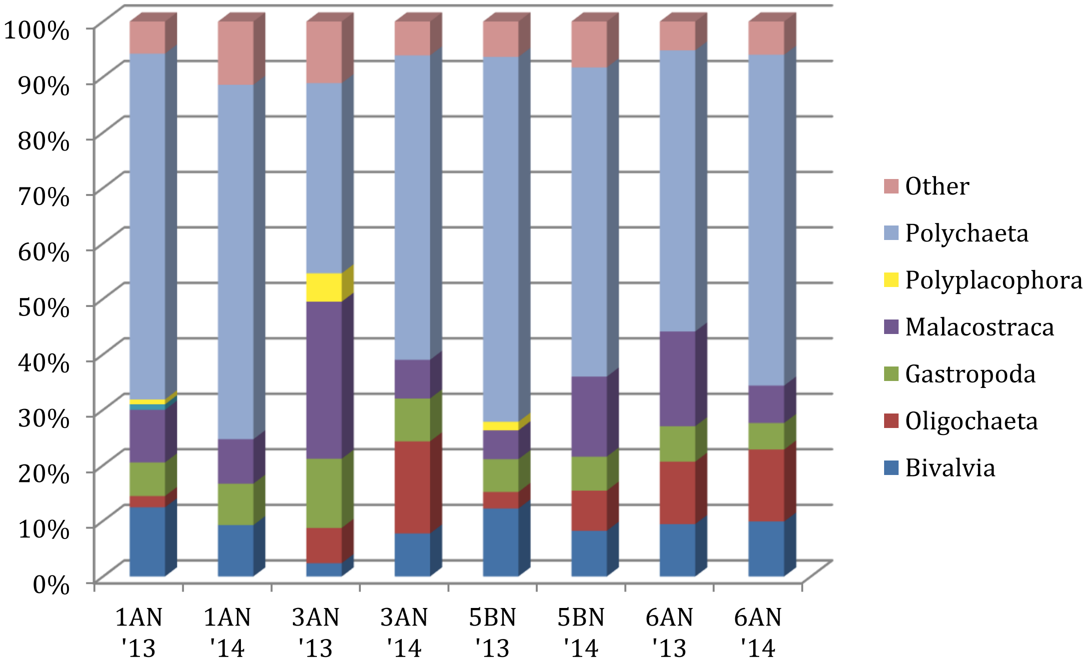

Figure 6. Percent distribution of major infaunal taxa from four natural reef sites in 2013 and 2014.

Table 3. Univariate community indices showing overall corrected model and main factors affecting Taxon diversity (*S*), Pielou's evenness (*J'*), and Average Phylogenetic Diversity (Phi+).

Index	R^2	Factor	df	F	Sig.	Significant Y/N
S	0.658	Overall	63	3.886	<0.001	Y
		Type of Reef	1	29.152	<0.001	Y
		Year	1	82.951	<0.001	Y
		Site	1	7.705	<0.001	Y
		Distance	3	2.110	0.102	N
J'	0.496	Overall	63	1.984	0.001	Y
		Type of Reef	1	.006	0.937	N
		Year	1	25.560	<0.001	Y
		Site	1	3.687	0.014	Y
		Distance	3	2.121	0.101	N
Phi+	0.600	Overall	63	3.023	<0.001	Y
		Type of Reef	1	17.741	<0.001	Y
		Year	1	81.785	<0.001	Y
		Site	1	2.124	0.100	N
		Distance	3	1.795	0.151	N

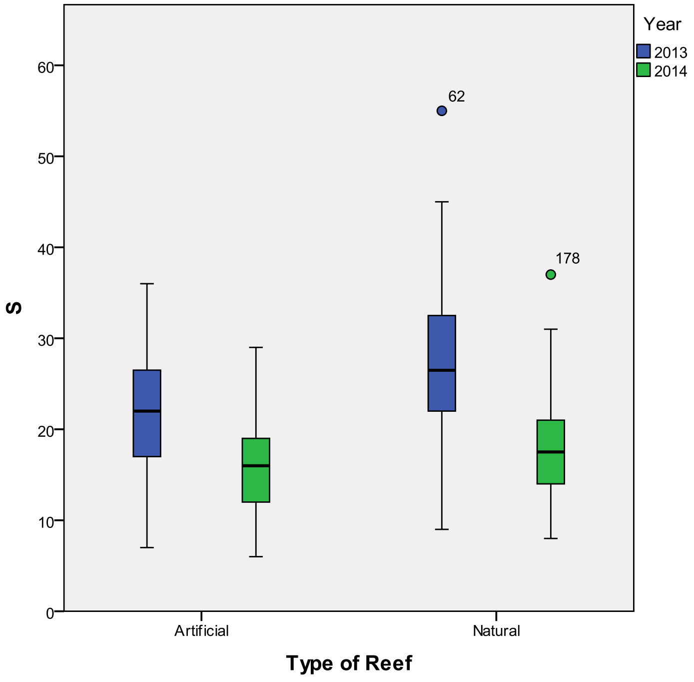

Figure 7. Boxplot of reef type by year showing a lower taxon diversity (S) in 2014 at both artificial and natural reefs sites.

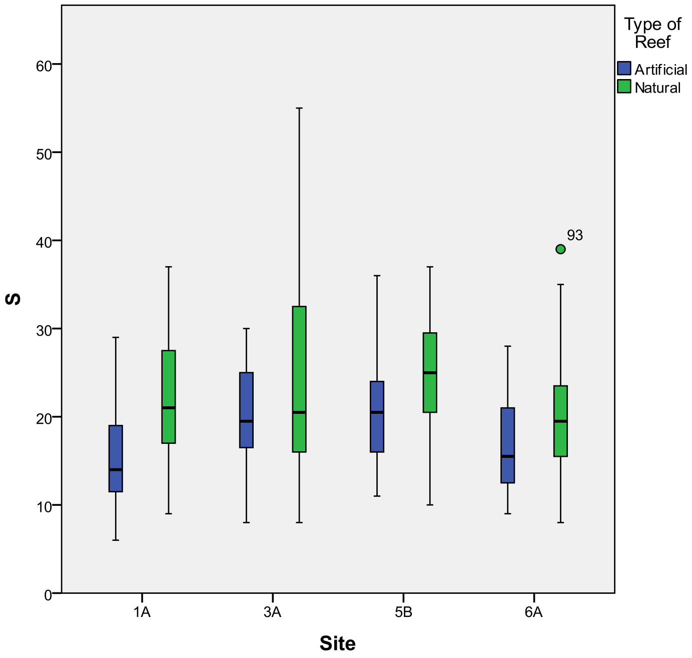

Figure 8. Boxplot of site by reef type showing significantly lower taxon diversities (S) at artificial reef sites relative to adjacent natural reef sites.

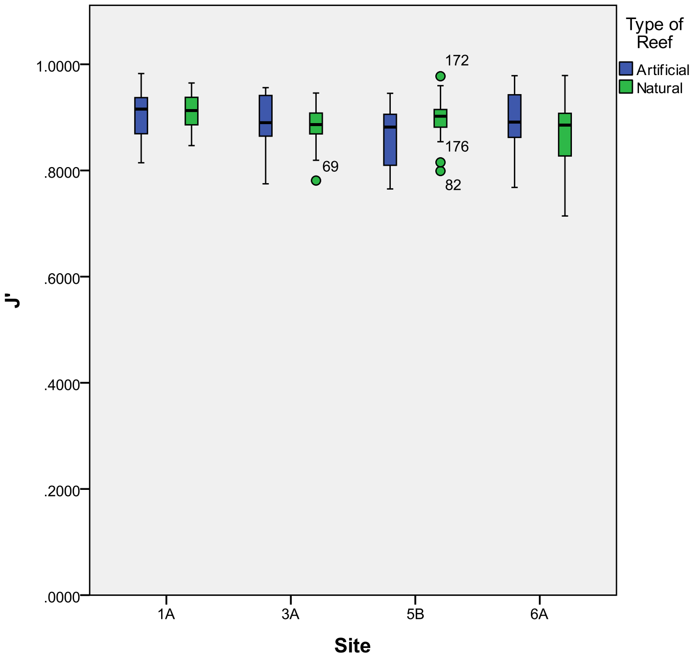

Figure 9. Boxplot of reef type by site showing no effect of reef type on evenness.

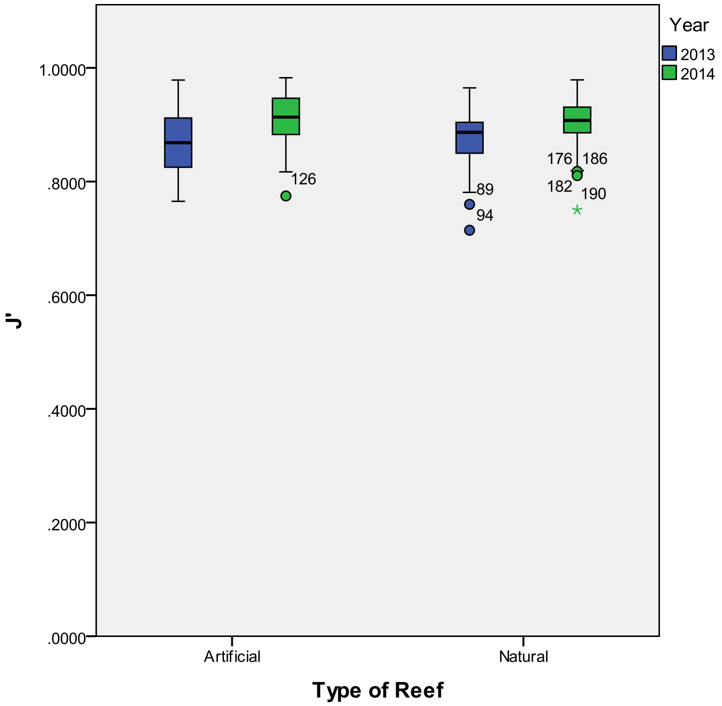

Figure 10. Boxplot of reef type by year showing an increase in evenness in 2014 regardless of reef type.

A pairwise community resemblance matrix using the Bray-Curtis similarity index clearly shows different communities in artificial versus natural reef samples with virtually no overlap (stress value=0.22) (Figure 11). The closer the triangles are to one another, the closer they are in taxa type and density. A second pairwise plot distinguishing both reef type and year illustrates a clear, consistent pattern of change in community structure between years (Figure 12).

PERMANOVA results by individual taxa showed significant differences between type of reef, year, site and distance (Table 4). PERMANOVA results for class and phylum showed significant differences among type of reef, year and site, but no difference among distance (Table 4). PERMANOVA analysis by individual taxa can be found in Appendix A5.

Using SIMPER, the two main effects--reef type and year—were crossed to determine density changes. The first five taxa, Tubificidae, Nereididae, Hesionidae, Syllidae, and Spionidae, all decreased in density near the artificial reef and accounted for 20% of the change between reef types. Of the top 76 taxa identified by SIMPER, 50 decreased near the artificial reef (Table 5). A sign test was used to determine that 50 of

76 taxa were statistically different from 50% (p=0.0012). A t-test to determine if the net change of density across all taxa was zero found that the mean change was significantly less than zero (-0.28) meaning there was net loss of density at the artificial reef for both years (Table 6).

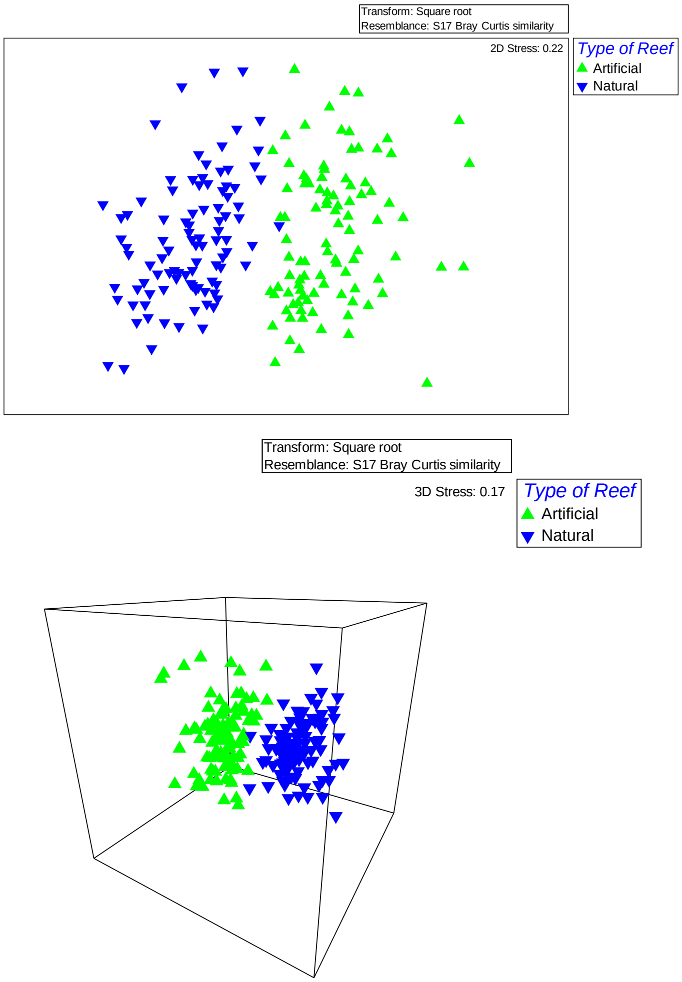

Figure 11. Two-dimensional and three-dimensional nMDS plots using the Bray-Curtis similarity index showing different communities between the artificial and natural reefs.

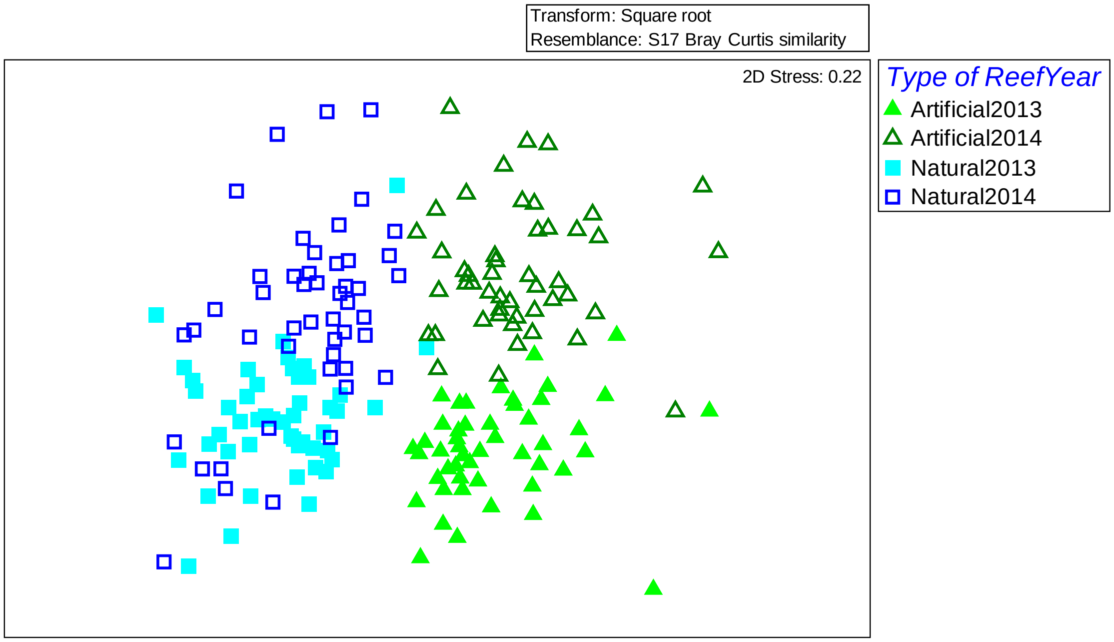

Figure 12. Two-dimensional nMDS plot using the Bray-Curtis similarity index comparing reef type and year. Reef types separate left and right; years separate vertically.

Table 4. Multivariate community indices showing main factors affecting PERMANOVA results across individual taxa and aggregated to class and phylum.

Index	Factor	df	Pseudo-F	P (perm)	Significant Y/N
PERMANOVA by individual taxa	Type of Reef	1	48.772	0.001	Y
	Year	1	22.166	0.001	Y
	Site	1	4.8721	0.001	Y
	Distance	3	1.2764	0.046	Y
PERMANOVA by Class	Type of Reef	1	68.907	0.001	Y
	Year	1	36.836	0.001	Y
	Site	1	7.6176	0.001	Y
	Distance	3	1.0067	0.479	N
PERMANOVA by Phylum	Type of Reef	1	60.769	0.001	Y
	Year	1	41.937	0.001	Y
	Site	1	6.0924	0.001	Y
	Distance	3	1.1621	0.334	N

Table 5. SIMPER analysis of individual taxon density changes affected by year and reef type. The red highlighted values show taxa that decreased on the artificial reef while green highlighted values show taxa that increased on the artificial reef in terms of density.

Groups Artificial & Natural

Average dissimilarity = 72.23

Species	Group Artificial	Group Natural	Difference	Contribution%	Cumulative %
	Average Abundance				
Tubific	0.4	2.83	-2.43	4.19	4.19
Nerei	0.47	2.89	-2.42	3.67	7.86
Hesion	3.18	4.49	-1.31	3.55	11.41
Sylli	1.48	2.96	-1.48	3.01	14.42
Spion	1.47	2.32	-0.85	2.98	17.41
Card	2.17	1.39	0.78	2.89	20.3
Dorvill	0.67	2.12	-1.45	2.81	23.11
Maldan	0.37	2.03	-1.66	2.73	25.84
SynelB	1.67	0.46	1.21	2.63	28.48
MeioCorn	0.01	1.71	-1.7	2.57	31.05
Sabell	1.75	1.75	0	2.52	33.57
BemlosSp	0.98	1.08	-0.1	2.5	36.08
AspiParv	1.37	0.4	0.97	2.31	38.39
AspilAlbu	1.22	0.33	0.89	2.11	40.5
Glyceri	1.51	0.73	0.78	2.02	42.52
Paraon	1.29	1.03	0.26	1.99	44.51
ApseudA	1.14	0.34	0.8	1.76	46.27
Chryso	0.07	1.22	-1.15	1.72	47.98
PitaSimp	0.44	1.03	-0.59	1.67	49.66
ApseudB	0	1.39	-1.39	1.67	51.33
Capi	0.61	0.97	-0.36	1.59	52.91
RutiDarb	0.74	0.58	0.16	1.46	54.37
CaecPulc	0.01	0.98	-0.97	1.46	55.83
PolyplacA	0.22	1.27	-1.05	1.43	57.27
HarbPauc	0.73	0.54	0.19	1.38	58.64
Eunici	0.56	0.64	-0.08	1.34	59.98
LeptoSp	0.04	1.07	-1.03	1.33	61.31
Lumbri	0.52	0.7	-0.18	1.31	62.62
Pholoid	0.01	0.88	-0.87	1.3	63.92
Bivalv	0.23	0.86	-0.63	1.29	65.21
CrasLunu	0.09	0.72	-0.63	1.08	66.29
ChevSp	0.06	0.53	-0.47	1.01	67.3
Onuph	0.13	0.49	-0.36	0.95	68.26

Table 5 cont.

Species	Group Artificial	Group Natural	Difference	Contribution%	Cumulative %
	Average Abundance				
Amphio	0.19	0.44	-0.25	0.95	69.2
Cirra	0.65	0.34	0.31	0.92	70.12
LottAnti	0	0.69	-0.69	0.88	71
ThracSp	0.47	0.16	0.31	0.86	71.86
Gastro	0.17	0.48	-0.31	0.77	72.63
PleuFlor	0	0.51	-0.51	0.73	73.36
AnthA	0.18	0.35	-0.17	0.73	74.08
CrasDupl	0.41	0.1	0.31	0.73	74.81
Opheli	0.12	0.4	-0.28	0.71	75.52
MyodoD	0	0.43	-0.43	0.68	76.21
PterPerp	0.03	0.38	-0.35	0.68	76.89
ApioMisa	0.39	0.06	0.33	0.67	77.56
IsopA	0	0.37	-0.37	0.67	78.23
Phyllo	0.27	0.27	0	0.61	78.84
MyodoA	0.41	0.03	0.38	0.58	79.42
CrenDecu	0.04	0.38	-0.34	0.57	79.99
MyodoB	0.2	0.25	-0.05	0.57	80.56
CaecNiti	0.03	0.46	-0.43	0.56	81.12
ChioElev	0.02	0.36	-0.34	0.55	81.67
SineStan	0	0.46	-0.46	0.53	82.2
RetusA	0.28	0.1	0.18	0.45	82.64
MoorSp	0.33	0	0.33	0.43	83.07
TiveFlor	0.15	0.16	-0.01	0.43	83.5
AlvanSp	0	0.35	-0.35	0.42	83.92
SynelA	0.18	0.09	0.09	0.42	84.34
AmphiurA	0.05	0.22	-0.17	0.41	84.75
SabellB	0.27	0.03	0.24	0.4	85.14
Amph	0.11	0.16	-0.05	0.39	85.53
AmacMagn	0.19	0.02	0.17	0.37	85.9
ParvCren	0.15	0.1	0.05	0.36	86.26
KalliaA	0.19	0.04	0.15	0.35	86.6
Terebell	0.05	0.2	-0.15	0.35	86.95
ChevCarp	0.22	0.02	0.2	0.33	87.28
ErviSp	0.04	0.16	-0.12	0.32	87.6
GranOvul	0.04	0.21	-0.17	0.32	87.92
PolyTetr	0.05	0.21	-0.16	0.31	88.23
Ophiur	0.01	0.25	-0.24	0.31	88.54
GlycymSp	0.05	0.14	-0.09	0.3	88.84
LimaSubo	0.22	0.03	0.19	0.29	89.13
PolyCaro	0.05	0.19	-0.14	0.28	89.41
DentSp	0.08	0.08	0	0.27	89.68
LimnorSp	0.01	0.25	-0.24	0.27	89.95
CtenMedi	0	0.2	-0.2	0.26	90.21

Table 6. T-test comparing various magnitudes of density to determine net change of density across all taxa.

One-Sample Test

	Test Value = 0					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
VAR00003	-3.482	75	.001	-.27566	-.4333	-.1180

Figure 13 shows the 15 taxa most responsible for shaping community similarity by reef type and year (Table 5). The five taxa that increased near the artificial reef are Cardiidae (Bivalvia), Pilargiidae *Synelmis sp. B*, Glyceridae (all Polychaeta), *Aspidosiphon albus* and *Aspidosiphon parvulus* (Sipuncula) (Table 5). The Pseudo-F values determined that the annelids are the group most responsible for shaping overall community similarity (Table 4).

A 2-dimensional nMDS plot using Bray-Curtis similarity illustrates how several higher taxa (“class-group”) contributed to higher densities at natural reef sites, chiefly in 2013 (Figure 14). Only two higher taxon of 15, Phascolosomatidea and Ostracoda, recorded higher densities at the artificial reef sites, primarily in 2013 (Table 7). PERMANOVA analysis by class can be found in Appendix A6.

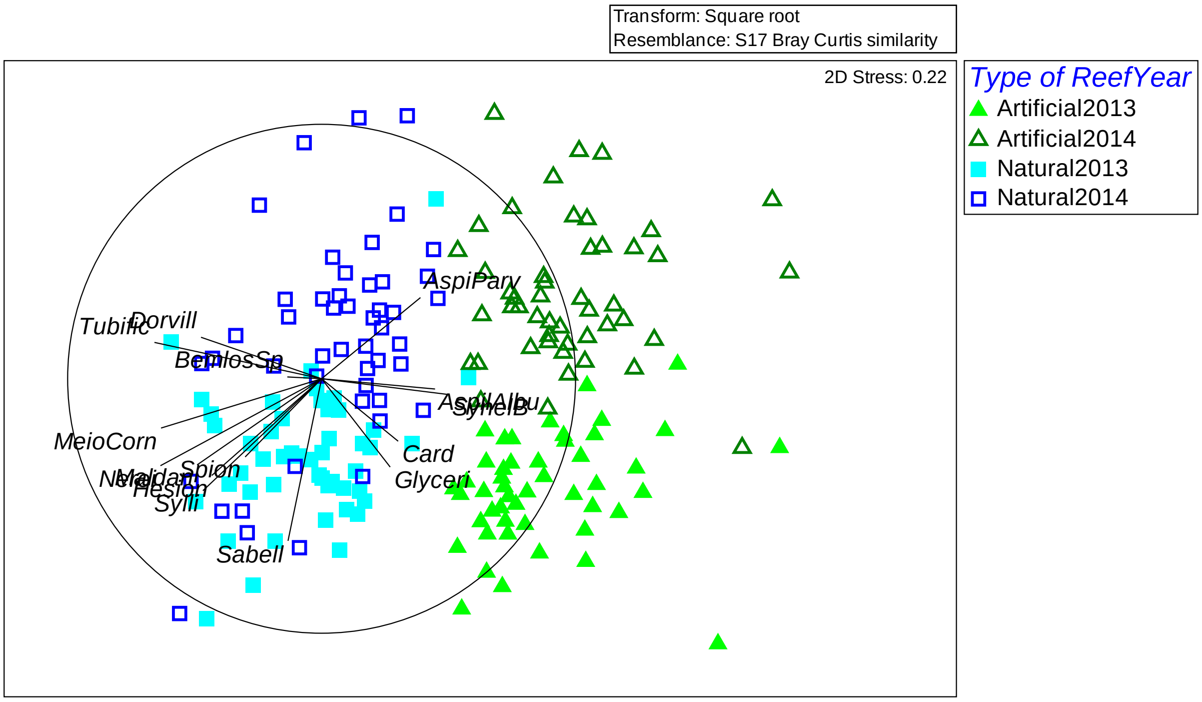

Figure 13. Two-dimensional nMDS indicating reef type and year. Length and direction of radiating lines indicate the 15 taxa most responsible for shaping community similarity. Taxon effect increases with line length.

Table 7. SIMPER analysis of density changes affected by year and reef type aggregated to class. The red highlighted values show taxa that decreased on the artificial reef while green highlighted values show taxa that increased on the artificial reef.

Groups Artificial & Natural by class
Average dissimilarity = 41.91

Species	Group Artificial	Group Natural	Difference	Contribution%	Cumulative%
	Average Abundance				
Polychaeta	6.52	9.22	-2.7	18.24	18.24
Oligochaeta	0.4	2.83	-2.43	13.52	31.76
Malacostraca	2.46	3.92	-1.46	12.57	44.32
Gastropoda	0.91	3.12	-2.21	12.12	56.45
Phascolosomatidea	2.22	0.74	1.48	10.55	67
Bivalvia	3.1	3.63	-0.53	9.04	76.04
Ostracoda	1.71	1.53	0.18	7.17	83.2
Polyplacophora	0.22	1.44	-1.22	5.77	88.98
Leptocardii	0.34	0.44	-0.1	3.37	92.35

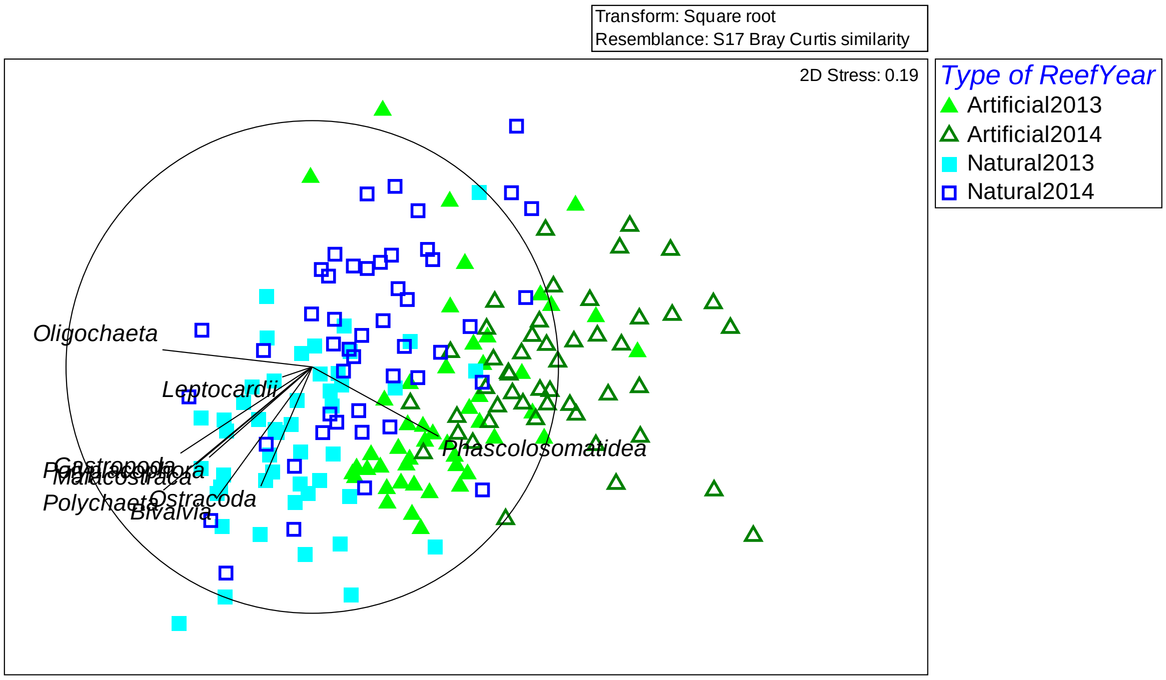

Figure 14. Two-dimensional nMDS plot indicating reef type and year, and illustrating those higher taxa ("class-group") contributing most to high densities at natural reef sites, primarily in 2013. Phascolosomatidea was the only higher taxon with higher density at artificial reef sites, predominantly in 2013.

PERMANOVA results by most inclusive taxon (phylum) showed significant differences among type of reef, year, and site, but no difference among distance (Table 4; Appendix A7), the same pattern as results at the less inclusive higher taxon level. At the phylum level, Sipuncula yielded a higher density at artificial reef sites, while Annelida, Arthropoda, Mollusca, Echinodermata, and Chordata had higher densities at natural reef sites (Table 8) (Figure 15).

Across all PRIMER and PERMANOVA analyses, species diversity, richness, evenness, and taxonomic distinctness differed significantly between reef types and years. The natural reef samples were more diverse, had higher species richness, and included more low-density taxa. The artificial reef samples were slightly more taxonomically distinct at higher taxonomic levels. Community structure analyses showed profound differences in community composition between reef types. The most common pattern was a decrease in density among most taxa, particularly among the Annelida (Oligochaeta and Polychaeta) and Mollusca (Bivalvia and Gastropoda).

Table 8. SIMPER analysis of density changes affected by year and reef type aggregated to phylum. The red highlighted values show taxa that decreased on the artificial reef while green highlighted values show taxa that increased on the artificial reef

Groups Artificial & Natural
Average dissimilarity = 31.83

Species	Group Artificial	Group Natural	Difference	Contribution%	Cumulative%
	Average Abundance				
Annelida	6.61	9.82	-3.21	32.57	32.57
Arthropoda	3.18	4.41	-1.23	20.38	52.95
Mollusca	3.49	5.44	-1.95	19.98	72.93
Sipuncula	2.22	0.74	1.48	16.94	89.87
Chordata	0.34	0.44	-0.1	5.39	95.26

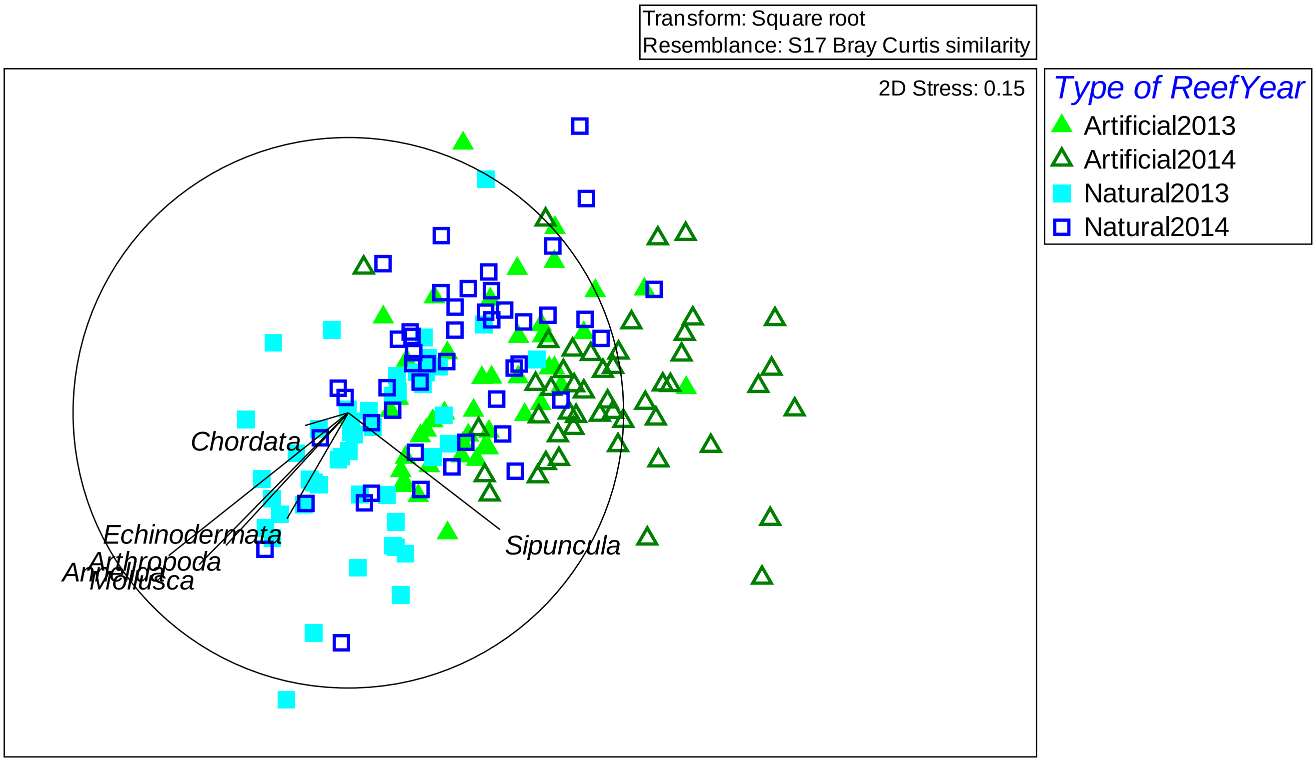

Figure 15. Two-dimensional nMDS illustrates the high density phylums affecting each reef type and year. Sipuncula is the only phylum with higher density at the artificial reef.

Discussion

As noted in the introduction, artificial reefs are important tools for resource management and ecosystem protection due to the vulnerability of coastal ecosystems to natural disturbances such as storms and anthropogenic impacts (Bohnsack and Sutherland 1985; Hueckel et al. 1989; Bohnsack et al.1994; Pickering et al. 1998; Pinnegar et al. 2000; Svane and Petersen 2001; Spieler et al. 2001; Perkol-Finkel et al. 2006; Walker and Schlacher 2014). However, they disturb both underlying and surrounding infaunal communities (Davis et al. 1982; Ambrose and Anderson 1990) in a variety of ways, such as species abundance and distribution patterns, predator-prey interactions, sedimentation rates, sediment composition (Ambrose and Anderson 1990) via acceleration or slowing of water flow (Brenchley 1982; Gallagher et al. 1983; Barros et al. 2001; Fabi et al. 2002), and establishment of new predator assemblages (Posey and Ambrose 1994). Although density was used in the current study to determine infaunal community changes, interpretation of the results (i.e. comparison with other studies) was complicated as terminology (i.e. distance, abundance, relative abundance) usage was inconsistent throughout the literature.

Many studies being conducted on artificial reefs focus on the plants and invertebrates on the actual structure, whereas few have looked at the natural sediment communities surrounding the artificial structure (Davis et al 1982). Davis et al. (1982) conducted fish and infaunal studies on a San Diego-La Jolla Underwater Park Reef two years out from construction in 1977. There study showed that reef-associated fish drawn to artificial structures decrease infaunal densities. The three reef structures varied in infaunal densities so no significant conclusions were drawn, but examining fish stomach contents determined that anywhere from 43.2%-65.8% of the diets of the reef fish present came from the sand community. Although not all reef associated fish studies from South Florida were reviewed, Davis et al. 1982 study suggests that within two years of artificial reef deployment, fish communities have been established and were foraging in the surrounding sediment. The current study began four years after artificial reef deployment (October 2009) and although reef-associated fish densities were not documented in this study, divers did report reef fish foraging on the sediment at all sample sites. This observation indicates fish foraging as a factor that could affect infaunal densities near the artificial reef structures.

Polychaetes and malacostracans were the two most abundant taxa across all eight sites. Polychaeta ranged from 39-68% on the artificial reef and 34-66% on the natural. Malacostracans yielded 3-18% of the composition on the artificial reef and 5-28% on the natural reef. Polychaeta was found to be the dominant higher taxon likely due to their wide adaptive and reproductive capabilities as well as their opportunistic feeding habits (Gravina et al. 1989; Hutchings 1998). Fabi et al. (2002) comparison of infauna over a two year period at Senigallia artificial reef and a control sight, both located along the central Adriatic coast, found mollusks and polychaetes to be the two dominant taxa followed by crustaceans. The current study found Bivalvia as the third most dominant class consisting of 8-21% on the artificial reef and 2-13% on the natural. Ambrose and Anderson (1990) determined that changes in benthic physical characteristics (sediment size, organics, water movement) caused changes in infaunal densities at Pendelton Artificial Reef in San Diego, California. Polychaeta comprised 57% of the identified taxa followed by 36% Crustacea. Ambrose and Anderson (1990) found Amphipoda to be the largest order of Crustacea, which is consistent with the FFWCC findings.

Statistical analyses (PRIMER, PERMANOVA and SIMPER) all yielded significant differences between the artifical and natural reefs. The univariate analysis for taxon diversity yielded signifcant differences between type of reef, year, and site, but not distance. Evenness was significantly different between year and site, but not type of reef and distance. Average phylogenetic diveristy yielded significant differences between type of reef and year, but not site and distance. The multivariate analyses and nMDS plots showed significant changes affected by type of reef and year.

Barros et al. (2001) compared infauna adjacent to one artificial rocky reef with three natural reefs in Botany Bay, New South Wales, Australia and found fewer individuals and taxa associated with the artficial reef, which was statistically significant. Infaunal samples were collected at three distances along transects starting 1m from the reef (1, 5, and 10m). Their nMDS plots showed that assemblages were not clearly separated by distance. The artificial reef infaunal composition was clealy different from the natural reef sites (Barros et al. 2001). This data supports the current study's findings that distances ranging 1-10 m from the reef are not significanty different, and artficial reefs have fewer taxa than their adjacent natural reefs.

Communities associated with their respective reef type also differed significantly between samples years. Interestingly, the nMDS plot showed that artificial and natural reef infaunal community compositions may have become slightly more similar to each other in 2014 relative to 2013. This increased similarity suggests that infaunal communities associated with artificial reefs may continue to approach natural reef-associated communities. However, because only two years were sampled, it remains unknown whether the two communities will continue to converge. For example, micro-circulation around the artificial reef concrete boulders may generate significant differences in sediment composition that would likely affect infaunal assemblages (Ambrose and Anderson 1990; Fabi et al. 2002). Sampling over several subsequent years would be needed to determine longer-term effects.

By contrast, no differences were found among samples taken at different distances from either artificial or natural reefs. The possibility exists that the 10-m transects may not have been long enough to identify distance-related variations. Posey and Ambrose (1994) found an initial decrease in infauna abundance within 10 m of the natural rock ledge site off Wrightsville Beach, North Carolina. However, abundance was higher at the 20m distance increasing out to 75 m. As explained above, this decrease in infaunal density within 10m of the rock outcrop could be attributed to fish foraging on the sediment adjacent to the reef. The current study showed a decrease in infaunal density from 2013 to 2014 at the natural reef sites as well as the artificial sites. Although fish density was not taken in this study, previous studies have shown that fish foraging near the reef can reduce infaunal densities (Davis et al. 1982; Posey and Ambrose 1994). Ambrose and Anderson (1990) results also followed this pattern of initial decrease within 10 m of the artificial reef. Ambros and Anderson (1990), Posey and Ambrose (1994), Barros et al. (2001), Danovaro et al. (2002), and People (2006) all found significant differences among infaunal communities by distance from the reef, but compared samples taken along transects ranging from 20 to 75m in length. This pattern of decreased abundance could explain distance not being a significant factor across all PRIMER analysis conducted in this study as 7m from the reef was the furthest distance sampled for both years.

Taxon diversity was consistently lower in 2014 at both the artificial and natural reef. When broken down by site, all four artificial sites had lower diversity compared to their adjacent natural reefs. Therefore, it is not surprising to see that evenness increased in 2014 following a common pattern where diversity and evenness are inversely proportional to one another. The artificial reef shifting to a more homogenous community can be attributed to changing environmental factors. Although, no physical factors (i.e. current, water temperature, turbidity, depth, sediment-grain size) were quantified in this study, they are large contributors to soft-bottom benthic communities around artificial reefs (Ambrose and Anderson 1990). Divers recorded noticeable current at some sites, but this was not consistent among years. To establish a baseline of sediment grain size for future research, sediment cores were collected in 2014 at the same four distances on the north and south transects at all sites. Barros et al. (2001) found coarser sediments up to 10m away from the reef, diminishing to finer grain sizes 10 to 25m away. Coarser sediment may not be a suitable habitat for some soft-bodied organisms and could be responsible for low densities uniformly across all distances sampled in their study.

Sipuncula were the dominant taxon at artificial reef sites with four species identified. The other five phyla identified, Echinodermata, Chordata, Annelida, Arthropoda, and Mollusca had higher densities on the natural reef. From 2013 to 2014, density decreased adjacent to both artificial and natural reefs. All four artificial reef sites had lower densities than their adjacent natural reefs, suggesting that new species had not yet successfully colonized those areas or the deployment of the artificial reef reduced the surrounding infauna community. These lower densities coincided with a higher number of individuals per species found at the natural reef sites compared to the artificial reef sites.

PERMANOVA results by individual taxa yielded 10 individual taxa (all annelids) out of 15 (42% of the difference between reefs) making Annelida the main phylum driving density changes on the reefs. When aggregated to class, again Oligochaeta and Polychaeta were the main classes affecting density. The top five taxa that increased near the artificial reef were Cardiidae, *Aspidosiphon parvulus*, *Aspidosiphon albus*, Pilargiidae *Synelmis sp. B*, and Glyceridae. Several species of Glyceridae and Pilargiidae are active predators and opportunists in sandy bottoms, which could explain their thriving in a habitat continuously affected by changing physical factors (Fauchald and Jumars 1979). The increase of two species of sipunculans on the artificial reefs could be attributed to the low competition for space on the sandy bottom or the introduction of hard substrate for borrowing. Across all four sites, the artificial reef concrete boulders are slightly more taxonomically rich at the phylum and class level than the adjacent natural reef.

The natural reef yielded annelids as the top five taxa that increased in density: Nereididae, Hesionidae, Tubificidae, Syllidae, and Spionidae. Nereididae and Hesionidae are common in shallow water and some are omnivores feeding on diatoms and algae, which would be in higher abundance on the natural reef then a recently deployed artificial structure. Tubificidae are also common in shallow water and eat mud and small bits of plants and animals. Spionidae and Syllidae are abundant on coral reefs. Syllidae feed on hydroids, bryozoans and other colonial invertebrates whereas several species of Spionidae drill into calcareous substrate and filter feed as adults. Although the majority of annelids were not identified past family, it is not surprising to find several of these families in greater densities on the natural reef based on their feeding and habitat preferences (Fauchald and Jumars 1979).

Of the physical characteristics affecting artificial reef communities, sedimentation (Brenchley 1982; Gallagher et al. 1983; Carter et al. 1985; Gravina et al. 1989; Hutchings 1998; Edinger and Risk

2000; Pinnegar et al. 2000; Barros et al. 2001) and current were found to have the greatest effects (Ambrose and Anderson 1990; Fabi et al. 2002; Wilding and Sayer 2002; Perkol-Finkel and Benayahu 2007). Currents bring both food, in the form of organic detritus and plankton, and small sand and clay particles to artificial reefs (Perkol-Finkel and Benayahu 2007). This influx of organic material may be a factor in the greater density of Cardiidae found at the artificial reef site as they filter microscopic organisms from the water. Fabi et al. (2002) sampled by season and found that siltation and organic matter accumulation was higher in spring and fall, which corresponds to the sampling in May and September. Further studies collecting samples during winter and summer at the FFWCC concrete boulders would be beneficial for comparison.

Disturbance and space availability are leading factors affecting diversity of soft-bottom communities (Hughes et al. 1984). Somaschini et al. (1997) found that disturbance led to a decline in community diversity two years after an artificial reef had been established. However, Gravina et al. (1989) reported that polychaete communities were the least affected of invertebrates. The diminished densities of other identified taxa such as the mollusks and crustaceans following artificial reef deployment could be correlated with the introduction of new predators attracted to the artificial structures (Posey and Ambrose 1994). The natural reef sites overall boasted higher diversity and species richness, and included more low-density taxa associated with their longer establishment. The significant reduction in species diversity from 2013 to 2014 could be due to a level of disturbance from either weather or ocean changes from September 2013 to May 2014, but environmental factors were not quantified.

The majority of artificial reef studies have been conducted on reefs, mainly concrete structures and rock piles, ranging from new to 10 years old. Several have reported contrasting results. Ambrose and Anderson (1990) found reduced taxa densities in the immediate vicinity of the artificial reef, whereas Davis et al. (1982) found no changes in density until 4 m away from the artificial structure. Such contrasting findings could be due to predation intensity, reef rugosity, type of artificial structure and the other biological and physical factors mentioned previously as shaping artificial and natural reef taxon densities (REFS).

The current study is one of the first to focus on infaunal communities adjacent to artificial reefs in Florida. Additional information, e.g., longer time-series datasets, longer transects, and physical and geological data, collected from natural- and artificial-reef-associated as well as undisturbed infaunal communities in Florida, would provide a more detailed picture of how these structures affect these communities. Such data would allow reef managers to design future artificial reefs in a way to permit infaunal communities to more closely and quickly approach natural assemblages.

Conclusions

The current study conducted 4-5 years after the original FDOT artificial reef concrete boulders were deployed produced significant differences in taxa densities and communities between the artificial and natural reef. The artificial reef was more taxonomically rich at the phylum and class level, whereas, the natural reef had higher diversity, higher species richness, and more low-density taxa regardless of year. Five years after deployment, community assemblages differed between reef types and years. A slight shift in taxa communities may have occurred in 2014 with the artificial reef taxa becoming more similar to the adjacent natural reef taxa. Distance, however, was not significant at any of the sites, artificial or natural. Longer transects might be needed to identify variations with distance from either reef type. Sediment grain-size would be an important factor to quantify in the future. A baseline was established in 2014 and several similar studies found grain-size to be a significant factor affecting artificial reef taxa density. Seasonality was also not measured, nor were organisms differentiated as juvenile or adult life history stages. Future studies should include this information and other environmental factors (water temperature, current direction, current speed etc.) in order to draw definitive conclusions on the effect of artificial reef concrete boulders on the surrounding infaunal communities offshore Broward County, Florida.

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Appendix 1- Taxonomy with total organisms by reef type and year and PRIMER labels.

Taxonomy	Artificial 2013 Abundance	Natural 2013 Abundance	Artificial 2014	Natural 2014	Total Abundance	PRIMER labels
Annelida						
Oligochaeta						
Haplotaxida						
Tubificidae						
unidentified	127	242	22	200	591	Tubific
Polychaeta						
Amphinomida						
Amphinomidae						
sp. A	9	0	0	0	9	AmphA
sp. B	2	0	0	0	2	AmphB
unidentified	4	5	6	4	19	Amph
Eunicida						
Dorvilleidae						
unidentified	0	137	74	90	301	Dorvill
Eunicidae						
unidentified	32	28	24	22	106	Eunici
Lumbrineridae						
unidentified	32	30	12	15	89	Lumbri
Onuphidae						
Mooreonuphis						
pallidula	1	0	0	0	1	MoorPall
sp.	41	0	0	0	41	MoorSp
unidentified	2	14	8	23	47	Onuph
Phyllodocida						
Chrysopetalidae						
unidentified	0	58	5	56	119	Chryso
Glyceridae						
Glycera						
abranchiata	1	0	0	0	1	GlycAbra
americana	1	0	0	0	1	GlycAmer
unidentified	160	27	45	21	253	Glyceri
Hesionidae						
Gyptis						
vitatta	1	0	0	0	1	GyptVita
unidentified	551	542	187	313	1593	Hesion
Nereididae						

Taxonomy	Artificial 2013 Abundance	Natural 2013 Abundance	Artificial 2014	Natural 2014	Total Abundance	PRIMER labels
Ceratonereis						
mirabilis	3	0	0	0	3	CeraMira
unidentified	40	334	5	98	477	Nerei
Phyllodocidae						
unidentified	26	9	1	4	40	Phyllo
Pilargiidae						
Synelmis						
sp. A	9	7	9	1	26	SynelA
sp. B	124	23	111	10	268	SynelB
Sigalionidae						
Sthenelais						
boa	0	0	1	0	1	StheBoa
unidentified	0	0	0	1	1	Sigal
Syllidae						
unidentified	163	244	37	10	454	Sylli
Sabellida						
Sabellidae						
sp. B	26	0	0	0	26	SabellB
unidentified	437	148	16	49	650	Sabell
Serpulidae						
sp. A	5	0	0	0	5	SerpA
unidentified	1	0	0	0	1	SerpSp
Scolecida						
Capitellidae						
unidentified	34	56	21	19	130	Capi
Maldanidae						
unidentified	28	195	12	54	289	Maldan
Opheliidae						
unidentified	2	16	7	12	37	Opheli
Orbiniidae						
unidentified	2	0	0	0	2	Orbinn
Paraonidae						
Aricidea						
cerruitii	1	0	0	0	1	AricCerr
Cirrophorus						
lyra	1	0	0	0	1	CirrLyra
unidentified	77	32	66	43	218	Paraon
Pholoidae						

Taxonomy	Artificial 2013 Abundance	Natural 2013 Abundance	Artificial 2014	Natural 2014	Total Abundance	PRIMER labels
unidentified	1	31	0	51	83	Pholoid
Spionida						
Magelonidae						
unidentified	4	0	4	1	9	Magelon
Spionidae						
unidentified	127	103	54	162	446	Spion
Terebellida						
Cirratulidae						
unidentified	61	26	5	2	94	Cirra
Terebellidae						
unidentified	5	8	0	6	19	Terebell
Arthropoda						
Cephalocarida						
unidentified	0	0	0	1	1	Cepha
Malacostraca						
Amphipoda						
Aoridae						
Amphideutopus						
sp.	5	5	0	0	10	AmphidSp
Bemlos						
sp.	28	114	106	17	265	BemlosSp
Caprellidae						
Caprella						
sp.	3	3	1	3	10	CaprellaSp
unidentified	24	0	0	0	24	Caprel
Chevaliidae						
Chevalia						
sp.	7	0	0	63	70	ChevSp
carpenteri	29	1	7	0	37	ChevCarp
Haustoriidae						
Acanthohaustorius						
pansus	2	0	0	0	2	AcanPans
Haustorius						
sp.	0	1	0	0	1	HausSp
Megaluropidae						
Gibberosus						
myersi	0	6	0	2	8	GibbMyer
Phliantidae						

Taxonomy	Artificial 2013 Abundance	Natural 2013 Abundance	Artificial 2014	Natural 2014	Total Abundance	PRIMER labels
Pariphinotus						
sp.	0	2	0	0	2	PariphSP
Phoxocephalidae						
Metharpinia						
floridana	0	0	6	0	6	MethFlor
Cumacea						
Bodotriidae						
Cyclaspis						
cf. varians	0	2	1	1	4	CyclVari
sp. D	0	2	0	1	3	CyclD
sp. A	1	0	0	0	1	CumacA
sp. B	1	0	0	0	1	CumacB
sp. C	0	5	0	1	6	CumacC
sp. D	0	7	0	0	7	CumacD
sp. E	0	0	0	2	2	CumacE
Decapoda						
Leucosiidae						
unidentified	0	3	0	0	3	Leuco
Majoidea						
unidentified	0	0	0	1	1	Majo
Paguroidea						
unidentified	0	1	2	3	6	Paguro
Pinnotheridae						
unidentified	0	1	0	1	2	Pinno
Portunidae						
Portunus						
sp.	0	2	0	0	2	PortSp.
Xanthoidea						
unidentified	0	0	0	1	1	Xanth
unidentified crab	0	1	0	0	1	DecaCrab
unidentified shrimp	0	1	0	0	1	DecaShrimp
Decapoda/Caridea						
sp. A	0	0	0	5	5	CarideaA
sp. B	0	0	1	0	1	CarideaB
sp. C	0	1	0	0	1	CarideaC
Isopoda						
Aegidae						
Rocinella						

Taxonomy	Artificial 2013 Abundance	Natural 2013 Abundance	Artificial 2014	Natural 2014	Total Abundance	PRIMER labels
signata	0	2	0	0	2	RociSign
Anthuridae						
Amakusanthura						
magnifica	2	0	22	1	25	AmacMagn
sp. A	11	15	2	25	53	AnthA
sp. B	0	4	1	1	6	AnthB
Cymodocidae						
unidentified	1	0	0	0	1	CymoSp
Gnathiidae						
Praniza						
larvae	0	0	0	9	9	PranLarv
Hyssuridae						
Xenanthura						
brevitelson	0	0	1	0	1	XenaBrev
sp.	4	1	3	0	8	XenaSp
Limnoriidae						
Limnoria						
sp.	0	24	1	0	25	LimnorSp
Pleurocopide						
Pleurocope						
floridensis	0	18	0	19	37	PleuFlor
Serolidae						
unidentified	1	0	0	0	1	Serol
Sphaeromatidae						
Paradella						
sp.	2	1	1	2	6	ParaSp
Stenitriidae						
Stenetrium						
sp.	0	2	0	0	2	StenSp
sp. A	0	6	0	15	21	IsopA
Tanaidacea						
Apseudidae						
Apseudes						
sp. A	104	27	38	3	172	ApseudA
unidentified	0	209	0	9	218	ApseudB
Kalliapseudidae						
Cirratadactylas						
floridensis	1	0	0	0	1	CirrFlor

Taxonomy	Artificial 2013 Abundance	Natural 2013 Abundance	Artificial 2014	Natural 2014	Total Abundance	PRIMER labels
Kalliapseudes						
sp. A	5	0	7	3	15	KalliaA
Psammokalliapseudes						
sp.	1	0	0	0	1	Psamm
unidentified	5	0	0	0	5	Kalliaps
Leptocheliidae						
Leptachelia						
sp.	2	116	1	8	127	LeptoSp
Tanaididae						
Sinelobus						
stanfordi	0	76	0	0	76	SineStan
Ostracoda						
Myodocopida						
Cylindroleberididae						
Astropella						
punctata	7	0	0	0	7	AstrPunc
Philomedidae						
Harbansus						
paucichelatus	39	38	24	5	106	HarbPauc
Rutidermatidae						
Rutiderma						
darbyi	36	49	41	5	131	RutiDarb
sp. A	42	1	3	1	47	MyodoA
sp. B	19	7	1	8	35	MyodoB
sp. C	9	0	0	0	9	MyodoC
sp. D	0	5	0	24	29	MyodoD
sp. E	0	0	0	2	2	MyodoE
sp. F	2	4	0	0	6	MyodoF
sp. G	6	0	1	0	7	MyodoG
sp. H	4	0	0	0	4	MyodoH
Pycnogonida						
unidentified	0	5	0	2	7	Pycno
Chordata						
Leptocardii						
Amphioxiformes						
Asymmetronidae						
Branchiostoma						
sp.	12	0	0	0	12	AmphioBra

Taxonomy	Artificial 2013 Abundance	Natural 2013 Abundance	Artificial 2014	Natural 2014	Total Abundance	PRIMER labels
unidentified	0	16	16	15	47	Amphio
Echinodermata						
Echinoidea						
Clypeasteroidea						
Mellitidae						
Encope						
michelini	1	0	0	0	1	EncoMich
Spatangoida						
unidentified	0	0	1	0	1	Spata
sp. A	0	2	5	2	9	EchiA
Holothuroidea						
sp. A	1	0	0	0	1	Holo
Ophiuroidea						
Ophiurida						
Amphiuridae						
unidentified	1	3	4	13	21	AmphiurA
Ophiuridae						
unidentified	0	0	0	2	2	Ophiuri
unidentified	0	15	1	2	18	Ophiur
Mollusca						
Bivalvia						
Anomalodesmata						
Thraciidae						
Thracia						
sp.	23	5	16	5	49	ThracSp
Anomalodesmata						
Verticordiidae						
Trigonulina						
sp.	1	0	0	0	1	TrigSp
Arcoida						
Glycymerididae						
Glycymeris						
sp.	0	4	4	4	12	GlycymSp
unidentified	1	0	0	0	1	Glycmeri
Carditoida						
Carditidae						
Pteromeris						

Taxonomy	Artificial 2013 Abundance	Natural 2013 Abundance	Artificial 2014	Natural 2014	Total Abundance	PRIMER labels
perplana	0	20	2	9	31	PterPerp
Crassitellidae						
Crassinella						
dupliniana	19	3	16	1	39	CrasDupl
lunulata	3	27	5	22	57	CrasLunu
Limoida						
Limidae						
Crenella						
decussata	4	21	2	6	33	CrenDecu
Limaria						
pellucida	0	1	0	0	1	LimaPell
Limatula						
subovata	38	2	0	0	40	LimaSubo
sp.	4	0	0	0	4	LimaSp
unidentified	20	0	0	0	20	Limid
Lucinoida						
Lucinidae						
Cavilinga						
blanda	1	0	0	0	1	CaviBlan
Parvilucina						
crenella	4	4	6	1	15	ParvCren
unidentified	0	0	1	0	1	Lucin
Myoida						
Corbulidae						
Carycorbula						
contracta	0	2	0	1	3	CaryCont
Varicorbula						
limatula	0	1	2	0	3	VariLima
philippii	0	1	0	0	1	VariPhil
sp.	4	0	0	0	4	VariSp
Mytiloida						
Mytilidae						
unidentified	0	3	0	2	5	Mytil
Veneroida						
Cardidae						
Ctenocardia						
media	0	12	0	2	14	CtenMedi
Laevicardium						

Taxonomy	Artificial 2013 Abundance	Natural 2013 Abundance	Artificial 2014	Natural 2014	Total Abundance	PRIMER labels
serratum	0	3	0	4	7	LaevSerr
sp.	0	2	0	0	2	LaevSP
Papyridea						
soleniformis	0	0	0	1	1	PapySole
unidentified	178	86	165	57	486	Card
Chamidae						
Arcinella						
cornuta	1	0	0	0	1	ArciCorn
Semelidae						
Abra						
sp.	0	1	0	1	2	AbraSp
Alora						
lioica	2	0	0	0	2	AlorLioi
Ervilia						
concentrica	5	0	0	0	5	ErviConc
nitens	1	0	0	0	1	ErviNite
sp.	1	7	2	4	14	ErviSp
Semele						
bellastriata	0	2	3	3	8	SemeBell
sp.	1	0	0	0	1	SemeSp
Semelina						
nuculoides	2	0	0	0	2	SemeNucl
sp.	1	0	0	0	1	SemelinSp
unidentified	0	2	0	0	2	Semeli
Tellinidae						
Angulus						
versicolor	0	0	2	0	2	AnguVers
sp.	3	0	0	0	3	AnguSp
Tellina						
listeri	0	1	0	0	1	TellList
unidentified	1	0	0	0	1	Tellin
Veneridae						
Chione						
elevata	0	13	2	12	27	ChioElev
mazycki	6	0	0	0	6	ChioMazy
Chionopsis						
intapurpurea	1	0	0	0	1	ChioInta
Cooperella						

Taxonomy	Artificial 2013 Abundance	Natural 2013 Abundance	Artificial 2014	Natural 2014	Total Abundance	PRIMER labels
sp.	0	4	0	0	4	CoopSp
Cyclinella						
tenuis	1	0	0	0	1	CyclTenu
Pitar						
simpsoni	19	42	11	32	104	PitaSimp
Tivela						
floridana	4	10	6	1	21	TiveFlor
unidentified	0	0	1	0	1	Veneri
unidentified	6	67	14	14	101	Bivalv
Gastropoda						
Caenogastropoda						
Cerithiidae						
unidentified	1	0	0	0	1	Cerith
Cephalaspidea						
Haminoeidae						
Haminoea						
succinea	1	0	0	0	1	HamiSucc
sp. F	0	1	0	0	1	HamiF
Retusidae						
Retusa						
sp. A	11	6	3	0	20	RetusA
sp. B	13	8	0	0	21	RetusB
sp. C	1	0	0	0	1	RetusC
Littorinimorpha						
Caecidae						
Caecum						
floridanum	2	0	0	0	2	CaecFlor
imbricatum	0	0	1	1	2	CaecImbr
nitidum	2	53	0	4	59	CaecNiti
pulchellum	0	71	1	34	106	CaecPulc
strigosum	0	2	0	0	2	CaecStri
subvolutum	0	2	0	1	3	CaecSubv
Meioceras						
cornucopiae	0	96	1	67	164	MeioCorn
Capulidae						
unidentified juvenile	7	1	0	0	8	Capul
Littorinidae						
Littorina						

Taxonomy	Artificial 2013 Abundance	Natural 2013 Abundance	Artificial 2014	Natural 2014	Total Abundance	PRIMER labels
sp.	0	0	1	0	1	LittorSp
Rissoidae						
Alvania						
sp.	0	37	0	2	39	AlvanSp
Rissoina						
sp.	2	0	0	2	4	RissoSp
unidentified	2	0	0	2	4	Rissoid
Lottioidea						
Acmaeidae						
Lottia						
antillarum	0	43	0	15	58	LottAnti
Neogastropoda						
Cystiscidae						
Gibberula						
fluctuata	0	0	1	0	1	GibbFluc
Persicula						
sp.	0	1	0	0	1	PersSp
Marginellidae						
Granulina						
margaritula	1	0	0	0	1	GranMarg
ovuliformis	1	14	2	0	17	GranOvul
Marginella						
aurantia	1	0	0	0	1	MargAura
auroeocincta	0	1	0	0	1	AuroSp
eburneola	5	0	0	0	5	MargEbur
sp.	1	0	3	0	4	MargSp
unidentified	1	0	0	0	1	Margin
Mitridae						
Mitra						
sp.	1	0	0	0	1	MitraSp
Nassariidae						
Nassarius						
albus	1	1	2	0	4	NassAlbu
sp.	1	0	0	0	1	NassSp
unidentified	0	1	0	0	1	Nassari
Olividae						
Olivella						
nivea	3	0	0	0	3	OliNive

Taxonomy	Artificial 2013 Abundance	Natural 2013 Abundance	Artificial 2014	Natural 2014	Total Abundance	PRIMER labels
Oliva						
sp.	0	0	1	4	5	OlivaSp
Phasianelloidea						
Phasianellidae						
Tricolia						
sp.	0	2	0	0	2	TricSp
sp. A	0	7	0	1	8	GastroA
sp. B	0	1	0	2	3	GastroB
sp. C	0	0	0	1	1	GastroC
sp. F	0	1	0	0	1	GastroF
sp. G	0	3	2	0	5	GastroG
sp. H	1	3	2	0	6	GastroH
sp. I	0	2	0	0	2	GastroI
sp. J	0	1	0	0	1	GastroJ
unidentified	14	27	1	2	44	Gastro
unidentified juvenile	0	2	3	0	5	GastroJuv
Polyplacophora						
sp. A	16	138	2	17	173	PolyplacA
sp. B	0	10	0	3	13	PolyplacB
sp. C	0	2	0	2	4	PolyplacC
sp. D	0	2	0	3	5	PolyplacD
sp. E	0	1	0	0	1	PolyplacE
Scaphopoda						
Dentaliida						
Dentaliidae						
Antalis						
antillaris	0	1	0	0	1	AntaAnti
Dentalium						
floridense	8	0	0	0	8	DentFlor
laqueatum	5	0	0	0	5	DentLaqu
sp.	4	2	2	3	11	DentSp
Graptacme						
calamus	0	1	0	3	4	GrapCala
Gadilida						
Gadilidae						
Polyschides						
carolensis	3	14	1	0	18	PolyCaro
quadridentatus	2	0	0	0	2	PolyQuad
tetrachistus	2	18	2	1	23	PolyTetr

Taxonomy	Artificial 2013 Abundance	Natural 2013 Abundance	Artificial 2014	Natural 2014	Total Abundance	PRIMER labels
sp.	2	0	0	1	3	PolySp
sp. A	1	0	0	0	1	ScaphA
unidentified	11	0	0	0	11	Scaph
Sipuncula						
Phascolosomatidea						
Aspidosiphonida						
Aspidosiphonidae						
Aspidosiphon						
albus	66	16	85	8	175	AspilAlbu
parvulus	28	5	179	28	240	AspiParv
Phascolosomatida						
Phascolosomatidae						
Apionsoma						
misakianum	28	4	14	0	46	ApioMisa
Total Abundance	3163	4066	1599	1934	10762	

Appendix A2- Tests of Between-Subjects Effects of Taxon Diversity

Dependent Variable:S

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	8005.263[a]	63	127.068	3.886	.000
Intercept	81718.616	1	81718.616	2498.880	.000
TypeofReef	953.335	1	953.335	29.152	.000
Year	2712.663	1	2712.663	82.951	.000
Site	755.895	3	251.965	7.705	.000
Distance	207.040	3	69.013	2.110	.102
TypeofReef * Year	128.198	1	128.198	3.920	.050
TypeofReef * Site	65.372	3	21.791	.666	.574
TypeofReef * Distance	181.034	3	60.345	1.845	.142
Year * Site	253.806	3	84.602	2.587	.056
Year * Distance	142.818	3	47.606	1.456	.230
Site * Distance	628.677	9	69.853	2.136	.031
TypeofReef * Year * Site	455.407	3	151.802	4.642	.004
TypeofReef * Year * Distance	45.752	3	15.251	.466	.706
TypeofReef * Site * Distance	322.296	9	35.811	1.095	.371
Year * Site * Distance	280.643	9	31.183	.954	.482
TypeofReef * Year * Site * Distance	856.733	9	95.193	2.911	.004
Error	4153.167	127	32.702		
Total	94344.000	191			
Corrected Total	12158.429	190			

a. R Squared = .658 (Adjusted R Squared = .489)

Appendix A3- Tests of Between-Subjects Effects of Pielou's Evenness

Dependent Variable:J'

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.246[a]	63	.004	1.984	.001
Intercept	150.674	1	150.674	76700.068	.000
TypeofReef	1.237E-5	1	1.237E-5	.006	.937
Year	.050	1	.050	25.560	.000
Site	.022	3	.007	3.687	.014
Distance	.013	3	.004	2.121	.101
TypeofReef * Year	.002	1	.002	.909	.342
TypeofReef * Site	.026	3	.009	4.473	.005
TypeofReef * Distance	.012	3	.004	1.954	.124
Year * Site	.004	3	.001	.651	.584
Year * Distance	.016	3	.005	2.710	.048
Site * Distance	.035	9	.004	1.967	.048
TypeofReef * Year * Site	.003	3	.001	.451	.717
TypeofReef * Year * Distance	.003	3	.001	.476	.699
TypeofReef * Site * Distance	.027	9	.003	1.502	.154
Year * Site * Distance	.023	9	.003	1.278	.255
TypeofReef * Year * Site * Distance	.012	9	.001	.655	.748
Error	.249	127	.002		
Total	151.496	191			
Corrected Total	.495	190			

a. R Squared = .496 (Adjusted R Squared = .246)

Appendix A4- Tests of Between-Subjects Effects of Average Phylogenetic Diversity

Dependent Variable:Phi+

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	3836.516[a]	63	60.897	3.023	.000
Intercept	510137.725	1	510137.725	25325.494	.000
TypeofReef	357.355	1	357.355	17.741	.000
Year	1647.418	1	1647.418	81.785	.000
Site	128.335	3	42.778	2.124	.100
Distance	108.474	3	36.158	1.795	.151
TypeofReef * Year	1.953	1	1.953	.097	.756
TypeofReef * Site	125.305	3	41.768	2.074	.107
TypeofReef * Distance	153.027	3	51.009	2.532	.060
Year * Site	87.378	3	29.126	1.446	.233
Year * Distance	10.036	3	3.345	.166	.919
Site * Distance	383.196	9	42.577	2.114	.033
TypeofReef * Year * Site	141.566	3	47.189	2.343	.076
TypeofReef * Year * Distance	6.636	3	2.212	.110	.954
TypeofReef * Site * Distance	123.387	9	13.710	.681	.725
Year * Site * Distance	280.539	9	31.171	1.547	.138
TypeofReef * Year * Site * Distance	258.055	9	28.673	1.423	.185
Error	2558.193	127	20.143		
Total	517979.481	191			
Corrected Total	6394.708	190			

a. R Squared = .600 (Adjusted R Squared = .402)

Appendix A5- PERMANOVA results by individual taxa

```
PERMANOVA table of results
                                                              Unique
Source         df        SS      MS  Pseudo-F  P(perm)   perms
Ty              1     71961   71961    48.772    0.001     999
Ye              1     32705   32705    22.166    0.001     999
Si              3     21566  7188.6    4.8721    0.001     997
Di              3    5649.8  1883.3    1.2764    0.046     998
TyxYe           1     19420   19420    13.162    0.001     997
TyxSi           3     15056  5018.6    3.4014    0.001     997
TyxDi           3    5807.3  1935.8     1.312    0.041     998
YexSi           3    9660.2  3220.1    2.1824    0.001     999
YexDi           3    5390.1  1796.7    1.2177    0.104     997
SixDi           9     13407  1489.7    1.0096    0.456     998
TyxYexSi        3     12497  4165.7    2.8233    0.001     998
TyxYexDi        3    5024.9    1675    1.1352    0.211     999
TyxSixDi        9     14225  1580.6    1.0713    0.236     997
YexSixDi        9     13510  1501.1    1.0174    0.413     998
TyxYexSixDi     9     16222  1802.4    1.2216    0.015     994
Res           128 1.8886E5  1475.5
Total         191 4.5096E5
```

Appendix A6- PERMANOVA results by class

```
PERMANOVA table of results
                                                   Unique
Sce           df       SS     MS  Pseudo-F P(perm)  perms
Ty             1    32196  32196    68.907   0.001    998
Ye             1    17211  17211    36.836   0.001    998
Si             3    10678 3559.2    7.6176   0.001    998
Di             3   1411.1 470.36    1.0067   0.479    996
TyxYe          1   4516.1 4516.1    9.6654   0.001    997
TyxSi          3     4413   1471    3.1483   0.001    998
TyxDi          3   3192.2 1064.1    2.2774   0.004    998
YexSi          3   3367.1 1122.4    2.4021   0.002    999
YexDi          3   2241.3 747.11     1.599    0.05    996
SixDi          9   4606.7 511.86    1.0955   0.312    996
TyxYexSi       3   5352.7 1784.2    3.8186   0.001    999
TyxYexDi       3   1325.5 441.84   0.94565   0.526    997
TyxSixDi       9   3888.4 432.04   0.92467   0.623    999
YexSixDi       9   5130.2 570.03      1.22   0.171    996
TyxYexSixDi    9   3911.7 434.64   0.93023   0.602    998
Res          128    59807 467.24
Total 191   1.6325E5
```

Appendix A7- PERMANOVA results by phylum

```
PERMANOVA table of results
                                                     Unique
Source        df       SS     MS  Pseudo-F  P(perm)   perms
Ty             1    18521  18521    60.769    0.001     998
Ye             1    12781  12781    41.937    0.001     999
Si             3   5570.5 1856.8    6.0924    0.001     998
Di             3   1062.5 354.17    1.1621    0.334     999
TyxYe          1   3177.4 3177.4    10.425    0.001     999
TyxSi          3   2546.2 848.73    2.7847    0.003     998
TyxDi          3   2522.3 840.77    2.7586    0.003     999
YexSi          3   2577.6 859.21    2.8191    0.002     998
YexDi          3   1257.9 419.29    1.3757    0.168     997
SixDi          9   2552.3 283.59   0.93046    0.569     997
TyxYexSi       3   2715.2 905.07    2.9696    0.001     997
TyxYexDi       3    837.4 279.13   0.91585    0.536     999
TyxSixDi       9   2954.7  328.3    1.0772    0.378     999
YexSixDi       9   3371.7 374.63    1.2292    0.194     997
TyxYexSixDi    9   2444.3 271.59   0.89111    0.637     998
Res          128    39012 304.78
Total        191  1.039E5
```

Appendix A8 - 2014 sediment grain-size and volume data by site. The last column is the average of the north and south transect volumes to calculate total sediment volumes for the middle transects.

NATURAL STATION	SITE	DISTANCE (m)	2.00 (g)	1.40 (g)	1.00 (g)	0.500 (g)	0.250 (g)	0.125 (g)	0.063 (g)	<0.063 (g)	Total	1AN M
1AN	N	0	120.49	45.72	37.03	60.17	18.86	3.49	0.48	0.57	286.81	340.955
1AN	N	1	136.02	59.69	52.38	74.59	22.55	5.66	1.07	1.3	353.26	356.555
1AN	N	3	29.13	35.3	45.89	79.39	24.76	6.97	1.11	1.52	224.07	310.775
1AN	N	7	113.4	84.12	66.57	99.49	27.72	7.15	1.07	1.01	400.53	397.73
1AN	S	0	103.42	72.95	70.18	109.85	29.87	7	0.93	0.9	395.1	
1AN	S	1	60.12	57.54	70.78	123.41	36.42	9.87	1.19	0.52	359.85	
1AN	S	3	68.94	73.85	83.24	116.12	37.39	15.32	2.21	0.41	397.48	
1AN	S	7	62.22	66.54	80.25	134.13	40.49	9.79	1.11	0.4	394.93	3AN M
3AN	N	0	19.95	32.78	66.57	231.01	165.37	14.52	0.32	0.36	530.88	455.85
3AN	N	1	22.53	23.66	51.37	218.87	187.31	16.08	0.29	0.24	520.35	451.02
3AN	N	3	34.76	22.86	38.06	129	87.05	5.23	0.11	0.26	317.33	358.29
3AN	N	7	78.27	39.93	59.12	208.91	137.27	11.56	0.33	0.38	535.77	539.765
3AN	S	0	39.76	58.31	81.59	136.65	57.33	6.48	0.28	0.42	380.82	
3AN	S	1	75.16	67.39	71.97	109.68	51.22	5.34	0.24	0.69	381.69	
3AN	S	3	36.51	27.64	52.87	169.98	103.96	7.85	0.17	0.27	399.25	
3AN	S	7	43.89	32.38	55.85	240.83	161.14	8.99	0.2	0.48	543.76	5BN M
5BN	N	0	109.42	62.3	56.43	88.13	33.2	12.03	1.84	2.26	365.61	317.375
5BN	N	1	77.35	58.05	55.33	103.9	63.68	30.05	2.82	1.23	392.41	262.195
5BN	N	3	24.35	26.3	34.59	101.47	109.44	59.66	5.44	0.99	362.24	346.12
5BN	N	7	69.35	65.93	70.12	156.86	114.62	41.4	2.49	1.6	522.37	447.635
5BN	S	0	80.62	44.98	42.03	60.3	25.59	12.4	1.81	1.41	269.14	
5BN	S	1	28.99	20.71	22.31	37.7	14.84	5.97	0.79	0.67	131.98	
5BN	S	3	72.77	57.9	47.55	84.06	44.15	20.72	1.72	1.13	330	
5BN	S	7	101.89	85.52	67.13	80.35	20.71	10.54	4.08	2.68	372.9	6AN M
6AN	N	0	21.41	22.5	62.29	231.15	166.24	13.56	0.24	0.33	517.72	452.97
6AN	N	1	11.03	21.52	54.05	209.18	127.83	8.5	0.14	0.32	432.57	435.85
6AN	N	3	42.34	27.01	47.2	188.79	127.64	10.74	0.27	0.41	444.4	441.475
6AN	N	7	49.65	16.32	23.46	101.43	82.76	4.79	0.12	0.33	278.86	368.19
6AN	S	0	21.05	31.18	54.69	159.48	110.83	10.42	0.26	0.31	388.22	
6AN	S	1	17.44	27.42	54.64	191.85	134.58	12.26	0.24	0.7	439.13	
6AN	S	3	31.28	33.99	62.08	188.33	112.5	9.74	0.27	0.36	438.55	
6AN	S	7	41.63	26.18	43.07	180.83	153.82	11.28	0.35	0.36	457.52	

ARTIFICIAL STATION	SITE	DISTANCE (m)	2.00 (g)	1.40 (g)	1.00 (g)	0.500 (g)	0.250 (g)	0.125 (g)	0.063 (g)	<0.063 (g)	Total	1A M
1A	N	0	5.97	9.06	21.07	77.4	117.2	99.6	5.74	0.4	336.44	320.895
1A	N	1	21.01	27.95	55.17	185.83	237.5	117.64	5.82	0.65	651.57	452.76
1A	N	3	3.46	4.61	9.3	47.5	101.85	70.92	3.02	0.27	240.93	384.175
1A	N	7	14.41	13.68	26.1	98.47	151.84	124.53	7.58	0.54	437.15	496.62
1A	S	0	8.62	13.39	28.51	94.43	100.84	56.57	2.55	0.44	305.35	
1A	S	1	7.38	9.62	19.6	68.06	84.86	60.11	3.79	0.53	253.95	
1A	S	3	22.48	27.47	51.76	159.87	168.2	93.06	4.15	0.43	527.42	
1A	S	7	20.6	27.67	53.78	169.11	190.78	89.22	4.45	0.48	556.09	3A M
3A	N	0	29.24	34.17	63.77	271.64	255.11	96.07	3.5	0.64	754.14	731.635
3A	N	1	46.48	38.29	67.81	287.74	279.73	84.84	3.58	0.91	809.38	798.16
3A	N	3	23.55	26.55	53.99	223.21	229.67	80.01	3.03	0.47	640.48	682.025
3A	N	7	22.89	23.22	45.86	244.46	261.36	81.83	2.83	0.45	682.9	712.735
3A	S	0	29.53	29.93	57.66	268.08	252.64	68.56	2.17	0.56	709.13	
3A	S	1	22.53	30.02	58.97	290.1	292.05	89.39	3.43	0.45	786.94	
3A	S	3	39.41	31.65	56.06	258.67	253.3	80.25	3.33	0.9	723.57	
3A	S	7	19.06	29.56	65.93	311.85	242.97	70.16	2.52	0.52	742.57	5B M
5B	N	0	19.91	25.78	53.48	204.45	211.78	96.14	4.54	0.49	616.57	621.155
5B	N	1	15.31	22.98	52.51	215.61	185.81	70.66	3.23	0.44	566.55	602.085
5B	N	3	21.35	25.63	50.87	197.02	181.59	79.87	3.45	0.37	560.15	609.44
5B	N	7	11.17	17.37	34.09	148.67	155.54	78.4	4.21	0.58	450.03	534.385

Appendix A8 cont.

ARTIFICIAL STATION	SITE	DISTANCE (m)	2.00 (g)	1.40 (g)	1.00 (g)	0.500 (g)	0.250 (g)	0.125 (g)	0.063 (g)	<0.063 (g)	Total	
5B	S	0	31.45	30	68.02	235.44	184.62	72.31	3.31	0.59	625.74	
5B	S	1	25.6	25.1	55	229.38	209.57	86.78	4.91	1.28	637.62	
5B	S	3	22.34	27.43	58.8	231.67	220.72	93.2	4.11	0.46	658.73	
5B	S	7	15.98	30.14	68.61	235.23	194.31	71.15	2.99	0.33	618.74	6A M
6A	N	0	24.4	27.45	45.68	221.58	234.74	61.86	2.65	0.62	618.98	621.405
6A	N	1	28.24	34.32	59.2	310.94	277.83	57.48	2.03	0.33	770.37	698.085
6A	N	3	22.74	30.39	54.86	312.74	314.02	72.03	1.81	0.37	808.96	712.365
6A	N	7	47.38	44.16	71.2	335.14	280.25	63.34	2.38	0.31	844.16	683.935
6A	S	0	34.62	30.1	46.7	241.89	219.52	47.84	2.49	0.67	623.83	
6A	S	1	20.83	22.78	46.19	258.33	225.38	49.93	1.98	0.38	625.8	
6A	S	3	23.21	23.12	44.31	246.72	225.14	50.96	1.86	0.45	615.77	
6A	S	7	22.35	19.76	30.78	166.02	221.83	59.67	3.04	0.26	523.71	

Appendix A9- Density and abundance calculations for 2013 natural site 1AN.

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Alvania sp.	0	0.00	1	0.93	0	0.00	0	0.00
Amphinomidae	0	0.00	0	0.00	1	1.07	0	0.00
Amphioxiformes	0	0.00	1	0.93	2	2.15	2	1.68
Amphiuridae	0	0.00	2	1.87	0	0.00	0	0.00
Antalis antillaris	0	0.00	0	0.00	1	1.07	0	0.00
Anthuridae *sp.B*	1	0.98	0	0.00	0	0.00	1	0.84
Apseudes *sp.A*	0	0.00	0	0.00	2	2.15	0	0.00
Apseudidae	2	1.96	11	10.28	3	3.22	1	0.84
Aspidosiphon albus	0	0.00	0	0.00	3	3.22	2	1.68
Aspidosiphon parvulus	0	0.00	0	0.00	0	0.00	1	0.84
Bemlos sp.	2	1.96	0	0.00	1	1.07	1	0.84
Bivalvia unidentified	0	0.00	2	1.87	6	6.44	0	0.00
Caecum nitidum	0	0.00	0	0.00	0	0.00	1	0.84
Caecum pulchellum	0	0.00	0	0.00	1	1.07	2	1.68
Capitellidae	5	4.89	8	7.48	3	3.22	0	0.00
Cardiidae	5	4.89	16	14.96	3	3.22	8	6.70
Caryocorbula contracta	1	0.98	0	0.00	0	0.00	0	0.00
Chione elevata	0	0.00	0	0.00	1	1.07	0	0.00
Chrysopetalidae	2	1.96	4	3.74	1	1.07	4	3.35
Cirratulidae	1	0.98	0	0.00	0	0.00	0	0.00
Crassinella dupliniana	1	0.98	0	0.00	0	0.00	0	0.00
Crassinella lunulata	3	2.93	3	2.80	2	2.15	1	0.84
Crenella decussata	2	1.96	1	0.93	0	0.00	1	0.84
Ctenocardia media	1	0.98	4	3.74	0	0.00	1	0.84
Cumacea *sp.C*	0	0.00	1	0.93	2	2.15	1	0.84
Decapoda unidentified	0	0.00	1	0.93	0	0.00	0	0.00
Dorvilleidae	5	4.89	14	13.09	10	10.73	8	6.70
Eunicidae	0	0.00	1	0.93	3	3.22	0	0.00
Gastropoda *sp. B*	0	0.00	0	0.00	0	0.00	1	0.84
Gastropoda *sp. G*	0	0.00	0	0.00	1	1.07	0	0.00
Gastropoda unidentified juv.	0	0.00	0	0.00	2	2.15	0	0.00
Gastropoda unidentified	0	0.00	3	2.80	1	1.07	0	0.00
Gibberosus myersi	0	0.00	2	1.87	0	0.00	1	0.84
Glyceridae	1	0.98	2	1.87	2	2.15	4	3.35
Glycymeris sp.	0	0.00	1	0.93	1	1.07	0	0.00
Granulina ovuliformis	1	0.98	0	0.00	0	0.00	1	0.84

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Graptacme calamus	0	0.00	1	0.93	0	0.00	0	0.00
Haminoea sp. F	0	0.00	0	0.00	0	0.00	1	0.84
Harbansus paucichelata	1	0.98	1	0.93	1	1.07	0	0.00
Hesionidae	9	8.80	25	23.37	24	25.74	23	19.28
Isopoda *sp. A*	1	0.98	0	0.00	2	2.15	0	0.00
Leptachelia sp.	0	0.00	3	2.80	2	2.15	2	1.68
Limnoria sp.	0	0.00	0	0.00	1	1.07	0	0.00
Lottia antillarum	0	0.00	5	4.67	2	2.15	1	0.84
Lumbrineridae	1	0.98	2	1.87	0	0.00	1	0.84
Maldanidae	6	5.87	9	8.41	20	21.45	11	9.22
Marginella auroeocincta	0	0.00	0	0.00	1	1.07	0	0.00
Meioceras cornucopiae	6	5.87	3	2.80	8	8.58	2	1.68
Mytilidae	0	0.00	0	0.00	1	1.07	0	0.00
Nereididae	12	11.73	18	16.83	19	20.38	16	13.41
Onuphidae	0	0.00	0	0.00	1	1.07	0	0.00
Opheliidae	0	0.00	1	0.93	2	2.15	0	0.00
Ophiuroidea	0	0.00	0	0.00	2	2.15	1	0.84
Myodocopida *sp.B*	1	0.98	0	0.00	0	0.00	2	1.68
Myodocopida *sp.D*	0	0.00	0	0.00	0	0.00	1	0.84
Myodocopida *sp.F*	0	0.00	0	0.00	1	1.07	0	0.00
Paraonidae	1	0.98	3	2.80	2	2.15	2	1.68
Persicula sp.	0	0.00	0	0.00	1	1.07	0	0.00
Pholoidae	1	0.98	3	2.80	12	12.87	3	2.51
Phyllodocidae	1	0.98	1	0.93	0	0.00	0	0.00
Pitar simpsoni	2	1.96	3	2.80	2	2.15	6	5.03
Pleurocope floridensis	0	0.00	1	0.93	1	1.07	0	0.00
Polyplacophora *sp.A*	1	0.98	3	2.80	8	8.58	4	3.35
Polyplacophora *sp.C*	1	0.98	0	0.00	0	0.00	0	0.00
Polyschides carolensis	0	0.00	1	0.93	0	0.00	0	0.00
Pteromeris perplana	0	0.00	2	1.87	0	0.00	0	0.00
Pycnogonida	1	0.98	0	0.00	0	0.00	0	0.00
Rutiderma darbyi	0	0.00	0	0.00	2	2.15	2	1.68
Sabellidae	6	5.87	3	2.80	12	12.87	6	5.03
Semele bellastriata	0	0.00	1	0.93	0	0.00	0	0.00
Sinelobus stanfordi	0	0.00	1	0.93	0	0.00	0	0.00
Spionidae	4	3.91	3	2.80	8	8.58	2	1.68
Stenetrium sp.	0	0.00	1	0.93	0	0.00	0	0.00

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Syllidae	8	7.82	18	16.83	28	30.03	29	24.30
Synelmis sp.A	0	0.00	0	0.00	0	0.00	1	0.84
Synelmis sp.B	0	0.00	1	0.93	3	3.22	4	3.35
Terebellidae	0	0.00	1	0.93	1	1.07	0	0.00
Thracia sp.	1	0.98	0	0.00	0	0.00	0	0.00
Tivella floridana	0	0.00	0	0.00	2	2.15	0	0.00
Tubificidae	4	3.91	9	8.41	0	0.00	0	0.00

Appendix A10- Density and abundance calculations for 2013 natural site 3AN.

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Alvania sp.	0	0.00	3	2.22	4	3.72	3	1.85
Amphideutopus sp.	1	0.63	1	0.74	1	0.93	1	0.62
Amphioxiformes	0	0.00	1	0.74	0	0.00	0	0.00
Anthuridae *sp.B*	1	0.63	0	0.00	0	0.00	1	0.62
Apionsoma misakianum	0	0.00	0	0.00	1	0.93	2	1.24
Apseudes *sp.A*	10	6.25	0	0.00	12	11.16	2	1.24
Apseudidae	24	15.00	13	9.61	40	37.21	32	19.76
Aspidosiphon albus	0	0.00	0	0.00	0	0.00	2	1.24
Aspidosiphon parvulus	0	0.00	0	0.00	3	2.79	1	0.62
Bemlos sp.	4	2.50	4	2.96	31	28.84	13	8.03
Bivalvia	5	3.13	4	2.96	14	13.02	6	3.71
Caecum nitidum	6	3.75	2	1.48	24	22.33	13	8.03
Caecum pulchellum	9	5.63	4	2.96	24	22.33	8	4.94
Caecum subvolutum	0	0.00	0	0.00	2	1.86	0	0.00
Capitellidae	1	0.63	0	0.00	5	4.65	4	2.47
Caprella sp.	0	0.00	0	0.00	2	1.86	1	0.62
Capulidae	1	0.63	0	0.00	0	0.00	0	0.00
Cardidae	0	0.00	0	0.00	3	2.79	0	0.00
Chione elevata	1	0.63	2	1.48	3	2.79	3	1.85
Chrysopetalidae	2	1.25	0	0.00	13	12.09	2	1.24
Cirratulidae	1	0.63	2	1.48	4	3.72	4	2.47
Cooperella sp.	1	0.63	0	0.00	0	0.00	1	0.62
Crassinella lunulata	0	0.00	0	0.00	1	0.93	2	1.24
Crenella decussata	0	0.00	0	0.00	0	0.00	1	0.62
Ctenocardia media	1	0.63	0	0.00	0	0.00	0	0.00
Cumacea *sp. D*	1	0.63	0	0.00	3	2.79	0	0.00
Decapoda unidentified shrimp	0	0.00	0	0.00	0	0.00	1	0.62
Decapoda/Caridea *sp. A*	0	0.00	0	0.00	1	0.93	0	0.00
Decapoda/Caridea *sp. C*	0	0.00	0	0.00	1	0.93	0	0.00
Dentalium sp.	1	0.63	0	0.00	1	0.93	0	0.00
Dorvilleidae	3	1.88	5	3.70	12	11.16	11	6.79
Echinoidea	0	0.00	0	0.00	1	0.93	0	0.00
Eunicidae	1	0.63	2	1.48	8	7.44	1	0.62
Gastropoda *sp. A*	0	0.00	0	0.00	7	6.51	0	0.00
Gastropoda *sp. G*	0	0.00	0	0.00	1	0.93	0	0.00
Gastropoda *sp. H*	0	0.00	0	0.00	1	0.93	0	0.00

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Gastropoda unidentified	2	1.25	2	1.48	3	2.79	7	4.32
Gastropoda unidentified juvenile	0	0.00	0	0.00	1	0.93	0	0.00
Gibberosus myersi	1	0.63	0	0.00	1	0.93	0	0.00
Glyceridae	0	0.00	0	0.00	0	0.00	1	0.62
Glycymeris sp.	0	0.00	0	0.00	1	0.93	0	0.00
Granulina ovuliformis	2	1.25	0	0.00	2	1.86	3	1.85
Harbansus paucichelata	3	1.88	1	0.74	14	13.02	3	1.85
Hesionidae	22	13.75	12	8.87	37	34.42	37	22.85
Isopoda *sp. A*	0	0.00	0	0.00	1	0.93	0	0.00
Laevicardium serratum	0	0.00	0	0.00	1	0.93	1	0.62
Leptachelia sp.	13	8.13	13	9.61	14	13.02	16	9.88
Leucosiidae	0	0.00	0	0.00	0	0.00	1	0.62
Limatula subovata	0	0.00	0	0.00	1	0.93	0	0.00
Limnoria sp.	1	0.63	0	0.00	13	12.09	5	3.09
Lottia antillarum	0	0.00	5	3.70	11	10.23	1	0.62
Lumbrineridae	4	2.50	2	1.48	5	4.65	3	1.85
Maldanidae	0	0.00	2	1.48	11	10.23	11	6.79
Meioceras cornucopiae	2	1.25	2	1.48	10	9.30	15	9.26
Mytilidae	0	0.00	1	0.74	1	0.93	0	0.00
Nassaridae	0	0.00	0	0.00	1	0.93	0	0.00
Nassarius albus	0	0.00	0	0.00	0	0.00	1	0.62
Nereididae	25	15.63	13	9.61	41	38.14	16	9.88
Onuphidae	1	0.63	0	0.00	2	1.86	1	0.62
Opheliidae	1	0.63	0	0.00	1	0.93	1	0.62
Ophiuroidea	0	0.00	0	0.00	6	5.58	1	0.62
Myodocopida *sp.B*	0	0.00	0	0.00	2	1.86	0	0.00
Myodocopida *sp.D*	1	0.63	0	0.00	1	0.93	1	0.62
Myodocopida *sp.F*	0	0.00	0	0.00	1	0.93	0	0.00
Paguroidea	0	0.00	0	0.00	0	0.00	1	0.62
Paraonidae	3	1.88	1	0.74	2	1.86	1	0.62
Pariphinotus sp.	0	0.00	0	0.00	2	1.86	0	0.00
Pholoidae	0	0.00	0	0.00	2	1.86	0	0.00
Phyllodocidae	1	0.63	0	0.00	1	0.93	0	0.00
Pitar simpsoni	2	1.25	1	0.74	0	0.00	1	0.62
Pleurocope floridensis	2	1.25	5	3.70	5	4.65	2	1.24
Polyplacophora *sp. D*	1	0.63	0	0.00	1	0.93	0	0.00
Polyplacophora *sp.A*	4	2.50	11	8.13	32	29.77	25	15.44

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Polyplacophora *sp.B*	1	0.63	1	0.74	5	4.65	2	1.24
Polyplacophora *sp.C*	0	0.00	0	0.00	1	0.93	0	0.00
Polyschides carolensis	3	1.88	1	0.74	3	2.79	3	1.85
Polyschides tetrachistus	2	1.25	2	1.48	8	7.44	5	3.09
Portunus sp.	0	0.00	0	0.00	0	0.00	1	0.62
Pteromeris perplana	0	0.00	1	0.74	3	2.79	4	2.47
Pycnogonida	0	0.00	1	0.74	2	1.86	0	0.00
Retusa sp.A	0	0.00	0	0.00	0	0.00	1	0.62
Rocinella signata	0	0.00	0	0.00	2	1.86	0	0.00
Rutiderma darbyi	3	1.88	3	2.22	14	13.02	7	4.32
Sabellidae	7	4.38	5	3.70	28	26.05	12	7.41
Semelidae	0	0.00	2	1.48	0	0.00	0	0.00
Sinelobus stanfordi	8	5.00	24	17.74	29	26.98	11	6.79
Spionidae	2	1.25	6	4.43	9	8.37	7	4.32
Syllidae	6	3.75	10	7.39	10	9.30	6	3.71
Synelmis sp.A	0	0.00	4	2.96	2	1.86	0	0.00
Terebellidae	1	0.63	1	0.74	0	0.00	0	0.00
Thracia sp.	0	0.00	0	0.00	1	0.93	1	0.62
Tricolia sp.	0	0.00	0	0.00	1	0.93	0	0.00
Tubificidae	19	11.88	18	13.30	17	15.82	26	16.06

Appendix 11- Density and abundance calculations for 2013 natural site 5BN.

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Abra sp.	0	0.00	0	0.00	0	0.00	1	0.74
Alvania sp.	2	2.10	0	0.00	0	0.00	0	0.00
Amphideutopus sp.	1	1.05	0	0.00	0	0.00	0	0.00
Amphinomidae	0	0.00	1	1.27	0	0.00	2	1.49
Amphioxiformes	0	0.00	0	0.00	0	0.00	4	2.98
Amphiuridae	0	0.00	0	0.00	0	0.00	1	0.74
Anthuridae *sp. A*	3	3.15	1	1.27	1	0.96	1	0.74
Apionsoma misakianum	0	0.00	1	1.27	0	0.00	0	0.00
Apseudes sp.A	1	1.05	0	0.00	0	0.00	0	0.00
Apseudidae	7	7.35	6	7.63	0	0.00	3	2.23
Aspidosiphon albus	2	2.10	2	2.54	3	2.89	2	1.49
Bemlos sp.	7	7.35	9	11.44	0	0.00	0	0.00
Bivalvia	13	13.65	3	3.81	2	1.93	1	0.74
Caecum nitidum	0	0.00	0	0.00	1	0.96	1	0.74
Caecum pulchellum	3	3.15	0	0.00	4	3.85	2	1.49
Caecum strigosum	0	0.00	0	0.00	0	0.00	2	1.49
Capitellidae	5	5.25	5	6.36	5	4.82	5	3.72
Cardidae	7	7.35	6	7.63	11	10.59	14	10.43
Carycorbula contracta	0	0.00	1	1.27	0	0.00	0	0.00
Chevalia carpenteri	0	0.00	1	1.27	0	0.00	0	0.00
Chione elevata	0	0.00	0	0.00	2	1.93	0	0.00
Chrysopetalidae	1	1.05	7	8.90	6	5.78	5	3.72
Cirratulidae	0	0.00	1	1.27	2	1.93	4	2.98
Cooperella sp.	0	0.00	0	0.00	0	0.00	1	0.74
Crasinella lunulata	1	1.05	4	5.09	1	0.96	1	0.74
Crassinella dupliniana	1	1.05	0	0.00	0	0.00	0	0.00
Crenella decussata	5	5.25	4	5.09	4	3.85	1	0.74
Ctenocardia media	0	0.00	0	0.00	2	1.93	0	0.00
Cumacea *sp.C*	0	0.00	1	1.27	0	0.00	0	0.00
Cyclaspis cf. varians	1	1.05	0	0.00	0	0.00	0	0.00
Decapoda unidentified crab	1	1.05	0	0.00	0	0.00	0	0.00
Dorvilleidae	6	6.30	9	11.44	12	11.56	8	5.96
Echinoidea	0	0.00	0	0.00	1	0.96	0	0.00
Ervilia sp.	2	2.10	0	0.00	2	1.93	2	1.49
Eunicidae	3	3.15	4	5.09	0	0.00	3	2.23
Gastropoda *sp. F*	1	1.05	0	0.00	0	0.00	0	0.00

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Gastropoda *sp. G*	0	0.00	0	0.00	1	0.96	0	0.00
Gastropoda *sp. I*	0	0.00	0	0.00	0	0.00	1	0.74
Gastropoda *sp. J*	0	0.00	0	0.00	0	0.00	1	0.74
Gastropoda unidentified	2	2.10	0	0.00	0	0.00	0	0.00
Gastropoda unidentified	2	2.10	0	0.00	1	0.96	0	0.00
Gastropoda unidentified juvenile	0	0.00	0	0.00	0	0.00	1	0.74
Gastropoda *sp. H*	0	0.00	0	0.00	0	0.00	1	0.74
Gibberosus myersi	0	0.00	0	0.00	1	0.96	0	0.00
Glyceridae	2	2.10	4	5.09	4	3.85	2	1.49
Glycymeris sp.	0	0.00	0	0.00	1	0.96	0	0.00
Granulina ovuliformis	1	1.05	2	2.54	0	0.00	0	0.00
Harbansus paucichelatus	1	1.05	1	1.27	1	0.96	0	0.00
Hesionidae	22	23.11	27	34.33	38	36.60	38	28.30
Laevicardium sp.	0	0.00	0	0.00	0	0.00	1	0.74
Leptachelia sp.	4	4.20	2	2.54	1	0.96	2	1.49
Leucosiidae	0	0.00	0	0.00	0	0.00	1	0.74
Limaria pellucida	0	0.00	0	0.00	1	0.96	0	0.00
Lottia antillarum	0	0.00	0	0.00	0	0.00	6	4.47
Lumbrineridae	3	3.15	1	1.27	0	0.00	6	4.47
Maldanidae	25	26.26	25	31.78	27	26.00	11	8.19
Meioceras cornucopiae	4	4.20	2	2.54	6	5.78	8	5.96
Nereididae	27	28.36	24	30.51	18	17.34	26	19.36
Onuphidae	1	1.05	1	1.27	0	0.00	1	0.74
Opheliidae	0	0.00	3	3.81	2	1.93	1	0.74
Ophiuroidea	1	1.05	1	1.27	0	0.00	2	1.49
Myodocopida *sp.B*	0	0.00	0	0.00	1	0.96	0	0.00
Myodocopida *sp.F*	1	1.05	0	0.00	0	0.00	0	0.00
Paraonidae	4	4.20	3	3.81	0	0.00	1	0.74
Parvilucina crenella	1	1.05	1	1.27	1	0.96	0	0.00
Pholoidae	1	1.05	3	3.81	1	0.96	5	3.72
Phyllodocidae	1	1.05	1	1.27	1	0.96	2	1.49
Pitar simpsoni	6	6.30	3	3.81	4	3.85	0	0.00
Pleurocope floridensis	0	0.00	2	2.54	0	0.00	0	0.00
Polyplacophora *sp. D*	0	0.00	1	1.27	0	0.00	0	0.00
Polyplacophora *sp.A*	4	4.20	7	8.90	5	4.82	7	5.21
Portunus sp.	0	0.00	0	0.00	1	0.96	0	0.00
Retusa sp.A	1	1.05	0	0.00	1	0.96	1	0.74

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Retusa sp.B	0	0.00	0	0.00	5	4.82	2	1.49
Rutiderma darbyi	10	10.50	2	2.54	1	0.96	1	0.74
Sabellidae	13	13.65	15	19.07	11	10.59	17	12.66
Semele bellastriata	*1*	1.05	0	0.00	0	0.00	0	0.00
Sinelobus stanfordi	0	0.00	0	0.00	1	0.96	0	0.00
Spionidae	23	24.16	6	7.63	1	0.96	12	8.94
Syllidae	19	19.96	21	26.70	28	26.97	15	11.17
Synelmis sp.B	1	1.05	2	2.54	5	4.82	3	2.23
Tellina listeri	1	1.05	0	0.00	0	0.00	0	0.00
Terebellidae	1	1.05	0	0.00	3	2.89	0	0.00
Thracia sp.	1	1.05	0	0.00	0	0.00	0	0.00
Tivela floridana	1	1.05	2	2.54	1	0.96	1	0.74
Tubificidae	5	5.25	11	13.98	7	6.74	11	8.19
Varicorbula philippii	0	0.00	0	0.00	1	0.96	0	0.00

Appendix 12- Density and abundance calculations for 2013 natural site 6AN.

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Alvania sp.	5	3.68	7	5.35	3	2.27	9	8.15
Amphinomidae	1	0.74	0	0.00	0	0.00	0	0.00
Amphioxiformes	1	0.74	3	2.29	1	0.76	1	0.91
Anthuridae *sp. A*	8	5.89	1	0.76	0	0.00	0	0.00
Apseudes sp.A	0	0.00	3	2.29	2	1.51	0	0.00
Apseudidae	22	16.19	30	22.94	4	3.02	11	9.96
Bemlos sp.	13	9.57	13	9.94	11	8.31	5	4.53
Bivalvia	3	2.21	6	4.59	1	0.76	1	0.91
Caecum nitidum	2	1.47	3	2.29	0	0.00	0	0.00
Caecum pulchellum	3	2.21	9	6.88	1	0.76	1	0.91
Capitellidae	0	0.00	3	2.29	3	2.27	4	3.62
Cardidae	3	2.21	5	3.82	3	2.27	2	1.81
Chione elevata	1	0.74	1	0.76	1	0.76	0	0.00
Chrysopetalidae	6	4.42	3	2.29	1	0.76	1	0.91
Cirratulidae	2	1.47	2	1.53	3	2.27	0	0.00
Cooperella sp.	0	0.00	0	0.00	1	0.76	0	0.00
Crassinella dupliniana	0	0.00	1	0.76	0	0.00	1	0.91
Crassinella lunulata	5	3.68	3	2.29	0	0.00	0	0.00
Crenella decussata	1	0.74	0	0.00	1	0.76	0	0.00
Ctenocardia media	1	0.74	2	1.53	0	0.00	0	0.00
Cumacea *sp.D*	1	0.74	1	0.76	0	0.00	1	0.91
Cyclaspis cf. varians	1	0.74	0	0.00	0	0.00	0	0.00
Cyclaspis sp. D	0	0.00	0	0.00	0	0.00	2	1.81
Decapoda unidentified	0	0.00	1	0.76	0	0.00	0	0.00
Dorvilleidae	2	1.47	15	11.47	6	4.53	11	9.96
Ervilia sp.	0	0.00	1	0.76	0	0.00	0	0.00
Eunicidae	0	0.00	2	1.53	0	0.00	0	0.00
Gastropoda *sp. H*	0	0.00	0	0.00	0	0.00	1	0.91
Gastropoda *sp. I*	1	0.74	0	0.00	0	0.00	0	0.00
Gastropoda unidentified juvenile	2	1.47	1	0.76	0	0.00	1	0.91
Glyceridae	1	0.74	2	1.53	2	1.51	1	0.91
Granulina ovuliformis	2	1.47	0	0.00	0	0.00	0	0.00
Harbansus paucichelata	1	0.74	5	3.82	2	1.51	3	2.72
Haustorius sp.	0	0.00	0	0.00	0	0.00	1	0.91
Hesionidae	40	29.44	81	61.95	58	43.79	49	44.36

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Isopoda *sp. A*	0	0.00	2	1.53	0	0.00	0	0.00
Laevicardium serratum	0	0.00	1	0.76	0	0.00	1	0.91
Laevicardium sp.	0	0.00	1	0.76	0	0.00	0	0.00
Leptachelia sp.	16	11.77	18	13.77	4	3.02	6	5.43
Leucosiidae	0	0.00	0	0.00	1	0.76	0	0.00
Limatula subovata	0	0.00	0	0.00	1	0.76	0	0.00
Limnoria sp.	0	0.00	2	2.29	0	0.00	1	0.91
Lottia antillarum	3	2.21	4	3.06	2	1.51	3	2.72
Lumbrineridae	0	0.00	2	1.53	0	0.00	0	0.00
Maldanidae	9	6.62	10	7.65	9	6.80	9	8.15
Meioceras cornucopiae	8	5.89	11	8.41	6	4.53	3	2.72
Nereididae	21	15.45	34	26.00	14	10.57	10	9.05
Onuphidae	1	0.74	2	1.53	0	0.00	3	2.72
Opheliidae	0	0.00	3	2.29	1	0.76	0	0.00
Ophiuroidea	0	0.00	1	0.76	0	0.00	0	0.00
Myodocopida *sp.A*	0	0.00	1	0.76	0	0.00	0	0.00
Myodocopida *sp.B*	0	0.00	0	0.00	1	0.76	0	0.00
Myodocopida *sp.D*	0	0.00	1	0.76	0	0.00	0	0.00
Myodocopida *sp.F*	1	0.74	0	0.00	0	0.00	0	0.00
Paradella sp.	0	0.00	0	0.00	1	0.76	0	0.00
Paraonidae	0	0.00	5	3.82	1	0.76	3	2.72
Parvilucina crenella	1	0.74	0	0.00	0	0.00	0	0.00
Pinnotheridae	1	0.74	0	0.00	0	0.00	0	0.00
Pitar simpsoni	1	0.74	6	4.59	2	1.51	3	2.72
Polyplacophora *sp.A*	13	9.57	10	7.65	0	0.00	4	3.62
Polyplacophora *sp.B*	0	0.00	0	0.00	1	0.76	0	0.00
Polyschides carolensis	1	0.74	1	0.76	0	0.00	1	0.91
Polyschides tetrachistus	0	0.00	0	0.00	1	0.76	0	0.00
Pteromeris perplana	5	3.68	1	0.76	2	1.51	2	1.81
Pycnogonida	0	0.00	1	0.76	0	0.00	0	0.00
Retusa sp.A	0	0.00	2	1.53	0	0.00	0	0.00
Retusa sp.B	0	0.00	0	0.00	1	0.76	0	0.00
Rutiderma darbyi	0	0.00	4	3.06	0	0.00	0	0.00
Sabellidae	6	4.42	2	1.53	2	1.51	3	2.72
Sinelobus stanfordi	0	0.00	1	0.76	1	0.76	0	0.00
Spionidae	7	5.15	4	3.06	2	1.51	7	6.34
Stenetrium sp.	0	0.00	1	0.76	0	0.00	0	0.00

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Syllidae	12	8.83	12	9.18	9	6.80	13	11.77
Synelmis sp.B	0	0.00	1	0.76	1	0.76	4	3.62
Thracia sp.	0	0.00	0	0.00	0	0.00	1	0.91
Tivela floridana	2	1.47	0	0.00	0	0.00	1	0.91
Tricolia sp.	0	0.00	1	0.76	0	0.00	0	0.00
Tubificidae	24	17.66	39	29.83	23	17.37	29	26.25
Varicorbula limatula	0	0.00	1	0.76	0	0.00	0	0.00
Xenanthura sp.	0	0.00	1	0.76	0	0.00	0	0.00

Appendix 13- Density and abundance calculations for 2013 artificial site 1A.

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Alora lioica	0	0.00	0	0.00	0	0.00	1	0.67
Amakusanthura magnifica	0	0.00	0	0.00	0	0.00	2	1.34
Amphinomidae *sp.A*	0	0.00	1	0.74	0	0.00	0	0.00
Anthuridae *sp.A*	2	2.08	0	0.00	1	0.87	1	0.67
Apseudes sp.A	5	5.19	12	8.83	4	3.47	8	5.37
Aricidea cerruitii	0	0.00	1	0.74	0	0.00	0	0.00
Aspidosiphon albus	4	4.16	6	4.42	4	3.47	1	0.67
Aspidosiphon parvulus	3	3.12	0	0.00	2	1.74	0	0.00
Aspionsoma misakianum	0	0.00	0	0.00	7	6.07	0	0.00
Bemlos sp.	0	0.00	1	0.74	0	0.00	13	8.73
Bivalvia	1	1.04	1	0.74	0	0.00	0	0.00
Branchiostoma sp.	0	0.00	0	0.00	1	0.87	0	0.00
Capitellidae	1	1.04	1	0.74	4	3.47	4	2.68
Caprellidae	0	0.00	0	0.00	2	1.74	1	0.67
Cardiidae	12	12.47	6	4.42	12	10.41	8	5.37
Ceratonereis mirabilis	0	0.00	0	0.00	3	2.60	0	0.00
Chevalia carpenteri	0	0.00	0	0.00	0	0.00	1	0.67
Chevalia sp.	0	0.00	0	0.00	0	0.00	1	0.67
Chione mazycki	0	0.00	0	0.00	0	0.00	2	1.34
Cirratulidae	8	8.31	3	2.21	5	4.34	6	4.03
Crassinella dupliniana	0	0.00	0	0.00	2	1.74	1	0.67
Decapoda	0	0.00	0	0.00	1	0.87	0	0.00
Dentalium floridense	0	0.00	0	0.00	0	0.00	1	0.67
Dentalium sp.	0	0.00	0	0.00	0	0.00	1	0.67
Encope michelini	0	0.00	0	0.00	0	0.00	1	0.67
Eunicidae	1	1.04	0	0.00	0	0.00	2	1.34
Gastropoda	0	0.00	0	0.00	0	0.00	1	0.67
Glyceridae	11	11.43	4	2.94	14	12.15	12	8.05
Harbansus paucichelatus	0	0.00	2	1.47	1	0.87	5	3.36
Hesionidae	16	16.62	26	19.14	24	20.82	43	28.86
Holothuroidea	0	0.00	0	0.00	0	0.00	1	0.67
Kalliapseudidae	0	0.00	0	0.00	3	2.60	1	0.67
Limatula subovata	3	3.12	1	0.74	0	0.00	2	1.34
Limidae	0	0.00	0	0.00	7	6.07	0	0.00
Lumbrineridae	4	4.16	2	1.47	4	3.47	0	0.00
Magelonidae	0	0.00	1	0.74	1	0.87	0	0.00

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Maldanidae	5	5.19	3	2.21	2	1.74	1	0.67
Mooreonuphis pallidula	1	1.04	0	0.00	0	0.00	0	0.00
Mooreonuphis sp.	3	3.12	0	0.00	0	0.00	2	1.34
Nereididae	2	2.08	1	0.74	4	3.47	2	1.34
Olivella nivea	0	0.00	0	0.00	1	0.87	0	0.00
Onuphidae	0	0.00	1	0.74	0	0.00	0	0.00
Ophellidae	0	0.00	0	0.00	1	0.87	0	0.00
Myodocopida *sp.A*	0	0.00	0	0.00	6	5.21	2	1.34
Myodocopida *sp.B*	0	0.00	0	0.00	4	3.47	1	0.67
Myodocopida *sp.C*	0	0.00	0	0.00	2	1.74	0	0.00
Myodocopida *sp.F*	0	0.00	0	0.00	0	0.00	1	0.67
Paraonidae	10	10.39	0	0.00	5	4.34	12	8.05
Parvilucina crenella	1	1.04	0	0.00	0	0.00	0	0.00
Pholoidae	0	0.00	0	0.00	0	0.00	1	0.67
Phyllodocidae	0	0.00	0	0.00	1	0.87	3	2.01
Pitar simponsi	1	1.04	1	0.74	0	0.00	2	1.34
Polyplacophora *sp.A*	0	0.00	0	0.00	0	0.00	3	2.01
Polyschides quadridentatus	0	0.00	0	0.00	0	0.00	1	0.67
Psammokalliapseudes sp.	1	1.04	0	0.00	0	0.00	0	0.00
Retusa sp.A	0	0.00	2	1.47	2	1.74	1	0.67
Retusa sp.B	0	0.00	0	0.00	0	0.00	2	1.34
Retusa sp.C	0	0.00	0	0.00	0	0.00	1	0.67
Rutiderma darbyi	1	1.04	3	2.21	5	4.34	4	2.68
Sabellidae	11	11.43	8	5.89	7	6.07	40	26.85
Sabellidae *sp.B*	2	2.08	3	2.21	9	7.81	0	0.00
Scaphopoda	1	1.04	0	0.00	0	0.00	1	0.67
Spionidae	9	9.35	3	2.21	6	5.21	14	9.40
Syllidae	7	7.27	8	5.89	6	5.21	10	6.71
Synelmis sp.A	0	0.00	0	0.00	0	0.00	1	0.67
Synelmis sp.B	5	5.19	0	0.00	1	0.87	5	3.36
Teribellidae	0	0.00	1	0.74	0	0.00	0	0.00
Thracia sp.	0	0.00	0	0.00	1	0.87	2	1.34
Tivela floridana	0	0.00	0	0.00	1	0.87	0	0.00
Tubificidae	10	10.39	2	1.47	0	0.00	1	0.67
Varicorbula sp.	0	0.00	2	1.47	2	1.74	0	0.00
Xenanthura sp.	1	1.04	0	0.00	0	0.00	0	0.00

Appendix 14- Density and abundance calculations for 2013 artificial site 3A.

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Amphideutopus sp.	0	0.00	0	0.00	0	0.00	2	0.94
Amphinomidae	0	0.00	1	0.42	0	0.00	0	0.00
Anthuridae *sp.A*	0	0.00	1	0.42	2	0.98	2	0.94
Apseudes sp.A	8	3.64	7	2.92	7	3.42	17	7.95
Arcinella cornuta	1	0.46	0	0.00	0	0.00	0	0.00
Aricidea cerruitii	0	0.00	0	0.00	0	0.00	0	0.00
Aspidosiphon albus	7	3.19	5	2.09	11	5.38	7	3.27
Aspidosiphon parvulus	2	0.91	4	1.67	5	2.44	3	1.40
Aspionsoma misakianum	0	0.00	0	0.00	1	0.49	2	0.94
Bemlos sp.	0	0.00	0	0.00	2	0.98	5	2.34
Branchiostoma sp.	0	0.00	1	0.42	0	0.00	0	0.00
Caecum floridanum	0	0.00	0	0.00	0	0.00	2	0.94
Capitellidae	4	1.82	1	0.42	1	0.49	5	2.34
Caprellidae	0	0.00	2	0.84	0	0.00	0	0.00
Capulidae	0	0.00	0	0.00	2	0.98	2	0.94
Cardiidae	11	5.01	13	5.43	4	1.95	20	9.35
Chevalia carpenteri	1	0.46	0	0.00	0	0.00	21	9.82
Chione mazycki	0	0.00	1	0.42	0	0.00	0	0.00
Cirratulidae	2	0.91	4	1.67	4	1.95	3	1.40
Crassinella dupliniana	2	0.91	0	0.00	0	0.00	5	2.34
Crenella decussata	1	0.46	0	0.00	0	0.00	0	0.00
Crenella sp.	0	0.00	0	0.00	3	1.47	0	0.00
Decapoda	0	0.00	0	0.00	1	0.49	0	0.00
Dentalium sp.	0	0.00	1	0.42	0	0.00	0	0.00
Dentalium floridense	2	0.91	0	0.00	1	0.49	0	0.00
Dentalium laqueatum	0	0.00	1	0.42	0	0.00	1	0.47
Ervilia concentrica	0	0.00	0	0.00	0	0.00	1	0.47
Eunicidae	4	1.82	2	0.84	1	0.49	0	0.00
Gastropoda	0	0.00	0	0.00	0	0.00	1	0.47
Glyceridae	8	3.64	6	2.51	12	5.86	17	7.95
Granulina margaritula	1	0.46	0	0.00	0	0.00	0	0.00
Harbansus pauichelatus	1	0.46	0	0.00	1	0.49	3	1.40
Hesionidae	27	12.30	38	15.87	13	6.35	49	22.92
Kalliapseuidae	1	0.46	0	0.00	0	0.00	0	0.00
Limatula sp.	1	0.46	0	0.00	0	0.00	0	0.00
Limatula subovata	3	1.37	2	0.84	0	0.00	5	2.34

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Limidae	1	0.46	3	1.25	0	0.00	0	0.00
Lumbrineridae	1	0.46	1	0.42	2	0.98	1	0.47
Maldanidae	0	0.00	1	0.42	0	0.00	1	0.47
Marginella eburneola	0	0.00	1	0.42	0	0.00	0	0.00
Marginella sp.	0	0.00	0	0.00	0	0.00	1	0.47
Mitra sp.	0	0.00	1	0.42	0	0.00	0	0.00
Mooreonuphis pallidula	0	0.00	0	0.00	0	0.00	0	0.00
Mooreonuphis sp.	3	1.37	2	0.84	2	0.98	1	0.47
Nassarius sp.	1	0.46	0	0.00	0	0.00	0	0.00
Nereididae	0	0.00	1	0.42	0	0.00	1	0.47
Onuphidae	0	0.00	0	0.00	0	0.00	1	0.47
Onuphidae	1	0.46	0	0.00	0	0.00	0	0.00
Ophellidae	0	0.00	0	0.00	0	0.00	0	0.00
Orbinidae	1	0.46	0	0.00	0	0.00	0	0.00
Myodocopida	0	0.00	2	0.84	0	0.00	0	0.00
Myodocopida *sp.A*	0	0.00	2	0.84	1	0.49	9	4.21
Myodocopida *sp.B*	4	1.82	1	0.42	1	0.49	2	0.94
Myodocopida *sp.C*	1	0.46	2	0.84	0	0.00	2	0.94
Myodocopida *sp.H*	0	0.00	0	0.00	1	0.49	0	0.00
Paraonidae	2	0.91	4	1.67	5	2.44	4	1.87
Parvilucina crenella	0	0.00	0	0.00	0	0.00	1	0.47
Phyllodocidae	1	0.46	2	0.84	2	0.98	2	0.94
Pitar simpsoni	1	0.46	1	0.42	3	1.47	5	2.34
Polyplacophora *sp.A*	1	0.46	0	0.00	1	0.49	1	0.47
Polyschides carolinensis	0	0.00	1	0.42	0	0.00	1	0.47
Polyschides quadridentatus	0	0.00	1	0.42	0	0.00	0	0.00
Polyschides tetrachistus	2	0.91	0	0.00	0	0.00	0	0.00
Retusa sp.A	3	1.37	1	0.42	3	1.47	1	0.47
Retusa sp.B	0	0.00	0	0.00	1	0.49	0	0.00
Rutiderma darbyi	2	0.91	3	1.25	2	0.98	4	1.87
Sabellidae	19	8.66	31	12.95	35	17.11	67	31.33
Sabellidae *sp.B*	0	0.00	0	0.00	0	0.00	0	0.00
Scaphopoda	0	0.00	0	0.00	0	0.00	1	0.47
Semelina nuculoides	1	0.46	0	0.00	1	0.49	0	0.00
Serpulidae	0	0.00	1	0.42	0	0.00	0	0.00
Spionidae	7	3.19	11	4.59	3	1.47	10	4.68
Syllidae	13	5.92	8	3.34	14	6.84	19	8.89

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Synelmis sp.A	0	0.00	1	0.42	0	0.00	0	0.00
Synelmis sp.B	8	3.64	11	4.59	12	5.86	22	10.29
Tellinidae	1	0.46	0	0.00	0	0.00	0	0.00
Terebellidae	0	0.00	1	0.42	0	0.00	0	0.00
Thracia sp.	3	1.37	1	0.42	2	0.98	3	1.40
Tubificidae	12	5.47	4	1.67	6	2.93	27	12.63
Varicorbula sp.	0	0.00	0	0.00	0	0.00	0	0.00
Xenanthura sp.	1	0.46	0	0.00	0	0.00	0	0.00

Appendix 15- Density and abundance calculations for 2013 artificial site 5B.

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Abra lioica	0	0.00	0	0.00	1	0.55	0	0.00
Amphideutopus sp.	0	0.00	0	0.00	0	0.00	3	1.87
Amphinomidae *sp.A*	2	1.07	0	0.00	3	1.64	1	0.62
Amphinomidae *sp.B*	0	0.00	0	0.00	1	0.55	1	0.62
Amphiuridae	0	0.00	0	0.00	0	0.00	1	0.62
Angulus sp.	3	1.61	0	0.00	0	0.00	0	0.00
Anthuridae *sp. A*	0	0.00	0	0.00	0	0.00	1	0.62
Apseudes sp.A	9	4.83	4	2.21	3	1.64	15	9.36
Aricidea cerruitii	0	0.00	0	0.00	0	0.00	0	0.00
Aspidosiphon albus	6	3.22	3	1.66	1	0.55	3	1.87
Aspidosiphon parvulus	0	0.00	1	0.55	1	0.55	0	0.00
Aspionsoma misakianum	2	1.07	0	0.00	0	0.00	1	0.62
Astropella punctutata	2	1.07	0	0.00	2	1.09	0	0.00
Bemlos sp.	0	0.00	0	0.00	2	1.09	2	1.25
Bivalvia	1	0.54	1	0.55	1	0.55	1	0.62
Branchiostoma sp.	4	2.15	1	0.55	2	1.09	2	1.25
Caecum nitidum	0	0.00	0	0.00	1	0.55	1	0.62
Capitellidae	7	3.76	2	1.11	2	1.09	0	0.00
Caprella sp.	0	0.00	0	0.00	3	1.64	0	0.00
Caprellidae	0	0.00	0	0.00	11	6.02	4	2.50
Capulidae	1	0.54	0	0.00	1	0.55	0	0.00
Cardiidae	23	12.34	7	3.88	19	10.39	9	5.61
Chevalia carpenteri	0	0.00	0	0.00	3	1.64	1	0.62
Chevalia sp.	4	2.15	0	0.00	0	0.00	0	0.00
Cirratulidae	4	2.15	0	0.00	1	0.55	4	2.50
Crassinella dupliniana	1	0.54	0	0.00	1	0.55	1	0.62
Crassinella lunulata	1	0.54	1	0.55	0	0.00	0	0.00
Cumacea *sp.A*	1	0.54	0	0.00	0	0.00	0	0.00
Cumacea *sp.B*	0	0.00	1	0.55	0	0.00	0	0.00
Dentalium floridense	1	0.54	0	0.00	1	0.55	1	0.62
Dentalium laqueatum	0	0.00	0	0.00	0	0.00	1	0.62
Ervilia concentrica	0	0.00	0	0.00	0	0.00	2	1.25
Ervilia nitens	0	0.00	0	0.00	1	0.55	0	0.00
Ervilia sp.	0	0.00	0	0.00	1	0.55	0	0.00
Eunicidae	1	0.54	4	2.21	2	1.09	0	0.00

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Gastropoda	1	0.54	3	1.66	0	0.00	5	3.12
Gastropoda *sp.H*	1	0.54	0	0.00	0	0.00	0	0.00
Glyceridae	14	7.51	3	1.66	8	4.38	14	8.73
Glycymerididae	0	0.00	1	0.55	0	0.00	0	0.00
Granulina margaritula	0	0.00	0	0.00	0	0.00	0	0.00
Granulina ovuliformis	0	0.00	1	0.55	0	0.00	0	0.00
Harbansus pauichelatus	6	3.22	0	0.00	7	3.83	1	0.62
Hesionidae	60	32.20	33	18.27	50	27.35	34	21.21
Chionopsis intapurpurea	0	0.00	1	0.55	0	0.00	0	0.00
Kalliapseudes sp.	1	0.54	0	0.00	1	0.55	0	0.00
Leptachelia sp.	1	0.54	0	0.00	0	0.00	0	0.00
Limatula subovata	9	4.83	1	0.55	0	0.00	5	3.12
Limidae	1	0.54	2	1.11	0	0.00	0	0.00
Lumbrineridae	2	1.07	2	1.11	4	2.19	5	3.12
Maldanidae	3	1.61	1	0.55	3	1.64	3	1.87
Marginella eburneola	0	0.00	0	0.00	0	0.00	2	1.25
Marginellidae	0	0.00	0	0.00	0	0.00	1	0.62
Mooreonuphis	8	4.29	1	0.55	1	0.55	1	0.62
Mooreonuphis pallidula	0	0.00	0	0.00	0	0.00	0	0.00
Myodocopida *sp.A*	2	1.07	1	0.55	3	1.64	5	3.12
Myodocopida *sp.B*	3	1.61	0	0.00	0	0.00	2	1.25
Myodocopida *sp.C*	0	0.00	1	0.55	0	0.00	0	0.00
Myodocopida *sp.F*	0	0.00	1	0.55	0	0.00	0	0.00
Nassarius albus	1	0.54	0	0.00	0	0.00	0	0.00
Nereidae	2	1.07	5	2.77	3	1.64	7	4.37
Olivella nivea	0	0.00	1	0.55	0	0.00	0	0.00
Ophellidae	0	0.00	0	0.00	0	0.00	0	0.00
Orbiniidae	0	0.00	0	0.00	0	0.00	0	0.00
Paraonidae	4	2.15	6	3.32	2	1.09	6	3.74
Parvilucina crenella	0	0.00	0	0.00	1	0.55	0	0.00
Phyllodocidae	5	2.68	3	1.66	1	0.55	4	2.50
Pitar simpsoni	0	0.00	0	0.00	3	1.64	2	1.25
Polyplacophora *sp. A*	1	0.54	1	0.55	1	0.55	1	0.62
Polyschides sp.	0	0.00	2	1.11	0	0.00	0	0.00
Polyschides tetrachistus	0	0.00	0	0.00	0	0.00	0	0.00
Retusa sp.A	1	0.54	0	0.00	1	0.55	0	0.00
Retusa sp.B	3	1.61	0	0.00	1	0.55	2	1.25

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Rissoidae	0	0.00	0	0.00	0	0.00	1	0.62
Rissoina sp.	0	0.00	0	0.00	2	1.09	0	0.00
Rutiderma darbyi	0	0.00	2	1.11	2	1.09	0	0.00
Sabellidae	16	8.59	5	2.77	65	35.55	70	43.66
Sabellidae *sp.B*	7	3.76	2	1.11	0	0.00	0	0.00
Scaphopoda	1	0.54	0	0.00	2	1.09	2	1.25
Semelina sp.	0	0.00	0	0.00	1	0.55	0	0.00
Serpulidae *sp.A*	4	2.15	0	0.00	0	0.00	1	0.62
Pitar simpsoni	0	0.00	0	0.00	1	0.55	1	0.62
Spionidae	5	2.68	6	3.32	7	3.83	9	5.61
Syllidae	18	9.66	13	7.20	9	4.92	6	3.74
Synelmis sp.A	2	1.07	1	0.55	0	0.00	0	0.00
Synelmis sp.B	3	1.61	9	4.98	5	2.73	9	5.61
Terebellidae	0	0.00	0	0.00	1	0.55	0	0.00
Thracia sp.	1	0.54	2	1.11	1	0.55	3	1.87
Tivela floridana	4	2.15	0	0.00	0	0.00	0	0.00
Trigonulina sp.	1	0.54	0	0.00	0	0.00	0	0.00
Tubificidae	6	3.22	7	3.88	8	4.38	14	8.73
Xenanthura sp.	1	0.54	0	0.00	0	0.00	0	0.00

Appendix 16- Density and abundance calculations for 2013 artificial site 6A.

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Acanthohaustorius pansus	0	0.00	0	0.00	2	0.94	0	0.00
Amphinomidae	2	1.07	0	0.00	1	0.47	0	0.00
Amphinomidae *sp.A*	0	0.00	1	0.48	1	0.47	0	0.00
Anthuridae *sp.A*	0	0.00	0	0.00	0	0.00	1	0.49
Apionsoma misakianum	6	3.22	0	0.00	9	4.21	0	0.00
Apseudes sp.A	2	1.07	0	0.00	0	0.00	3	1.46
Aspidosiphon albus	3	1.61	2	0.95	3	1.40	0	0.00
Aspidosiphon parvulus	1	0.54	3	1.43	3	1.40	0	0.00
Astropella punctata	0	0.00	3	1.43	0	0.00	0	0.00
Bemlos sp.	0	0.00	0	0.00	0	0.00	3	1.46
Branchiostoma sp.	1	0.54	0	0.00	0	0.00	0	0.00
Capitellidae	0	0.00	0	0.00	0	0.00	2	0.97
Caprellidae	0	0.00	1	0.48	0	0.00	3	1.46
Capulidae	1	0.54	0	0.00	0	0.00	0	0.00
Cardiidae	8	4.29	4	1.91	4	1.87	0	0.00
Cavilinga blanda	0	0.00	1	0.48	0	0.00	0	0.00
Cerithiidae	0	0.00	0	0.00	1	0.47	0	0.00
Chevalia carpenteri	0	0.00	0	0.00	0	0.00	2	0.97
Chevalia sp.	0	0.00	0	0.00	1	0.47	1	0.49
Chione mazycki	0	0.00	0	0.00	2	0.94	1	0.49
Cirratadactylas floridensis	0	0.00	0	0.00	1	0.47	0	0.00
Cirratulidae	2	1.07	3	1.43	3	1.40	9	4.39
Cirrophorus lyra	0	0.00	0	0.00	1	0.47	0	0.00
Crassinella dupliniana	5	2.68	1	0.48	0	0.00	1	0.49
Crassinella lunulata	0	0.00	0	0.00	1	0.47	0	0.00
Cyclinella tenuis	0	0.00	0	0.00	1	0.47	0	0.00
Cymodocidae	1	0.54	0	0.00	0	0.00	0	0.00
Dentalium laqueatum	0	0.00	1	0.48	1	0.47	0	0.00
Dentalium sp.	0	0.00	0	0.00	1	0.47	1	0.49
Ervilia concentrica	0	0.00	2	0.95	0	0.00	0	0.00
Eunicidae	9	4.83	4	1.91	2	0.94	0	0.00
Gastropoda	1	0.54	2	0.95	0	0.00	0	0.00
Glycera abranchiata	0	0.00	0	0.00	1	0.47	0	0.00
Glycera americana	1	0.54	0	0.00	0	0.00	0	0.00

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Glyceridae	13	6.97	11	5.25	4	1.87	9	4.39
Gyptis vitatta	1	0.54	0	0.00	0	0.00	0	0.00
Haminoea succinea	0	0.00	0	0.00	1	0.47	0	0.00
Harbansus paucichelatus	0	0.00	6	2.86	3	1.40	3	1.46
Hesionidae	31	16.63	24	11.46	35	16.38	48	23.39
Kalliapseudes sp.A	1	0.54	1	0.48	1	0.47	0	0.00
Leptachelia sp.	0	0.00	0	0.00	0	0.00	1	0.49
Limatula	3	1.61	0	0.00	0	0.00	0	0.00
Limatula subovata	0	0.00	3	1.43	0	0.00	0	0.00
Limidae	4	2.15	0	0.00	1	0.47	1	0.49
Lumbrineridae	2	1.07	0	0.00	1	0.47	1	0.49
Magelonidae	0	0.00	0	0.00	0	0.00	2	0.97
Maldanidae	2	1.07	0	0.00	3	1.40	0	0.00
Marginella aurantia	0	0.00	0	0.00	0	0.00	1	0.49
Marginella eburneola	1	0.54	1	0.48	0	0.00	0	0.00
Mooreonuphis sp.	10	5.36	1	0.48	5	2.34	1	0.49
Myodocopida *sp.A*	2	1.07	1	0.48	2	0.94	5	2.44
Myodocopida *sp.B*	0	0.00	1	0.48	0	0.00	0	0.00
Myodocopida *sp.C*	0	0.00	0	0.00	1	0.47	0	0.00
Myodocopida *sp.G*	1	0.54	0	0.00	0	0.00	0	0.00
Nereidae	3	1.61	3	1.43	0	0.00	6	2.92
Olivella nivea	1	0.54	0	0.00	0	0.00	0	0.00
Opheliidae	0	0.00	0	0.00	0	0.00	1	0.49
Orbiniidae	1	0.54	0	0.00	0	0.00	0	0.00
Paradella sp.	0	0.00	2	0.95	0	0.00	0	0.00
Paraonidae	6	3.22	3	1.43	5	2.34	3	1.46
Parvilucina crenella	0	0.00	1	0.48	0	0.00	0	0.00
Phyllodocidae	0	0.00	0	0.00	1	0.47	1	0.49
Pitar simponsi	1	0.54	2	0.95	2	0.94	0	0.00
Polyplacophora *sp.A*	0	0.00	2	0.95	0	0.00	1	0.49
Polyschides carolinensis	0	0.00	0	0.00	1	0.47	0	0.00
Retusa sp.A	0	0.00	1	0.48	0	0.00	1	0.49
Retusa sp.B	0	0.00	1	0.48	1	0.47	0	0.00
Rissoidae	0	0.00	0	0.00	0	0.00	1	0.49
Rutiderma darbyi	2	1.07	2	0.95	4	1.87	0	0.00
Sabellidae	10	5.36	19	9.07	14	6.55	20	9.75
Sabellidae *sp.B*	3	1.61	0	0.00	0	0.00	0	0.00

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Scaphapoda	0	0.00	1	0.48	2	0.94	0	0.00
Scaphapoda *sp. A*	1	0.54	0	0.00	0	0.00	0	0.00
Semele sp.	0	0.00	1	0.48	0	0.00	0	0.00
Serolidae	1	0.54	0	0.00	0	0.00	0	0.00
Spionidae	6	3.22	8	3.82	4	1.87	19	9.26
Syllidae	7	3.75	12	5.73	4	1.87	9	4.39
Synelmis sp.A	0	0.00	2	0.95	2	0.94	0	0.00
Synelmis sp.B	16	8.58	5	2.39	7	3.28	6	2.92
Terebellidae	0	0.00	0	0.00	2	0.94	0	0.00
Thracia sp.	3	1.61	0	0.00	0	0.00	1	0.49
Tivela floridana	1	0.54	0	0.00	0	0.00	3	1.46
Tubificidae	13	6.97	9	4.30	6	2.81	2	0.97
Xenanthura sp.	1	0.54	0	0.00	0	0.00	0	0.00

Appendix 17- Density and abundance calculations for 2014 natural site 1AN.

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Amphinomidae	1	0.98	0	0.00	1	1.07	0	0.00
Amphioxiformes	1	0.98	0	0.00	0	0.00	1	0.84
Amphiuridae	5	4.89	0	0.00	0	0.00	0	0.00
Apseudidae	0	0.00	4	3.74	0	0.00	0	0.00
Aspidosiphon parvulus	5	4.89	1	0.93	3	3.22	2	1.68
Bemlos sp.	0	0.00	2	1.87	2	2.15	0	0.00
Bivalvia	0	0.00	0	0.00	2	2.15	0	0.00
Caecum nitidum	0	0.00	2	1.87	0	0.00	0	0.00
Caecum pulchellum	1	0.98	3	2.80	0	0.00	0	0.00
Capitellidae	1	0.98	2	1.87	1	1.07	2	1.68
Caprella sp.	*0*	*0.00*	*1*	*0.93*	*0*	*0.00*	*0*	*0.00*
Cardidae	5	4.89	3	2.80	1	1.07	1	0.84
Caridea *sp.A*	0	0.00	2	1.87	0	0.00	1	0.84
Caridea *sp.A*	0	0.00	0	0.00	0	0.00	2	1.68
Chevalia sp.	1	0.98	1	0.93	2	2.15	1	0.84
Chione elevata	0	0.00	1	0.93	0	0.00	0	0.00
Chrysopetalidae	3	2.93	6	5.61	1	1.07	0	0.00
Cirratulidae	0	0.00	1	0.93	0	0.00	1	0.84
Crassinella lunulata	3	2.93	0	0.00	3	3.22	1	0.84
Crenella decussata	0	0.00	0	0.00	3	3.22	0	0.00
Ctenocardia media	0	0.00	0	0.00	1	1.07	0	0.00
Cumacea *sp.E*	0	0.00	1	0.93	0	0.00	0	0.00
Decapoda	0	0.00	2	1.87	0	0.00	0	0.00
Dentalium sp.	0	0.00	1	0.93	0	0.00	0	0.00
Dorvilleidae	3	2.93	2	1.87	4	4.29	3	2.51
Echinoidea *sp.A*	1	0.98	0	0.00	0	0.00	0	0.00
Eunicidae	2	1.96	0	0.00	2	2.15	0	0.00
Gastropoda	0	0.00	0	0.00	1	1.07	0	0.00
Gastropoda *sp. A*	0	0.00	1	0.93	0	0.00	0	0.00
Gastropoda *sp.B*	0	0.00	1	0.93	0	0.00	0	0.00
Gibberosus myersi	0	0.00	0	0.00	0	0.00	1	0.84
Glyceridae	1	0.98	0	0.00	1	1.07	2	1.68
Glycymeris sp.	1	0.98	0	0.00	2	2.15	1	0.84
Harbansus paucichelatus	0	0.00	1	0.93	1	1.07	0	0.00
Hesionidae	25	24.44	15	14.02	23	24.67	14	11.73

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Isopoda *sp.A*	1	0.98	1	0.93	1	1.07	3	2.51
Kalliapseudes sp.	0	0.00	1	0.93	0	0.00	0	0.00
Laevicardium serratum	1	0.98	0	0.00	0	0.00	1	0.84
Leptachelia sp.	1	0.98	1	0.93	1	1.07	0	0.00
Lottia antillarum	2	1.96	1	0.93	1	1.07	1	0.84
Lumbrineridae	2	1.96	0	0.00	0	0.00	0	0.00
Majoidea	0	0.00	0	0.00	1	1.07	0	0.00
Maldanidae	7	6.84	9	8.41	6	6.44	6	5.03
Meioceras cornucopiae	7	6.84	12	11.22	5	5.36	2	1.68
Myodocopida *sp.B*	0	0.00	1	0.93	2	2.15	0	0.00
Myodocopida *sp.D*	4	3.91	7	6.54	3	3.22	1	0.84
Myodocopida *sp.E*	0	0.00	0	0.00	1	1.07	0	0.00
Mytilidae	0	0.00	1	0.93	0	0.00	0	0.00
Nereididae	4	3.91	13	12.15	4	4.29	8	6.70
Ophelidae	2	1.96	0	0.00	0	0.00	0	0.00
Ophiuroidea	0	0.00	0	0.00	1	1.07	0	0.00
Paguroidea	1	0.98	0	0.00	1	1.07	0	0.00
Papyridea soleniformis	0	0.00	0	0.00	1	1.07	0	0.00
Paranoidae	2	1.96	0	0.00	0	0.00	2	1.68
Parvilucina crenella	0	0.00	0	0.00	0	0.00	1	0.84
Pholoidae	3	2.93	9	8.41	9	9.65	5	4.19
Phyllodocidae	0	0.00	1	0.93	0	0.00	0	0.00
Pitar simpsoni	1	0.98	3	2.80	2	2.15	1	0.84
Pleurocope floridensis	0	0.00	1	0.93	0	0.00	0	0.00
Polyplacophora *sp. A*	0	0.00	2	1.87	1	1.07	0	0.00
Polyplacophora *sp.D*	0	0.00	1	0.93	0	0.00	0	0.00
Praniza larvae	1	0.98	0	0.00	1	1.07	0	0.00
Rutiderma darbyi	0	0.00	0	0.00	1	1.07	0	0.00
Sabellidae	6	5.87	11	10.28	6	6.44	7	5.87
Semele bellastriata	1	0.98	0	0.00	1	1.07	0	0.00
Spionidae	11	10.75	13	12.15	7	7.51	7	5.87
Syllidae	7	6.84	11	10.28	5	5.36	5	4.19
Synelmis sp.B	0	0.00	0	0.00	0	0.00	3	2.51
Terebellidae	2	1.96	0	0.00	2	2.15	0	0.00
Thracia sp.	1	0.98	0	0.00	0	0.00	1	0.84
Tivela floridana	1	0.98	0	0.00	0	0.00	0	0.00
Tubificidae	2	1.96	3	2.80	4	4.29	2	1.68

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Xanthoidea	0	0.00	0	0.00	1	1.07	0	0.00

Appendix 18- Density and abundance calculations for 2014 natural site 3AN.

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Alvania sp.	0	0.00	1	0.74	0	0.00	0	0.00
Amphioxiformes	1	0.63	0	0.00	0	0.00	3	1.85
Anthuridae *sp. B*	1	0.63	0	0.00	0	0.00	0	0.00
Apseudes sp.A	1	0.63	0	0.00	0	0.00	0	0.00
Aspidosiphon albus	0	0.00	0	0.00	0	0.00	3	1.85
Aspidosiphon parvulus	3	1.88	3	2.22	3	2.79	6	3.71
Bemlos sp.	2	1.25	1	0.74	2	1.86	2	1.24
Bivalvia	1	0.63	0	0.00	0	0.00	1	0.62
Caecum nitidum	0	0.00	1	0.74	0	0.00	0	0.00
Caecum pulchellum	5	3.13	2	1.48	5	4.65	4	2.47
Caecum subvolutum	0	0.00	0	0.00	0	0.00	1	0.62
Capitellidae	2	1.25	0	0.00	0	0.00	0	0.00
Caprella sp.	0	0.00	0	0.00	0	0.00	1	0.62
Cardidae	4	2.50	1	0.74	0	0.00	3	1.85
Chevalia sp.	6	3.75	0	0.00	1	0.93	6	3.71
Chione elevata	2	1.25	0	0.00	1	0.93	1	0.62
Chrysopetalidae	1	0.63	0	0.00	2	1.86	3	1.85
Crassinella lunulata	2	1.25	0	0.00	1	0.93	1	0.62
Crenella decussata	0	0.00	0	0.00	0	0.00	2	1.24
Cumacea *sp. E*	1	0.63	0	0.00	0	0.00	0	0.00
Dentalium calamus	1	0.63	0	0.00	0	0.00	0	0.00
Dentalium sp.	0	0.00	0	0.00	1	0.93	0	0.00
Dorvilleidae	9	5.63	3	2.22	10	9.30	11	6.79
Ervilia sp.	0	0.00	0	0.00	0	0.00	2	1.24
Eunicidae	4	2.50	3	2.22	2	1.86	2	1.24
Gastropoda	0	0.00	1	0.74	1	0.93	0	0.00
Gastropoda *sp. D*	1	0.63	0	0.00	0	0.00	0	0.00
Glyceridae	2	1.25	2	1.48	2	1.86	1	0.62
Hesionidae	32	20.00	17	12.56	19	17.68	11	6.79
Isopoda *sp. A*	5	3.13	0	0.00	1	0.93	2	1.24
Lottia antillarum	1	0.63	0	0.00	0	0.00	1	0.62
Lumbrineridae	0	0.00	0	0.00	0	0.00	1	0.62
Maldanidae	2	1.25	1	0.74	1	0.93	0	0.00
Meioceras cornucopiae	5	3.13	2	1.48	3	2.79	0	0.00

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Myodocopida *sp.B*	0	0.00	0	0.00	0	0.00	1	0.62
Myodocopida *sp.D*	1	0.63	0	0.00	1	0.93	0	0.00
Nereididae	1	0.63	1	0.74	8	7.44	5	3.09
Onuphidae	4	2.50	0	0.00	0	0.00	0	0.00
Ophelidae	3	1.88	0	0.00	3	2.79	0	0.00
Paranoidae	2	1.25	2	1.48	2	1.86	7	4.32
Pholoidae	1	0.63	0	0.00	0	0.00	0	0.00
Phyllodocidae	0	0.00	1	0.74	0	0.00	0	0.00
Pitar simpsoni	4	2.50	2	1.48	2	1.86	3	1.85
Pleurocope floridensis	0	0.00	1	0.74	1	0.93	0	0.00
Praniza larvae	0	0.00	0	0.00	0	0.00	1	0.62
Pteromeris perplana	0	0.00	2	1.48	0	0.00	1	0.62
Rutiderma darbyi	1	0.63	0	0.00	0	0.00	0	0.00
Sabellidae	2	1.25	0	0.00	0	0.00	0	0.00
Spionidae	11	6.88	7	5.17	9	8.37	12	7.41
Syllidae	3	1.88	2	1.48	2	1.86	2	1.24
Syllidae	5	3.13	2	1.48	2	1.86	1	0.62
Synelmis sp.A	0	0.00	0	0.00	1	0.93	0	0.00
Synelmis sp.B	0	0.00	1	0.74	1	0.93	0	0.00
Tubificidae	27	16.88	12	8.87	21	19.54	15	9.26

Appendix 19- Density and abundance calculations for 2014 natural site 5BN.

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Amakusanthura magnifica	0	0.00	0	0.00	0	0.00	1	0.74
Amphinomidae	1	1.05	0	0.00	1	0.96	0	0.00
Amphioxiformes	0	0.00	1	1.27	1	0.96	0	0.00
Amphiuridae	0	0.00	4	5.09	3	2.89	1	0.74
Anthuridae *sp. A*	3	3.15	0	0.00	3	2.89	10	7.45
Apseudidae	1	1.05	0	0.00	3	2.89	1	0.74
Aspidosiphon albus	0	0.00	2	2.54	0	0.00	0	0.00
Aspidosiphon parvulus	0	0.00	0	0.00	0	0.00	1	0.74
Bivalvia	0	0.00	0	0.00	4	3.85	2	1.49
Caecum nitidum	0	0.00	0	0.00	0	0.00	1	0.74
Caecum pulchellum	1	1.05	2	2.54	1	0.96	0	0.00
Capitellidae	1	1.05	4	5.09	3	2.89	2	1.49
Caprella sp.	1	1.05	0	0.00	0	0.00	0	0.00
Cardidae	4	4.20	8	10.17	16	15.41	0	0.00
Cephalocarida	0	0.00	0	0.00	0	0.00	1	0.74
Chevalia sp.	1	1.05	7	8.90	12	11.56	22	16.38
Chione elevata	0	0.00	2	2.54	3	2.89	0	0.00
Chrysopetalidae	15	15.75	1	1.27	11	10.59	10	7.45
Crassinella lunulata	0	0.00	2	2.54	5	4.82	1	0.74
Ctenocardia media	0	0.00	0	0.00	1	0.96	0	0.00
Cumacea *sp. C*	1	1.05	0	0.00	0	0.00	0	0.00
Dorvilleidae	3	3.15	5	6.36	5	4.82	0	0.00
Echinoidea *sp. A*	0	0.00	0	0.00	1	0.96	0	0.00
Eunicidae	1	1.05	0	0.00	5	4.82	0	0.00
Gastropoda	1	1.05	0	0.00	0	0.00	1	0.74
Gastropoda *sp. C*	0	0.00	1	1.27	0	0.00	0	0.00
Gibberosus myersi	0	0.00	0	0.00	0	0.00	1	0.74
Glyceridae	0	0.00	3	3.81	0	0.00	1	0.74
Harbansus paucichelata	0	0.00	0	0.00	1	0.96	0	0.00
Hesionidae	13	13.65	11	13.98	14	13.48	7	5.21
Kalliapseudes sp.	0	0.00	0	0.00	2	1.93	0	0.00
Laevicardium serratum	1	1.05	0	0.00	0	0.00	1	0.74
Leptachelia sp.	2	2.10	1	1.27	1	0.96	1	0.74
Lottia antillarum	1	1.05	1	1.27	3	2.89	3	2.23
Lumbrineridae	3	3.15	6	7.63	2	1.93	1	0.74

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Magelonidae	0	0.00	1	1.27	0	0.00	0	0.00
Maldanidae	2	2.10	7	8.90	8	7.70	7	5.21
Meioceras cornucopiae	6	6.30	5	6.36	5	4.82	7	5.21
Myodocopida *sp.B*	2	2.10	1	1.27	1	0.96	0	0.00
Myodocopida *sp.D*	3	3.15	2	2.54	1	0.96	0	0.00
Mytilidae	0	0.00	1	1.27	0	0.00	0	0.00
Nereididae	15	15.75	6	7.63	10	9.63	8	5.96
Onuphidae	0	0.00	0	0.00	0	0.00	3	2.23
Ophelidae	2	2.10	0	0.00	0	0.00	0	0.00
Ophiuridae	0	0.00	1	1.27	1	0.96	0	0.00
Ophiuroidea	1	1.05	0	0.00	0	0.00	0	0.00
Paguroida	0	0.00	1	1.27	0	0.00	0	0.00
Paranoidae	4	4.20	4	5.09	6	5.78	5	3.72
Pholoidae	9	9.45	6	7.63	6	5.78	2	1.49
Phyllodocidae	0	0.00	1	1.27	3	2.89	0	0.00
Pinnotheridae	0	0.00	1	1.27	0	0.00	0	0.00
Pitar simpsoni	1	1.05	0	0.00	1	0.96	2	1.49
Pleurocope floridensis	5	5.25	6	7.63	2	1.93	3	2.23
Polyplacophora *sp.A*	1	1.05	6	7.63	1	0.96	5	3.72
Polyplacophora *sp.B*	1	1.05	1	1.27	0	0.00	1	0.74
Polyplacophora *sp.C*	0	0.00	1	1.27	1	0.96	0	0.00
Polyplacophora *sp.D*	0	0.00	1	1.27	1	0.96	0	0.00
Polyschides sp.	0	0.00	0	0.00	0	0.00	1	0.74
Praniza larvae	2	2.10	1	1.27	1	0.96	2	1.49
Pteromeris perplana	1	1.05	0	0.00	0	0.00	0	0.00
Pycnogonida	0	0.00	0	0.00	2	1.93	0	0.00
Rissoina sp. E	2	2.10	0	0.00	0	0.00	0	0.00
Rutiderma darbyi	0	0.00	0	0.00	0	0.00	2	1.49
Sabellidae	4	4.20	3	3.81	4	3.85	4	2.98
Semele bellstriata	1	1.05	0	0.00	0	0.00	0	0.00
Spionidae	16	16.80	14	17.80	8	7.70	11	8.19
Syllidae	21	22.06	9	11.44	33	31.78	10	7.45
Terebellidae	0	0.00	0	0.00	2	1.93	0	0.00
Thracia sp.	1	1.05	0	0.00	2	1.93	0	0.00
Tubificidae	2	2.10	18	22.88	11	10.59	20	14.89

Appendix 20- Density and abundance calculations for 2014 natural site 6AN.

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Abra sp.	0	0.00	0	0.00	0	0.00	1	0.91
Alvania sp.	0	0.00	1	0.76	0	0.00	0	0.00
Amphioxiformes	2	1.47	3	2.29	1	0.76	1	0.91
Anthuridae *sp. A*	2	1.47	1	0.76	4	3.02	2	1.81
Apseudes sp.A	2	1.47	0	0.00	0	0.00	0	0.00
Aspidosiphon albus	0	0.00	1	0.76	1	0.76	1	0.91
Aspidosiphon parvulus	0	0.00	0	0.00	1	0.76	0	0.00
Bemlos sp.	0	0.00	0	0.00	2	1.51	4	3.62
Bivalvia	2	1.47	0	0.00	1	0.76	1	0.91
Caecum imbricatum	0	0.00	1	0.76	0	0.00	0	0.00
Caecum pulchellum	6	4.42	1	0.76	3	2.27	0	0.00
Capitellidae	0	0.00	0	0.00	1	0.76	0	0.00
Cardidae	2	1.47	2	1.53	5	3.78	2	1.81
Carycorbula contracta	0	0.00	0	0.00	1	0.76	0	0.00
Chevalia sp.	0	0.00	3	2.29	0	0.00	0	0.00
Chione elevata	1	0.74	0	0.00	1	0.76	0	0.00
Chrysopetalidae	1	0.74	0	0.00	2	1.51	0	0.00
Crassinella dupliniana	0	0.00	1	0.76	0	0.00	0	0.00
Crassinella lunultata	0	0.00	1	0.76	1	0.76	0	0.00
Crassinella martinicensis	1	0.74	0	0.00	0	0.00	0	0.00
Crenella decussata	1	0.74	0	0.00	0	0.00	0	0.00
Cyclaspis cf. varians	0	0.00	1	0.76	0	0.00	0	0.00
Cyclaspis sp. D	1	0.74	0	0.00	0	0.00	0	0.00
Dentalium calamus	0	0.00	0	0.00	1	0.76	1	0.91
Dentalium sp.	0	0.00	0	0.00	0	0.00	1	0.91
Dorvilleidae	12	8.83	9	6.88	8	6.04	3	2.72
Ervilia sp.	1	0.74	1	0.76	0	0.00	0	0.00
Eunicidae	0	0.00	0	0.00	0	0.00	1	0.91
Gastropoda	1	0.74	0	0.00	0	0.00	0	0.00
Glyceridae	1	0.74	0	0.00	3	2.27	2	1.81
Glycymeris sp.	0	0.00	0	0.00	0	0.00	0	0.00
Harbansus paucichelata	0	0.00	1	0.76	1	0.76	0	0.00
Hesionidae	20	14.72	16	12.24	64	48.32	12	10.86
Isopoda *sp. A*	1	0.74	0	0.00	0	0.00	0	0.00
Meioceras cornucopiae	2	1.47	2	1.53	4	3.02	0	0.00

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Myodocopida *sp.A*	1	0.74	0	0.00	0	0.00	0	0.00
Myodocopida *sp.D*	0	0.00	0	0.00	1	0.76	0	0.00
Myodocopida *sp.E*	0	0.00	1	0.76	0	0.00	0	0.00
Nereididae	1	0.74	6	4.59	6	4.53	2	1.81
Oliva sp.	1	0.74	0	0.00	2	1.51	1	0.91
Onuphidae	3	2.21	5	3.82	5	3.78	3	2.72
Ophelidae	0	0.00	1	0.76	1	0.76	0	0.00
Paradella sp.	0	0.00	2	1.53	0	0.00	0	0.00
Paranoidae	3	2.21	1	0.76	3	2.27	0	0.00
Pholoidae	0	0.00	1	0.76	0	0.00	0	0.00
Phyllodocidae	1	0.74	1	0.76	0	0.00	0	0.00
Pitar simpsoni	2	1.47	3	2.29	4	3.02	1	0.91
Polyplacophora *sp.A*	0	0.00	0	0.00	1	0.76	0	0.00
Polyschides tetrachistus	0	0.00	1	0.76	0	0.00	0	0.00
Pteromeris perplana	1	0.74	1	0.76	1	0.76	2	1.81
Rutiderma darbyi	0	0.00	1	0.76	0	0.00	0	0.00
Sabellidae	1	0.74	1	0.76	2	1.51	0	0.00
Sigalionidae	1	0.74	0	0.00	0	0.00	0	0.00
Spionidae	11	8.09	8	6.12	10	7.55	7	6.34
Syllidae	11	8.09	4	3.06	18	13.59	0	0.00
Synelmis sp.B	1	0.74	2	1.53	2	1.51	0	0.00
Tubificidae	12	8.83	10	7.65	34	25.67	7	6.34

Appendix 21- Density and abundance calculations for 2014 artificial site 1A.

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Amakusanthura magnifica	1	1.04	0	0.00	0	0.00	0	0.00
Amphioxiformes	0	0.00	1	0.74	2	1.74	0	0.00
Anthuridae *sp. A*	0	0.00	1	0.74	0	0.00	0	0.00
Apionsoma misakianum	2	2.08	0	0.00	1	0.87	1	0.67
Apseudes sp. A	2	2.08	1	0.74	2	1.74	1	0.67
Aspidosiphon albus	2	2.08	3	2.21	2	1.74	1	0.67
Aspidosiphon parvulus	4	4.16	7	5.15	2	1.74	4	2.68
Bemlos sp.	5	5.19	1	0.74	4	3.47	5	3.36
Bivalvia	1	1.04	0	0.00	0	0.00	0	0.00
Caecum imbricatum	1	1.04	0	0.00	0	0.00	0	0.00
Capitellidae	0	0.00	0	0.00	1	0.87	1	0.67
Cardidae	16	16.62	4	2.94	9	7.81	10	6.71
Chevalia carpenteri	0	0.00	0	0.00	2	1.74	0	0.00
Crassinella dupliniana	2	2.08	0	0.00	0	0.00	3	2.01
Dorvilleidae	4	4.16	3	2.21	3	2.60	5	3.36
Ervilia sp.	1	1.04	0	0.00	0	0.00	0	0.00
Eunicidae	0	0.00	0	0.00	1	0.87	0	0.00
Gastropoda	0	0.00	0	0.00	0	0.00	1	0.67
Gastropoda *sp. H*	0	0.00	0	0.00	1	0.87	1	0.67
Glyceridae	0	0.00	0	0.00	3	2.60	4	2.68
Glycymeris sp.	0	0.00	0	0.00	1	0.87	0	0.00
Harbansus paucichelatus	2	2.08	0	0.00	0	0.00	0	0.00
Hesionidae	2	2.08	4	2.94	8	6.94	6	4.03
Kalliapseudes sp. A	4	4.16	0	0.00	0	0.00	0	0.00
Lumbrineridae	0	0.00	0	0.00	0	0.00	1	0.67
Magelonidae	0	0.00	1	0.74	0	0.00	1	0.67
Maldanidae	0	0.00	2	1.47	1	0.87	7	4.70
Marginella sp.	1	1.04	0	0.00	0	0.00	0	0.00
Meioceras cornucopiae	0	0.00	0	0.00	0	0.00	1	0.67
Nereididae	0	0.00	0	0.00	2	1.74	0	0.00
Onuphidae	0	0.00	0	0.00	0	0.00	1	0.67
Ophelidae	0	0.00	1	0.74	0	0.00	0	0.00
Ophiuroidea	0	0.00	0	0.00	1	0.87	0	0.00
Paranoidae	3	3.12	0	0.00	4	3.47	9	6.04
Parvilucina crenella	1	1.04	0	0.00	1	0.87	0	0.00

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Pitar simpsoni	0	0.00	0	0.00	0	0.00	1	0.67
Retusa sp. A	1	1.04	0	0.00	0	0.00	0	0.00
Rutiderma darbyi	0	0.00	1	0.74	0	0.00	0	0.00
Sabellidae	1	1.04	0	0.00	4	3.47	0	0.00
Spionidae	3	3.12	1	0.74	1	0.87	3	2.01
Syllidae	0	0.00	4	2.94	3	2.60	3	2.01
Synelmis sp. A	0	0.00	1	0.74	0	0.00	0	0.00
Synelmis sp. B	1	1.04	19	13.99	9	7.81	4	2.68
Thracia sp.	2	2.08	0	0.00	3	2.60	0	0.00
Varicorbula limatula	0	0.00	0	0.00	1	0.87	0	0.00
Veneridae	1	1.04	0	0.00	0	0.00	0	0.00

Appendix 22- Density and abundance calculations for 2014 artificial site 3A.

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Amakusanthura magnifica	0	0.00	1	0.42	14	6.84	1	0.47
Amphinomidae	0	0.00	1	0.42	0	0.00	0	0.00
Amphioxiformes	0	0.00	2	0.84	1	0.49	1	0.47
Amphiuridae	0	0.00	2	0.84	0	0.00	0	0.00
Apionsoma misakianum	2	0.91	2	0.84	2	0.98	1	0.47
Apseudes sp. A	0	0.00	0	0.00	2	0.98	2	0.94
Aspidosiphon albus	7	3.19	9	3.76	11	5.38	13	6.08
Aspidosiphon parvulus	9	4.10	15	6.26	35	17.11	9	4.21
Bemlos sp.	2	0.91	0	0.00	2	0.98	5	2.34
Bivalvia	0	0.00	0	0.00	3	1.47	5	2.34
Capitellidae	2	0.91	0	0.00	2	0.98	3	1.40
Cardidae	8	3.64	16	6.68	13	6.35	11	5.14
Caridea *sp.B*	0	0.00	0	0.00	1	0.49	0	0.00
Chevalia carpenteri	3	1.37	0	0.00	1	0.49	0	0.00
Chione elevata	0	0.00	0	0.00	2	0.98	0	0.00
Chrysopetalidae	1	0.46	0	0.00	0	0.00	0	0.00
Cirratulidae	1	0.46	1	0.42	1	0.49	0	0.00
Crasinella lunulata	0	0.00	0	0.00	3	1.47	0	0.00
Crassinella dupliniana	0	0.00	1	0.42	3	1.47	0	0.00
Crenella decussata	0	0.00	0	0.00	0	0.00	1	0.47
Dentalium sp.	0	0.00	0	0.00	1	0.49	0	0.00
Dorvilleidae	3	1.37	3	1.25	8	3.91	6	2.81
Echinoidea *sp. A*	1	0.46	1	0.42	0	0.00	1	0.47
Ervilia sp.	1	0.46	0	0.00	0	0.00	0	0.00
Eunicidae	0	0.00	1	0.42	3	1.47	3	1.40
Gastropoda	0	0.00	0	0.00	1	0.49	0	0.00
Glyceridae	4	1.82	3	1.25	1	0.49	4	1.87
Glycymeris sp.	1	0.46	0	0.00	1	0.49	0	0.00
Harbansus paucichelatus	1	0.46	1	0.42	2	0.98	4	1.87
Hesionidae	11	5.01	15	6.26	17	8.31	9	4.21
Limnoria sp.	0	0.00	0	0.00	1	0.49	0	0.00
Littorina sp.	0	0.00	1	0.42	0	0.00	0	0.00
Lumbrineridae	1	0.46	1	0.42	3	1.47	0	0.00
Magelonidae	0	0.00	0	0.00	1	0.49	0	0.00
Marginella sp.	0	0.00	3	1.25	0	0.00	0	0.00

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Metharpinia floridana	0	0.00	0	0.00	2	0.98	0	0.00
Myodocopida *sp. A*	0	0.00	1	0.42	0	0.00	0	0.00
Onuphidae	1	0.46	0	0.00	0	0.00	1	0.47
Ophelidae	1	0.46	1	0.42	1	0.49	1	0.47
Paranoidae	7	3.19	4	1.67	12	5.86	6	2.81
Parvilucina crenella	2	0.91	0	0.00	1	0.49	0	0.00
Pitar simpsoni	1	0.46	0	0.00	2	0.98	1	0.47
Polyschides carolensis	0	0.00	0	0.00	0	0.00	1	0.47
Polyschides tetrachistus	1	0.46	0	0.00	0	0.00	0	0.00
Retusa sp. A	0	0.00	1	0.42	1	0.49	0	0.00
Rutiderma darbyi	0	0.00	0	0.00	4	1.95	1	0.47
Sabellidae	1	0.46	0	0.00	3	1.47	2	0.94
Spionidae	3	1.37	3	1.25	6	2.93	7	3.27
Sthenelais boa	0	0.00	0	0.00	0	0.00	1	0.47
Syllidae	2	0.91	0	0.00	7	3.42	1	0.47
Synelmis sp. A	2	0.91	1	0.42	0	0.00	1	0.47
Synelmis sp. B	7	3.19	4	1.67	14	6.84	7	3.27
Thracia sp.	1	0.46	1	0.42	3	1.47	1	0.47
Tivela floridana	0	0.00	1	0.42	1	0.49	0	0.00
Tubificidae	0	0.00	0	0.00	6	2.93	2	0.94
Xenanthura sp.	0	0.00	1	0.42	1	0.49	1	0.47

Appendix 23- Density and abundance calculations for 2014 artificial site 5B.

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Amakusanthura magnifica	1	0.54	2	1.11	0	0.00	2	1.25
Amphinomidae	1	0.54	0	0.00	1	0.55	0	0.00
Amphioxiformes	2	1.07	1	0.55	2	1.09	2	1.25
Amphiuridae	0	0.00	2	1.11	0	0.00	0	0.00
Angulus versicolor	0	0.00	2	1.11	0	0.00	0	0.00
Apionsoma misakianum	1	0.54	1	0.55	0	0.00	1	0.62
Apseudes sp. A	7	3.76	4	2.21	3	1.64	3	1.87
Aspidosiphon albus	4	2.15	6	3.32	1	0.55	3	1.87
Aspidosiphon parvulus	11	5.90	9	4.98	10	5.47	9	5.61
Bemlos sp.	9	4.83	14	7.75	19	10.39	24	14.97
Bivalvia	0	0.00	2	1.11	1	0.55	1	0.62
Capitellidae	3	1.61	0	0.00	1	0.55	4	2.50
Cardidae	23	12.34	18	9.97	13	7.11	16	9.98
Chrysopetalidae	1	0.54	0	0.00	0	0.00	1	0.62
Crassinella dupliniana	0	0.00	2	1.11	2	1.09	1	0.62
Crassinella lunulata	0	0.00	0	0.00	0	0.00	1	0.62
Crenella decussata	1	0.54	0	0.00	0	0.00	0	0.00
Cyclaspis cf. varians	1	0.54	0	0.00	0	0.00	0	0.00
Dentalium sp.	0	0.00	1	0.55	0	0.00	0	0.00
Dorvilleidae	7	3.76	5	2.77	9	4.92	5	3.12
Eunicidae	1	0.54	4	2.21	0	0.00	2	1.25
Gastropoda	0	0.00	1	0.55	0	0.00	0	0.00
Gastropoda *sp. G*	1	0.54	1	0.55	0	0.00	0	0.00
Gastropoda unidentified juvenile	0	0.00	1	0.55	0	0.00	0	0.00
Gibberula fluctuata	0	0.00	1	0.55	0	0.00	0	0.00
Glyceridae	4	2.15	1	0.55	1	0.55	6	3.74
Granulina ovulliformis	0	0.00	1	0.55	0	0.00	1	0.62
Harbansus paucichelatus	4	2.15	4	2.21	0	0.00	8	4.99
Hesionidae	15	8.05	15	8.30	12	6.56	25	15.59
Kalliapseudes sp. A	1	0.54	0	0.00	0	0.00	1	0.62
Lumbrineridae	1	0.54	3	1.66	0	0.00	2	1.25
Maldanidae	0	0.00	0	0.00	0	0.00	1	0.62
Metharpinia floridana	1	0.54	0	0.00	0	0.00	0	0.00
Myodocopida *sp. G*	1	0.54	0	0.00	0	0.00	0	0.00
Nereididae	0	0.00	1	0.55	2	1.09	0	0.00

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Oliva sp.	0	0.00	0	0.00	1	0.55	0	0.00
Onuphidae	0	0.00	0	0.00	1	0.55	0	0.00
Paguroidea	0	0.00	2	1.11	0	0.00	0	0.00
Paranoidae	3	1.61	6	3.32	1	0.55	1	0.62
Parvilucina crenella	1	0.54	0	0.00	0	0.00	0	0.00
Phyllodocidae	0	0.00	0	0.00	0	0.00	1	0.62
Pitar simpsoni	0	0.00	1	0.55	1	0.55	0	0.00
Rutiderma darbyi	5	2.68	3	1.66	4	2.19	10	6.24
Sabellidae	1	0.54	1	0.55	0	0.00	2	1.25
Semele bellastriata	0	0.00	0	0.00	1	0.55	0	0.00
Spatangoida	0	0.00	0	0.00	1	0.55	0	0.00
Spionidae	7	3.76	3	1.66	0	0.00	8	4.99
Syllidae	1	0.54	2	1.11	2	1.09	4	2.50
Synelmis sp. A	0	0.00	0	0.00	1	0.55	1	0.62
Synelmis sp. B	5	2.68	8	4.43	8	4.38	8	4.99
Thracia sp.	0	0.00	4	2.21	0	0.00	1	0.62
Tivela floridana	0	0.00	0	0.00	1	0.55	0	0.00
Tubificidae	2	1.07	3	1.66	4	2.19	5	3.12
Varicorbula limatula	1	0.54	0	0.00	0	0.00	0	0.00

Appendix 24- Density and abundance calculations for 2014 artificial site 6A.

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Amphinomidae	0	0.00	3	1.43	0	0.00	0	0.00
Amphioxiformes	0	0.00	2	0.95	0	0.00	0	0.00
Anthuridae *sp. A*	0	0.00	1	0.48	0	0.00	0	0.00
Anthuridae *sp.B*	1	0.54	0	0.00	0	0.00	0	0.00
Apseudes sp. A	2	1.07	5	2.39	2	0.94	2	0.97
Aspidosiphon albus	7	3.75	4	1.91	8	3.74	4	1.95
Aspidosiphon parvulus	8	4.29	10	4.77	17	7.95	20	9.75
Bemlos sp.	2	1.07	2	0.95	6	2.81	6	2.92
Bivalvia	0	0.00	1	0.48	0	0.00	0	0.00
Caecum pulchellum	1	0.54	0	0.00	0	0.00	0	0.00
Capitellidae	3	1.61	0	0.00	1	0.47	0	0.00
Caprella sp.	0	0.00	1	0.48	0	0.00	0	0.00
Cardidae	4	2.15	2	0.95	2	0.94	0	0.00
Chevalia carpenteri	0	0.00	0	0.00	1	0.47	0	0.00
Chrysopetalidae	1	0.54	0	0.00	0	0.00	1	0.49
Crassinella dupliniana	0	0.00	0	0.00	2	0.94	0	0.00
Crassinella lunulata	0	0.00	0	0.00	1	0.47	0	0.00
Dorvilleidae	5	2.68	1	0.48	4	1.87	3	1.46
Eunicidae	4	2.15	1	0.48	3	1.40	1	0.49
Glyceridae	1	0.54	5	2.39	3	1.40	5	2.44
Glycymeris sp.	0	0.00	0	0.00	1	0.47	0	0.00
Harbansus paucichelatus	2	1.07	1	0.48	1	0.47	2	0.97
Hesionidae	17	9.12	7	3.34	13	6.08	11	5.36
Kalliapseudes sp. A	0	0.00	1	0.48	0	0.00	0	0.00
Leptachelia sp.	1	0.54	0	0.00	0	0.00	0	0.00
Lucinidae	1	0.54	0	0.00	0	0.00	0	0.00
Magelonidae	1	0.54	0	0.00	0	0.00	0	0.00
Maldanidae	1	0.54	0	0.00	0	0.00	0	0.00
Metharpinia floridana	3	1.61	0	0.00	0	0.00	0	0.00
Myodocopida *sp. A*	0	0.00	2	0.95	0	0.00	0	0.00
Myodocopida *sp. B*	0	0.00	0	0.00	1	0.47	0	0.00
Nassarius albus	1	0.54	0	0.00	0	0.00	0	0.00
Onuphidae	0	0.00	3	1.43	0	0.00	1	0.49
Ophelidae	1	0.54	0	0.00	0	0.00	1	0.49
Paradella sp.	0	0.00	1	0.48	0	0.00	0	0.00

Taxon	Abundance 0m	Density 0m	Abundance 1m	Density 1m	Abundance 3m	Density 3m	Abundance 7m	Density 7m
Paranoidae	0	0.00	6	2.86	2	0.94	2	0.97
Pitar simpsoni	3	1.61	1	0.48	1	0.47	0	0.00
Polyplacophora *sp. A*	0	0.00	0	0.00	2	0.94	0	0.00
Polyschides tetrachistus	1	0.54	0	0.00	0	0.00	0	0.00
Pteromeris perplana	1	0.54	0	0.00	1	0.47	0	0.00
Rutiderma darbyi	2	1.07	0	0.00	3	1.40	8	3.90
Sabellidae	0	0.00	0	0.00	1	0.47	0	0.00
Semele bellastriata	0	0.00	0	0.00	1	0.47	0	0.00
Spionidae	1	0.54	6	2.86	2	0.94	0	0.00
Syllidae	1	0.54	1	0.48	1	0.47	5	2.44
Synelmis sp. A	0	0.00	0	0.00	0	0.00	1	0.49
Synelmis sp. B	3	1.61	7	3.34	2	0.94	5	2.44
Thracia sp.	0	0.00	0	0.00	0	0.00	2	0.97
Tivela floridana	2	1.07	0	0.00	0	0.00	0	0.00
Tubificidae	7	3.75	12	5.73	8	3.74	7	3.41
Xenanthura brevitelson	1	0.54	0	0.00	0	0.00	0	0.00