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Impacts of the Oyster Creek Nuclear Generating Station on the Zooplankton Community Structure of Barnegat Bay, New Jersey

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ABSTRACT

Estuaries are biologically diverse and productive marine ecosystems, but many have been degraded as a result of anthropogenic activity, which can also negatively impact sensitive aquatic organisms like zooplankton. Zooplankton represent the crucial link between phytoplankton and higher trophic-level organisms. They are sensitive to environmental variation and increasing water temperature can cause dramatic shifts in zooplankton community structure. Climate change and coastal development favor species that are more tolerant of poor water quality. Barnegat Bay, New Jersey is an eutrophied estuarine lagoon in the Mid-Atlantic Ocean region. A major stress on Barnegat Bay was the Oyster Creek Nuclear Generating Station (OCNGS), which relied on water from the bay for cooling. Power plants entrain organisms in the cooling process and discharge waste heat as thermal pollution, which can negatively impact planktonic community structure. OCNGS operation began in 1969 and closed in September 2018. The objective of this research was to assess the zooplankton community structure of Barnegat Bay in the year prior to and the year following the closure of OCNGS to determine its impacts on coastal zooplankton communities. The results show site-specific increases in the abundance of the scyphozoan *C. chesapeakei*, the ctenophore *M. leidyi*, and several zooplankton taxa including calanoid copepods, Brachyura larvae, and Caridea larvae. There was also a significant increase in the abundance of fish eggs along with larval Atlantic Silverside and Bay Anchovy, two important estuarine fish species. Overall, the closure of OCNGS appears to have reduced a significant stress on numerous zooplankton species within the Barnegat Bay estuary, but longer-term studies are necessary to determine whether populations will recover or if permanent community shifts have occurred.

MONTCLAIR STATE UNIVERSITY

Impacts of the Oyster Creek Nuclear Generating Station on the Zooplankton Community Structure of Barnegat Bay, New Jersey

by

Alyssa M. Petitdemange

A Master's Thesis Submitted to the Faculty of Montclair State University

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IMPACTS OF THE OYSTER CREEK NUCLEAR GENERATING STATION ON THE ZOOPLANKTON COMMUNITY STRUCTURE OF BARNEGAT BAY, NEW JERSEY

A THESIS

Submitted in partial fulfillment of the requirements
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Montclair State University
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INTRODUCTION

Coastal estuaries are commercially, recreationally, and ecologically important ecosystems (Kennish et al., 2007). They are biologically diverse and productive marine environments that serve as recruitment and nursery areas for numerous species (Champalbert et al., 2007; Woodland et al., 2012; Whitfield, 2017), but globally they are suffering the consequences of increasing anthropogenic activity and intervention (Gonzalez-Ortegon et al., 2010; Paul et al., 2016). Changes in land use and elevated pollution leads to changes in hydrology, water quality, declines in species richness and diversity, and result in an overall simplification of the food web. Additionally, biological and chemical processes that occur in marine environments are influenced by water temperature, impacting metabolic rates and oxygen consumption. Dissolved oxygen saturation is dependent upon temperature, so elevated water temperatures lead to increased metabolic demand and lower saturation values. Subsequently, eutrophied estuaries are prone to hypoxic water conditions (Summers et al., 1997). Many marine species also have a narrow tolerance for fluctuating salinity (Goodrow et al., 2017). Any one or combination of these water quality stresses can lead to the reduction of sensitive species, who are then replaced by those who are more tolerant of the changing environmental conditions.

Scyphozoans (true jellyfish) and ctenophores (comb jellyfish) are generally not hindered by poor water quality the way that other zooplankton and fish species are (Duarte et al., 2013; Finenko et al., 2013). Their populations can continue to persist under these conditions, disrupting the trophic structure by consuming large amounts of zooplankton, fish eggs, and larval fish; as well as competing with larval and adult fish for food resources (Purcell et al., 2001; Finenko et al., 2013). The ctenophore *Mnemiopsis leidyi* is a particularly important zooplankton predator that naturally occurs along the western coast of the North Atlantic Ocean. They exert strong top-down pressure on zooplankton populations unless their numbers are also controlled (Sullivan et al., 2001). The scyphozoan *Chrysaora chesapeakei* is also a key species in the same environment that consume both zooplankton and *M. leidyi*. The relative density and distribution of these two species in coastal communities is often the result of the variations salinity and dissolved oxygen concentrations, as well as water temperature, which influences the onset of blooms of these species (Stone et al., 2018).

In the Chesapeake Bay, scyphozoan medusae abundance and distribution are determined by salinity, temperature, and dissolved oxygen concentrations, while ctenophores are only initially limited by water temperature (Purcell & Decker, 2005). Depending on environmental conditions and the timing of the bloom for each of these species, *C. chesapeakei* often keeps *M. leidyi* populations in biological check through competition and predation (Stone et al., 2018). In Barnegat Bay, New Jersey, these gelatinous zooplankton species also assume the role of apex predators. While both species can influence the structure of zooplankton communities, *C. chesapeakei* exerts significant top-down pressure on *M. leidyi*, so there is no evidence of a trophic cascade similar to that in the Chesapeake Bay (Bologna et al., 2017).

Zooplankton communities are crucial for maintaining a healthy ecosystem because they are a key link in the transfer of energy from phytoplankton to higher trophic level organisms. They are ectothermic organisms with relatively short generation times, allowing them to acclimate and adapt to environmental stresses very quickly (Rice et al., 2015). Zooplankton are naturally regulated by environmental conditions like temperature and salinity but may become stressed when these conditions are severely unfavorable (Howson et al., 2017). Loss of primary zooplankton consumers would promote the growth of algae, subsequently shifting food webs and the transfer of energy up trophic levels (Jebakumar et al., 2018). Changes in zooplankton community structure radiate through entire ecosystems, impacting larger zooplanktivores like gelatinous zooplankton and fish populations, and ultimately human populations as well.

While the degradation of our coastal systems is of ever-growing concern, one form of coastal development that is not normally considered as a source of anthropogenic pollution, due to their rarity, are nuclear power plants. Many of these power plants, including Oyster Creek Nuclear Generating Station (OCNGS) in Barnegat Bay, New Jersey, are built along bays, rivers, or other bodies of water, so that they will have access to the large amounts of water that they need to cool their reactors. Most older plants use an open-cycle design for their cooling system, withdrawing water from one body of water, moving it through the equipment that needs cooling, and then discharging it out the other side, into the same or another nearby body of water (Vasslides et al., 2017). This process impacts the aquatic ecosystem at both the intake and discharge points. Like most plants, OCNGS is equipped to keep larger organisms such as adult fish, mammals, and birds from being drawn into the power plant with the coolant water using both steel bars that were 3 inches apart and a mesh screen with 3/8-inch openings (NJDEP, 2004a). Planktonic microorganisms, however, are still easily drawn into the cooling mechanisms through the screen and can suffer mortality from thermal shock (Jiang et al., 2009), mechanical pressure changes, and exposure to chlorine or other potentially toxic biocides (Capuzzo, 1980). Planktonic larvae and juvenile fish are especially susceptible due to their more sensitive physiological requirements (Vasslides et al., 2017). Depending on the community, this could result in lowered species diversity and abundance if too many individuals are physically removed from the environment. The second issue with coastal power plants is the wasted heat that is inefficiently discharged back into the aquatic environment after it is finished being used for cooling (Jiang et al., 2009). This increase in temperature is considered thermal pollution and can impose stress on temperature-sensitive species, resulting in changes in growth and reproductive success (Jebakumar et al., 2018). While most zooplankton are able to tolerate brief increases in temperature, most cannot survive consistent exposure to elevated temperatures from these power plants (Jiang et al., 2009). Warm water tends to favor the growth of certain species while inhibiting others, changing the overall community composition (Lin et al., 2018). Thermal pollution can also increase stratification of the water column, hindering nutrient cycling and oxygen mixing (Jebakumar et al., 2018). Metabolic rate naturally increases with temperature, causing organisms to use more dissolved oxygen, resulting in hypoxic conditions that cannot be remedied by vertical mixing due to the high stratification (Lin et al., 2018). Increasing water temperature from coolant water discharge can have multi-trophic level effects, including impacts to individual organisms, populations and local communities (Jiang et al., 2009); and these effects are not only observed at the site of the power plant, but can impact regional community structure as well (Jebakumar et al., 2018).

Most of the research done on the impacts of coastal power plant pollution has been focused on economically important species and not necessarily those that are ecologically important, so there is not much understanding of the overall impacts on food webs and community structure within the impact area of the power plant. Many power plants in the United States with open-loop cooling systems are either converting their mechanisms to closed-loop systems, which minimize the amount of water taken from the bay and do not discharge it back, or the plants are being decommissioned all together (Vasslides et al., 2017). The latter is true for Oyster Creek Nuclear Generating Station which began shutting down in the fall of 2018. The objective of this research was to assess the zooplankton community structure, including a focus on gelatinous zooplankton species, in the Barnegat Bay estuary, and to compare the summer prior to (2018) and the summer after (2019) the closure of Oyster Creek Nuclear Generating Station to determine the effects of the power plant on planktonic community structure.

MATERIALS & METHODS

Study Site

Barnegat Bay (34N, 74W) is a shallow, highly eutrophic, lagoonal estuary protected by two barrier islands along the east coast of New Jersey (Figure 1). It has three tidal inlets, two on the barrier island and another man-made canal. It is approximately 70 kilometers in length and up to 6 kilometers wide, with an average depth of 1.5 meters (Kennish et al., 2007). Its watershed is home to more than 500,000 residents, which can increase to over one million during the summer season (Vasslides et al., 2017). With this human population comes an increase in coastal development and urbanization, especially in the northern section of the bay. The increase in non-point source pollution has led to nutrient loading, eutrophication, and overall poor water quality (Kennish et al., 2007). Flushing time varies seasonally, anywhere from 27 to 71 days, and the barrier islands make circulation within the bay relatively weak (Able et al., 2017).

Oyster Creek Nuclear Generating Station (39.8145 N, 74.2058 W) is located between Oyster Creek and Forked River, both of which are directly connected to Barnegat Bay (Figure 2). OCNGS was the oldest, continuously operation nuclear power plant in the country that came online in December 1969 (Vasslides et al., 2017) and was decommissioned in September 2018 (Davis, 2018). During this time, the plant utilized an open-loop cooling system, withdrawing over 650 million gallons of cooling water per day from Forked River and discharging it on the other side, into Oyster Creek. The plant also moved an additional 750 million gallons of water per day from Forked River into Oyster Creek in an attempt to dilute the thermal effects of the coolant water discharge (Vasslides et al., 2017).

For this research, ten sampling locations were established in Barnegat Bay (Table 1, Figure 2). Three sites were located in the Forked River area (FRL, FRW, FRR9) and two sites were in the Oyster Creek area (OCR9, OCM). These sites were all within the direct impact area of Oyster Creek Nuclear Generating Station. Forked River Rt. 9 was located at the coolant water intake while Oyster Creek Rt. 9 was located at the coolant water discharge of OCNGS. Both of these sites, along with Forked River Lagoon, were located in the river while Forked River West and Oyster Creek Mouth were located in the bay (Figure 2). Flow of water was continuously towards the plant from Forked River and away from the plant in Oyster Creek due to the current generated by the cooling water pumps, regardless of the tide (Able et al., 2017). The remaining five sites included two northern control sites (TRW, SB), two eastern control sites (FRE, DCE), and one southern control site (DCW), all of which were located in the bay. All sites were sampled bi-monthly from June through August in both 2018 and 2019, with the exception of July 2018 and August 2019 due to unfavorable weather conditions. Samples collected in 2018 represent the zooplankton community prior to the closure of OCNGS, and samples collected in 2019 represent the community following the closure. The way that the sites are situated in the bay will show the differences in spatial and temporal distributions between designated control sites and those within the impact zone of the power plant, which can then be compared between the two years. Since sample collection in all of the same weeks in each year was not possible, only the sampling dates that fell within one week of each other were used for the comparison. These comparable sampling dates were 6/14, 6/26, 7/9-7/10, and 8/9 in 2018 and 6/12, 6/27, 7/9, and 8/15 in 2019. Excluding sampling dates that did not occur around the same time from year to year, eliminates any results that may have occurred solely due to seasonal trends and reduces temporal bias in the comparison.

Water Quality Monitoring

Water quality parameters were recorded at each site using a YSI Professional Plus Multi-Parameter meter calibrated and certified by the New Jersey Department of Environmental Protection and following the procedures outlined in the NJDEP Field Sampling Procedure Manual, August 2005 (Ren et al., 2017). These parameters included dissolved oxygen concentration (mg/L), dissolved oxygen saturation (%), temperature (°Celsius), and salinity (ppt). The meter was successfully calibrated prior to all field work.

Plankton Tow Sampling

Plankton tows were conducted in triplicate using 363-micron zooplankton nets that were 30-cm in diameter. The nets were towed behind the boat for 60 seconds at low speed. Tow length was measured using a mechanical flow meter (General Oceanics Model 2030R) and the distance traveled was then calculated using the manufacturer's conversion constant. Sample volume was determined by multiplying the area of the net opening by the distance traveled. Samples were then standardized to the number of individuals present per m^3 (sensu lato Bologna et al., 2018). Samples were sieved immediately in the field and ctenophores were counted, specifically because the species *M. leidyi* does not preserve well enough to be enumerated later. The zooplankton samples were then preserved in ethanol, stained with Bengal, and brought back to the laboratory where all organisms were identified to the lowest taxonomic level possible and counted.

Statistical Analyses

Analysis of the plankton tow data sets was conducted using analysis of covariance (ANCOVA) (SAS® 9.4) to discriminate seasonality of the zooplankton communities. A separate ANCOVA was used for each sampling year individually, with site as the independent variable, organism density as the dependent variable, and sampling date as the covariate. Significant differences among sites and sampling dates was determined using the REGWQ method in SAS, a method that uses step-down range tests to control for error in the results (Omer, 2013) A correlation analysis was also conducted for each year to determine significant relationships among taxa. In order to assess differences between the two sampling years, a three-way ANCOVA was conducted with two independent variables: site and year, organism density as the dependent variable, and sampling date as the covariate to account for the seasonal variability.

RESULTS

Water Quality

Four water quality parameters were recorded for each sampling site and date (see Appendix A: Table 2). Salinity values demonstrated two general patterns. Toms River West had significantly lower salinity values, 13 ppt on average in 2018 and 11.9 ppt in 2019, than the other sites due to its proximity to the input of freshwater from the river. Secondly, all other sites had relatively similar salinity values in 2018, ranging from 20.4 to 28.1 ppt (Figure 3a). Forked River Rt. 9 showed lower salinity values in 2019 than 2018, averaging 19.2 ppt and 24.5 ppt, respectively. Oyster Creek Rt. 9 also demonstrated lower salinity values in 2019, averaging 17.2 ppt versus 24.2 ppt in 2018 (Figures 3a-b). The increased salinity values in 2018 could potentially be explained by the plant’s withdrawal of water from Forked River Rt. 9, increasing the salt-to-water ratio, and then discharging salty water into Oyster Creek Rt. 9. Without the uptake and discharge of water in 2019, both of these sites were more largely impacted by rainfall and other freshwater inputs.

Temperature data show the seasonal patterns typical for this region, starting with the lowest values in May/June, peaking in July/early August, and then gradually declining again (Figure 4a-b). All sites indicate this pattern, however in 2018, Oyster Creek Rt. 9 exhibited water temperatures between 1.7 to 6.6°C greater than the other nine sites throughout the summer. Oyster Creek Rt. 9 temperature values ranged from 26.6°C in June to 31.8°C in early August. The other sites ranged from 20.8°C in June to 30.1°C in August. Oyster Creek Rt. 9 is located just downstream from where the water was discharged from OCNGS and was, on average, 4.4°C warmer than Forked River Rt. 9, the site from where the water was drawn into the plant. Oyster Creek Mouth, the second closest site to the plant's discharge point, and Forked River Lagoon show similar temperature values, both of which are greater than the remaining sites but still less than Oyster Creek Rt. 9. Oyster Creek Rt. 9 temperatures were between 2.5°C and 3.7°C greater than Oyster Creek Mouth, suggesting that by the time the warm discharge water from OCNGS reached the mouth of the river, the heat was able to dissipate, resulting in water temperatures normally seen in lagoons, but not quite as cool as the water farther out into the bay. In 2019, Oyster Creek Rt. 9 did not demonstrate the same prominent temperature increase that it did in 2018. The water temperature values showed a decrease between 2.1°C to 7.8°C across the four comparable sampling dates from 2018 to 2019. Water temperatures at Oyster Creek Mouth and Forked River Lagoon were also not any greater than the rest of the sites. The variation in temperature seen in 2019 can be attributed to summer weather conditions, rather than the influence of OCNGS on water temperatures that was present in 2018.

Given that dissolved oxygen saturation is inversely related to temperature, the dissolved oxygen concentration of all of the sites generally decreased as the summer progressed in both 2018 and 2019 (Figure 5a-b). Dissolved oxygen concentration values were relatively consistent across all sites, regardless of their proximity to OCNGS, ranging from 4.96 to 10.88 mg/L in 2018 and from 4.55 to 9.80 mg/L in 2019. The decreasing trend was much more uniform in 2018 than in 2019 and the values in June 2019 were not quite as high as they were in June 2018, even though there was not a large difference in water temperature. The sites located in the bay typically had higher dissolved oxygen concentrations than those sites in the river.

Plankton Tows

2018 **–** A total of 87 different taxonomic groups were identified in the plankton tow samples from 2018. Seven of these groups were unable to be identified to a taxonomic level lower than class, including some hydrozoans, hydroids, gelatinous zooplankton ephyrae, larval and adult fish, egg sacks, and cladocerans. The most abundant zooplankton taxa were Calanoid copepods (46.76/ m^3), Brachyura larvae (9.15/ m^3), Caridea larvae (5.23/ m^3) and fish eggs (1.48/ m^3). The average densities for every taxonomic group collected in 2018 can be found in Appendix E.

Results of the two-way ANCOVA revealed that of the taxa collected in plankton tows in 2018, seven showed significant density differences among sites (see Appendix B: Table 3). *Mnemiopsis leidyi* ($F_{9,123}$ = 2.39, p=0.0156) were more abundant at sites located in the bay compared to those located in the river (Figure 6a). *Chrysaora chesapeakei* ($F_{9,123}$ = 2.47, p=0.0125) were collected almost exclusively at Forked River Lagoon (Figure 7a). *Nemopsis sp.* ($F_{9,123}$ = 2.54, p=0.0104) had the highest densities at Sunrise Beach, one of the northern control sites, followed by the other sites located in the bay. Other zooplankton taxa exhibiting significant differences among sites included Amphipoda ($F_{9,123} = 2.28$, p=0.0212), Caridea larvae ($F_{9,123} = 2.37$, p=0.0167), and Brachyura larvae ($F_{9,123} = 2.72$, p=0.0064). The presence of amphipod species was highly correlated with the presence of floating seagrass that was also caught in the plankton tow net. Caridea larvae had the highest densities at both of the Eastern control sites (Figure 8a), while Brachyura larvae densities were concentrated in the central sites, including sites in the river (Figure 9a). The significant density differences between individual sites for each taxon can be found in Appendix C: Table 6.

Five taxa also showed significant density differences among sampling dates, indicating seasonality (Appendix B: Table 3). Two hydrozoans showed differences, including *Turritopsis sp.* ($F_{1,123} = 11.16$, p=0.0011) which did not appear until the later summer months, and *Obelia sp.* ($F_{1,123} =5.58$, p=0.0198), which were most abundant in the early summer months, but then disappeared. Brachyura larvae ($F_{1,123} = 13.05$, p=0.0004) and Calanoid copepods ($F_{1,123} = 25.06$, $p<0.0001$) followed seasonal patterns as well, peaking in abundance in early summer, prior to the bloom of their gelatinous zooplankton predators (Figures 9a, 10a). Polychaeta larvae ($F_{1,123} = 4.25$, p=0.0414) also showed significant differences among sampling dates, with significantly more individuals appearing earlier in the summer.

Correlation analysis revealed several significant, positive relationships between taxa collected in plankton tows (see Appendix D: Table 9a). Negative relationships were also present in the analysis, however none of them were significant. *C. chesapeakei* exhibited negative, but non-significant, relationships with all potential zooplankton and gelatinous zooplankton prey. This pattern suggests that *C. chesapeakei* are indiscriminate predators and have a similarly negative impact on all prey species instead of a disproportionate impact on only a few species.

M. leidyi is also often considered an indiscriminate predator, however the analysis did not result in as many negative relationships with their prey species. *C. chesapeakei* also showed significant, positive relationships with its own ephyrae ($p < 0.0001$) and the ephyrae that were "unidentified" ($p = 0.0032$). These unidentified ephyrae were most likely also those of *C. chesapeakei*, given this strong, positive relationship. Several other gelatinous zooplankton species had significant, positive relationships with one another: *Turritopsis sp.* with *Pleurobrachia pileus* ($p < 0.0001$), *Bougainvillia sp.* with *Nemopsis sp.* ($p < 0.0001$), and *Aequora sp.* with *Rathkea sp.* ($p = 0.0012$).

Many of the gelatinous zooplankton species collected in the tows also exhibited significant, positive relationships with zooplankton taxa, including *Bougainvillia sp.* with fish larvae ($p <0.0001$) and Brachyura larvae ($p = 0.046$), *Obelia sp.* with Calanoid copepods ($p = 0.001$) and fish larvae ($p = 0.03$), *Nemopsis sp.* with Calanoid copepods ($p = 0.0001$) and fish larvae ($p < 0.0001$), *Rathkea sp.* with Calanoid copepods ($p = 0.007$) and Brachyura larvae ($p <0.0001$), and *Pleurobrachia pileus* with fish larvae ($p = 0.025$). These zooplankton would typically be considered prey for gelatinous zooplankton, so these significant, positive relationships indicate that seasonal blooms of numerous species co-occur in this estuary and that predator blooms may coincide with their prey availability.

Several species of amphipods are significantly, positively correlated with each other and other benthic species. Calanoid copepods, Brachyura larvae, Caridea larvae, fish larvae and fish eggs also exhibit several significant, positive relationships among one another. These relationships are significant because benthic species occur together at the bottom of the bay or in floating racks of seagrass, while pelagic zooplankton species coexist throughout the water column where the nets were towed.

***2019* –** A total of 107 different taxonomic groups were identified in the plankton tow samples from 2019. Seven of these groups were unable to be identified to a taxonomic level lower than class, including certain hydrozoans, hydroids, gelatinous zooplankton ephyra, larval and adult fish, egg sacks, and cladocerans. The most abundant zooplankton species were Calanoid copepods (113.82/ m^3), Brachyura larvae (10.15/ m^3), Caridea larvae (6.56/ m^3) and fish eggs (5.1/ m^3). The average densities for every taxonomic group collected in 2019 can be found in Appendix E: Tables 11a – 11g.

Results of the two-way ANCOVA for the 2019 plankton tows revealed 13 taxa with significant differences in density among sites (see Appendix B: Table 4), and of these, only three were gelatinous zooplankton species. *M. leidyi* ($F_{9,193}$ = 2.59, p=0.0076) had the highest densities in the central sites, both in the bay and river (Figure 6b), *C. chesapeakei* ($F_{9,193}$ = 3.91, p=0.0001) were almost exclusively present at Forked River Lagoon and Forked River Rt. 9 (Figure 7b), and *Thalia sp.* ($F_{9,193}$ = 3.02, p=0.0021) were highly abundant at Double Creek East. All other significant density differences among sites were seen in Amphipoda ($F_{9,193}$ = 3.18, p=0.0013), Calanoid copepods ($F_{9,193}$ = 3.12, p=0.0016), Ostracoda ($F_{9,193}$ = 2.91, p=0.0030), fish eggs ($F_{9,193}$ = 3.26, p=0.0010), fish larvae ($F_{9,193}$ = 2.99, p=0.0023), Caridea larvae ($F_{9,193}$ = 5.15, p<0.0001), Brachyura larvae ($F_{9,193}$ = 3.45, p=0.0049), and Ascidian larvae ($F_{9,193}$ = 9.68, p<0.0001). Amphipods and ostracods had higher densities at Double Creek East along with Caridea larvae (Figure 8b), where floating seagrass rack was prevalent. Brachyura larvae and Calanoid copepods both had greater densities at sites located in the bay versus the river (Figures 9b, 10b). The most interesting results were seen for fish eggs, which were present in high densities in the central bay sites (Sunrise Beach, Forked River West, Oyster Creek Mouth, and Double Creek West), followed by the exterior bay sites (Double Creek East and Forked River

East), and then having the lowest densities in the river sites (Forked River Rt. 9 and Oyster Creek Rt. 9) (Figure 11b). This correlates with the higher densities of Atlantic Silverside larvae (Figure 12b) and Bay Anchovy larvae (Figure 13b) present at the bay sites along the coastline. The significant density differences between individual sites for each taxon can be found in Appendix C: Table 7.

There were 14 taxonomic groups that also showed significant differences in density between sampling dates, indicating seasonality (see Appendix B: Table 4). The gelatinous zooplankton species *Bougainvillia sp.* ($F_{1,193} = 5.16$, $p=0.0242$), *Nemopsis sp.* ($F_{1,193} = 5.76$, $p=0.0174$), and *Obelia sp.* ($F_{1,193} = 3.92$, $p=0.0493$) all peaked in abundance earlier in the summer, while *M. leidyi* ($F_{1,193} = 41.25$, $p<0.0001$), *Turritopsis sp.* ($F_{1,193} = 7.49$, $p=0.0068$), and *Pleurobrachia pileus* ($F_{1,193} = 8.03$, $p=0.0051$) had higher densities later in the summer. The early summer months were also preferred by Calanoid copepods ($F_{1,193} = 5.37$, $p=0.0215$), fish larvae ($F_{1,193} = 28.50$, $p<0.0001$), Caridea larvae ($F_{1,193} = 9.70$, $p=0.0021$), and Brachyura larvae ($F_{1,193} = 4.77$, $p=0.0302$), prior to their gelatinous zooplankton predator blooms. Fish egg ($F_{1,193} = 15.61$, $p=0.0001$) densities were highest in the middle of the summer.

Similar to 2018, the correlation analysis of the plankton tow taxa collected in 2019 showed several significant, positive relationships, as well as multiple negative relationships, none of which were significant (see Appendix D: Table 9b). *Chrysaora chesapeakei* was negatively correlated with all potential zooplankton prey, except for *M. leidyi* and *Bougainvillia sp*., but none of these relationships were statistically significant. *C. chesapeakei* also had a positive relationship with its own ephyra ($p < 0.0001$), as would be expected. The ctenophore *M. leidyi* exhibited negative, but non-significant relationships with most potential zooplankton prey and was also positively correlated with *Turritopsis sp*. ($p < 0.0001$). The number of negative, non-significant relationships exhibited by these two gelatinous zooplankton species suggests that both are indiscriminate zooplankton predators who also compete with each other, distributing predation pressure more evenly across prey species, especially in this sampling year.

Several gelatinous zooplankton taxa exhibited positive relationships with each other, including *Turritopsis sp.* with *Pleurobrachia pileus* ($p = 0.03$) and *Bougainvillia sp.* with *Nemopsis sp.* ($p = 0.0058$). Many gelatinous zooplankton also had significant positive relationships with other zooplankton species: *C. chesapeakei* with megalopa larvae ($p < 0.0001$), *Bougainvillia sp.* with Calanoid copepods ($p< 0.0001$) and Mysid shrimp ($p = 0.017$), *Obelia sp.* with ostracods, fish larvae, Caridea larvae, and Mysid shrimp ($p < 0.0001$), and *Nemopsis sp.* with Calanoid copepods ($p = 0.049$) and fish eggs ($p < 0.0001$).

Several families of amphipods were significantly, positively correlated with one another and other zooplankton species. Calanoid copepods, Brachyura larvae, Caridea larvae, fish larvae and fish eggs also exhibited several significant, positive relationships among one another. As in 2018, these relationships are significant because benthic species occur together in floating racks of seagrass and pelagic zooplankton species coexist throughout the water column where the nets were towed.

***Plankton Tow Comparison* –** Across all of the sampling sites and dates, there were 22 taxonomic groups identified in 2018 that were not present in 2019, and 39 new taxonomic groups identified in 2019 that had not been previously identified in 2018. Many of these differences are a result of better identification of anemones, amphipods, fish and fish larvae species in 2019, but there were also several different species of crustaceans, decapods, and gelatinous zooplankton present in the samples from year to year. However, in order to accurately compare the two years, only the four sampling dates of each year that fell within a week of one another were used for the comparison analysis. These dates in 2018 were 6/14, 6/26, 7/9-7/10, and 8/9, and in 2019 were 6/12, 6/27, 7/9, and 8/15. Additionally, Toms River West was not included in this analysis because it was located too far from the rest of the sites and had significantly lower salinity, which would likely skew the results. Considering just these four sets of dates, 86 and 82 different taxonomic groups were identified in 2018 and 2019, respectively. Of these, 32 of the taxonomic groups present in 2018 were not collected again in 2019, and 28 new taxonomic groups were identified in 2019, including species of gelatinous zooplankton, hydroids, amphipods, isopods, fish, fish larvae, crustaceans, decapods, mollusks, and tunicate life stages.

The three-way ANCOVA for the four sets of comparable dates between 2018 and 2019 revealed significant differences between sites, dates, and years for many taxa (see Appendix B: Table 5). Thirteen taxonomic groups showed significant differences among sites. *M. leidyi* ($F_{8,205} = 3.10$, $p=0.0025$) increased at Forked River Rt. 9 and the other central bay sites from 2018 to 2019 but decreased at Oyster Creek Rt. 9 (Figures 6a-b). *C. chesapeakei* ($F_{8,205} = 5.38$, $p<0.0001$) were abundant at Forked River Lagoon and Forked River Rt. 9, increasing in abundance in 2019, especially at Forked River Rt. 9 (Figure 7a-b). *Nemopsis sp.* ($F_{8,205} = 2.29$, $p=0.0025$) and *Bougainvillia sp.* ($F_{8,205} = 2.93$, $p=0.0040$) both had the highest densities in the central bay sites in both years. *Aequora sp.* ($F_{8,205} = 3.22$, $p=0.0016$) were primarily present at Double Creek West and East. Caridea larvae ($F_{8,205} = 4.10$, $p=0.0001$) were most abundant at Forked River East and Double Creek East, showing a density spike in July 2018, but not 2019 (Figure 8a-b). Brachyura larvae ($F_{8,205} = 4.15$, $p=0.0001$) and Calanoid copepods ($F_{8,205} = 2.93$, $p=0.0040$) were both more abundant at bay sites than river sites (Figures 9a-b, 10a-b). Fish eggs ($F_{8,205} = 3.47$, $p=0.0009$) were highly concentrated around the central bay sites, including Sunrise

Beach, Forked River West, Forked River East, Oyster Creek Mouth and Double Creek West, more so in 2019 than 2018 (Figures 11a-b). The significant density differences between individual sites for each taxon can be found in Appendix C: Table 8.

Several taxa also exhibited seasonal trends as significant differences between sampling dates. *Nemopsis sp.* ($F_{1,205} = 29.10$, $p<0.0001$) and *Bougainvillia sp*. ($F_{1,205} = 10.72$, $p=0.0012$) are most abundant early in the summer, while *Pleurobrachia pileus* ($F_{1,205} = 7.76$, $p=0.0058$) appears later in August. Other zooplankton species that showed seasonality include calanoid copepods ($F_{1,205} = 14.43$, $p=0.0002$) and Brachyura larvae ($F_{1,205} = 12.08$, $p=0.0006$) which peaked in abundance early in the summer, prior to the gelatinous zooplankton bloom. Atlantic Silverside larvae ($F_{1,205} = 7.92$, $p=0.0054$) and ascidian larvae ($F_{1,205} = 18.78$, $p<0.0001$) were also present in higher abundances earlier in the summer.

The most interesting results are those with significant differences between the two sampling years, particularly fish eggs ($F_{1,205} = 14.16$, $p=0.0002$), Atlantic Silverside larvae ($F_{1,205} = 5.22$, $p=0.0234$), and Bay Anchovy larvae ($F_{1,205} = 4.24$, $p=0.0408$). These three taxonomic groups had significantly greater abundances in 2019 than in 2018 and were highly concentrated in the central bay sites: Sunrise Beach, Forked River West, Oyster Creek Mouth, and Double Creek West (Figures 11a-b, 12a-b, 13a-b). There were also a few taxonomic groups that were only identified in one of the two years. *Aequora sp*. ($F_{1,205} = 5.46$, $p=0.0204$) were present in 2018 but not 2019, while Megalopae larvae ($F_{1,205} = 5.25$, $p=0.0229$), *Pleurobrachia pileus* ($F_{1,205} = 4.31$, $p=0.0391$), and ascidian larvae ($F_{1,205} = 14.73$, $p=0.0002$) which were only identified in 2019.

DISCUSSION

Estuaries all around the globe are suffering the consequences of anthropogenic development. The non-point source pollution that comes from this development results in the degradation of water quality and simplification of the estuarine food web and community structure (Byrnes et al., 2007). Thermal pollution may not be the first that comes to mind, but significant alternations to the normal temperature range of a system can be just as detrimental to the survival of species and the overall health of the environment as other pollutants. Power plants are a large source of thermal pollution that occurs in coastal waters, and as human demand for energy continues to increase, so will the amount of cooling water that is withdrawn from and subsequently discharged as superheated wastewater back into these aquatic ecosystems (Jebakumar et al., 2018). Not only must organisms adapt to water temperature increases near the power plant discharge areas that may approach or exceed their thermal limits, small organisms like zooplankton and larval fish are also easily moved by currents and drawn into the plant (Jiang et al., 2009). Mortality of organisms physically drawn into the plant with the cooling water is very high, and there is evidence that those that survive may have severely reduced respiration rates and reproductive success (Capuzzo, 1980). The objective of this research was to determine if Oyster Creek Nuclear Generating Station had an impact on the zooplankton community structure of Barnegat Bay as a result of thermal pollution or physical entrainment of organisms in the plant while it was using water from the bay to cool its nuclear reactors.

Water quality – Buchanan et al. (2017) provides a baseline set of conditions experienced by Barnegat Bay prior to the closure of OCNGS that help in assessing its impacts. They determined that the bay has been subject to recent increases in temperature, pH, and salinity, accompanied by a decrease in dissolved oxygen concentrations when compared to previous environmental data. The bay has also experienced a large increase in development, especially in the northern bay (Lathrop & Bognar, 2001), resulting in increased non-point source pollution, nutrient concentrations, algal growth, and overall eutrophication (Kennish et al., 2007). Despite this anthropogenic interference, Buchanan et al. (2017) also concluded that the water quality of Barnegat Bay is very dependent on weather patterns. With this in mind, we can determine whether water quality data can be attributed to environmental conditions or anthropogenic influence.

Water quality data showed both polyhaline (>18 ppt) and mesohaline (5-18 ppt) salinity values (Ren et al., 2017). Toms River West, one of the northern control sites, is fed mainly by Toms River (Taghon et al., 2017). Freshwater influx from the river, combined with the tides and circulation patterns of the bay created an increasing gradient of salinity from north to south (Ren et al., 2017), resulting in polyhaline samples from the nine central bay sites and mesohaline samples from Toms River West in 2018. There was slight variation in 2019 where mesohaline samples were also collected from Forked River Rt. 9 and Oyster Creek Rt. 9 (Appendix A: Table 2). This is most likely due to the lack of circulation from the bay into the river once the power plant was shut down. While OCNGS was in operation, it provided a current that allowed saline water to move more easily from the bay all the way into Forked River, through the plant and then out the other side into Oyster Creek. Without that extra force, tidal action alone is not enough to balance freshwater input from precipitation, causing in-river sites to have lower salinity values than the bay, lower than they were in 2018. This change from year to year may be significant enough to impact organisms that are sensitive to salinity.

The closure of OCNGS does not appear to have affected dissolved oxygen concentrations around the impact areas. Values follow the typical pattern of decreasing as the summer progressed, because as the water temperature increases, it becomes less capable of containing large amounts of dissolved oxygen. This is not unusual of water quality in Barnegat Bay. Oyster Creek Rt. 9 exhibited dissolved oxygen values on the lower end of the range of concentrations in 2018, which can be correlated with the higher water temperature resulting from the discharge of the coolant water. However, all samples were collected during the day when oxygen is both being produced though photosynthesis and consumed by respiration (Summers et al., 1997). Considering this, the dissolved oxygen concentrations at any given site were not only a function of water temperature but also relative biological and photosynthetic activity.

Oyster Creek Rt. 9 was the only site to exhibit a significant increase in water temperature, meaning that the heat from the plant was able to dissipate by the time it reached Oyster Creek Mouth, where the river meets the bay. This temperature difference was not present in 2019, so it can be entirely attributed to the coolant water discharge in 2018 that was no longer occurring in 2019. The elevated temperature at Oyster Creek Rt. 9 in 2018 may have had impacts on both populations and communities (Paul et al., 2016), affecting phytoplankton and zooplankton which can, in turn, affect higher trophic levels (Lin et al., 2018). These effects were assessed by comparing the zooplankton community structures both between sampling years and between Oyster Creek Rt. 9 and the rest of the sample sites.

Gelatinous Zooplankton **–** The scyphozoan *Chrysaora chesapeakei* and ctenophore *Mnemiopsis leidyi* were the two most abundant gelatinous zooplankton species collected in both sampling years, supporting the fact that both have well-established, reproductive populations in

Barnegat Bay (Bologna et al., 2017; Howson et al., 2017). *C. chesapeakei* populations are more sensitive to salinity and temperature when compared to *M. leidyi*, who have a much larger thermal tolerance (Howson et al., 2017) but are limited by food availability and predation by *C. chesapeakei* and other jellyfish species (Purcell & Decker, 2005). While neither species showed statistically significant differences in density between the two sampling years, there were key differences between sampling sites. First, looking at the sites individually, *M. leidyi* had significantly lower densities at Forked River Lagoon, Forked River Rt. 9, and Oyster Creek Rt. 9 in 2018 compared to the rest of the sites (Appendix C: Table 6). This was not the case again in 2019 when of these sites, only Forked River Lagoon had significantly lower densities of *M. leidyi* (Appendix C: Table 7). The average density of *M. leidyi* across the comparable sampling dates shows almost twice the abundance of individuals at Forked River Rt. 9 and Oyster Creek Rt. 9 in 2019 as there were in 2018, while the abundance in the rest of the bay remains relatively constant from year to year (Figure 6a-b). The most germane explanation of this result is the entrainment of *M. leidyi* into the cooling system of the OCNGS. *C. chesapeakei* was prominent at Forked River Lagoon in 2018 (Figure 7a) and both Forked River Lagoon and Forked River Rt. 9 in 2019 (Figure 7b). They remained absent from most of the bay sites as well as Oyster Creek Rt. 9 in both years, but their average density across the comparable sampling dates more than doubled at Forked River Rt. 9 and Forked River Lagoon in 2019 compared to 2018. When the sites were grouped by “Impact” and “Control”, average densities across the comparable dates for both *M. leidyi* and *C. chesapeakei* remained consistent for both years at the control sites, but both revealed a marked increase in abundance at the impact sites (Figures 6a-b, 7a-b). The presence of both of these species at Forked River Rt. 9 in 2019, but not in 2018, suggests that while OCNGS was in operation, it was pulling them in with the cooling water, entraining them in the plant and killing most, if not all individuals. There were no *C. chesapeakei* present at Oyster Creek Rt. 9, the discharge point, and only a few *M. leidyi* who were either able to survive passage through the plant due to their higher tolerance for disturbance, were part of the volume of water used to temper the heated discharge from the plant, or, though unlikely, were able to move into the river from the bay. Once the power plant was decommissioned, both species were found in high abundances at Forked River Rt. 9 where they were able to remain. *M. leidyi* was substantially more abundant here than *C. chesapeakei*, while the high populations of *C. chesapeakei* at Forked River Lagoon in both years were able to control *M. leidyi* populations and keep them at a minimum (sensu lato Bologna et al., 2017). Overall, most of the bay was dominated by *M. leidyi* in both 2018 and 2019, which could have further implications on zooplankton populations.

Zooplankton – The dominant fundamental zooplankton taxa in Barnegat Bay were the same as determined by Bologna et al. (2017): Calanoida, Brachyura larvae, and Caridea larvae, none of which exhibited significant differences in densities between sampling years. These are all prey species for gelatinous zooplankton species, especially Calanoid copepods which are the primary food of choice for *M. leidyi*. While some zooplankton communities have shown to remain relatively stable amidst changing environmental conditions (Shaheen & Steimle, 1995), others have proven to be quite sensitive to fluctuations in salinity and temperature. Because these changes are often a result of anthropogenic development, zooplankton diversity tends to increase with distance from highly developed areas (Howson et al., 2017). The results from the analysis of the zooplankton community structure showed some significant differences in densities between sites, as well as some interesting patterns overall. When the average densities for the three fundamental zooplankton taxa were grouped according to “Control” or “Impact” sites for the comparable sampling dates, there were much higher abundances of all three species at the control sites than at the impact sites. Calanoid copepods in particular were much more abundant in the control sites. There is not much of a change in zooplankton densities between the years within the control and impact site groups, however when the in-river sites are viewed separately from the bay sites, a large decrease in calanoid copepod abundance in 2019 compared to 2018 is apparent at both Oyster Creek Rt. 9 and Forked River Rt. 9 (Figure 8a-b). In their research, Jebakumar et al. (2018) saw a significant reduction in zooplankton density from the intake of the power plant to the discharge point, but that is not the case in this situation. In Barnegat Bay, zooplankton densities were much higher in the sites located in the bay, including the impact sites Oyster Creek Mouth and Forked River West, but there was also an abundance of zooplankton at both Oyster Creek Rt. 9 and Forked River Rt. 9 in 2018. Calanoid copepods and other zooplankton species are naturally carried along with currents and water movement in the bay (Jiang et al., 2009). OCNGS created an additional current when withdrawing coolant water from the river, moving zooplankton into Forked River, through the plant, and out into Oyster Creek. This explanation suggests that when zooplankton populations were relatively high at the river sites because individuals were able to withstand the physical stresses imposed by the plant itself. While the high temperature of the water inside the plant often approaches or exceeds the thermal limits of many species (Jiang et al., 2009), studies have also shown that zooplankton survival is based on a combination of water quality and exposure time (Capuzzo, 1980). If the zooplankton were not exposed to thermal and mechanical stress for an excessive length of time, individuals may have been able to survive passage through the plant. While zooplankton may have been able to avoid mortality, they might also have experienced reduced capacity for growth and reproduction. However, since only a portion of the intake water circulated through the plant and exposed individuals to extreme temperatures, it is more probable that the large volume of water that was diverted and remixed with the exiting thermal discharge allowed for the high survival of zooplankton taxa and would have resulted in the high densities observed at the Oyster Creek Rt. 9 sampling site. In 2019, without the extra force of the current to draw zooplankton into the river, they were able to remain in the bay, resulting in the visible decreases in zooplankton densities at Oyster Creek Rt. 9 and Forked River Rt. 9 from 2018 to 2019.

Another possible explanation for the reduction in zooplankton abundance from 2018 to 2019, specifically at Forked River Rt. 9, was the increase in *M. leidyi* abundance. The ctenophore is capable of consuming ten times its weight in zooplankton per day (Suthers & Rissick, 2009), much more than its competitor *C. chesapeakei* (Purcell & Decker, 2005). *C. chesapeakei* are often able to control *M. leidyi* populations through predation (Bologna et al., 2017, 2018), but at Forked River Rt. 9 in 2019, *M. leidyi* were the dominant predator and could have severely reduced zooplankton densities. This is a very probable explanation since *M. leidyi* need an abundance of zooplankton food resources to facilitate a bloom, as was seen at this site (Figure 6a-b). This, however, cannot be used to explain the lack of zooplankton at Oyster Creek Rt. 9, because there were also very few gelatinous zooplankton collected here. The decrease in zooplankton densities at these sites from 2018 to 2019 is likely a combination of increased predation by *M. leidyi* at Forked River Rt. 9 and the lack of a current that would move zooplankton into Oyster Creek.

***Fish Eggs & Larvae* –** The most compelling evidence for the environmental impact of OCNGS are the significant density differences in fish eggs, Atlantic Silverside larvae, and Bay Anchovy larvae between 2018 and 2019 (Figures 11a-b, 12a-b, 13a-b). Barnegat Bay estuary, like so many other estuarine ecosystems around the world, serves as nursery grounds for many fish species (Valenti et al., 2017), receiving larvae from both resident and migrant fish species because of the advantages for growth and survival in the estuary versus open water. Barnegat Bay has several inlets along its barrier islands that connect it to the ocean and provide pathways for fish to come into the estuary to spawn. This tends to occur in the spring, resulting in the highest larval densities in the summer (Able et al., 2017). Bay Anchovy (*Anchoa mitchilli*) and Atlantic Silverside (*Menidia menidia*) are dominant fish species in Barnegat Bay (Valenti et al., 2017). Both species are considered residents (Able et al., 2017), where all life stages exist within the bay, however adults are also known to migrate between the continental shelf and the estuary (Szedlmayer & Able, 1996). All of our sampling occurred during the summer months, following the migration of adults to spawn in the estuary, so higher densities of eggs and larval fish were to be expected. However, these densities were much higher in 2019 than they were in 2018. This increase in the second sampling year did not occur across all sites, instead it was specific to just a few. There was a large spike in the abundance of fish eggs in late June of 2019 at Sunrise Beach, Forked River West, Forked River East, Oyster Creek Mouth, and Double Creek West (Figures 11a-b). Looking at the map of sampling sites in Barnegat Bay (Figure 2), four of these sites run parallel to the coastline in the bay. This coincides with an increased density of larval Atlantic Silverside and Bay Anchovy at Forked River West, Oyster Creek Mouth, and Double Creek West (Figures 12a-b, 13a-b). This suggests that populations of these estuarine fish species prefer habitats close to the coastline. Fish eggs and larvae are much smaller in size and more easily influenced by currents than adult fish. Similar to zooplankton, they were easily drawn into Forked River by the current created by OCNGS. Unlike zooplankton however, eggs and larval stages are much more sensitive to environmental conditions, resulting in much higher mortality rates from passage through the power plant with the coolant water (Jebakumar et al., 2018). With the absence of this anthropogenically-induced current in 2019, the eggs were able to remain in their preferable bay habitats and mature into larvae and adult fish.

Fish eggs, larvae, and juveniles are also known to be prey for gelatinous zooplankton like *C. chesapeakei* and *M. leidyi* (Bologna et al., 2017). In 2019 specifically, the highest densities of fish eggs and larvae were collected prior to the jellyfish bloom, when *C. chesapeakei* and *M. leidyi* increased in abundance, following this pattern of predator-prey interaction. Growth and survival of fish larvae can also largely depend on the abundance of copepods as food resources (Shaheen & Steimle, 1995). *M. leidyi* not only prey on, but also compete with juvenile fish for these copepods (Sullivan et al., 2001). When *C. chesapeakei* are present to control *M. leidyi* populations, there are ultimately more prey available for fish populations (Purcell & Decker, 2005). In 2019, the presence of fish larvae was also correlated with the highest abundances of copepods, suggesting a substantial supply of food resources for the fish before gelatinous zooplankton densities increased.

CONCLUSIONS

Anthropogenic impacts on ecosystems around the world vary on both spatial and temporal scales. While a tremendous amount of research is focused on understanding global warming, acute thermal pollution may often be overlooked, but it could act as a bellwether on climate change. The increase in water temperature as a result of cooling water withdrawal and discharge often approaches or exceeds the thermal limits of zooplankton species (Jiang et al., 2009). These impacts can radiate through food webs and entire communities (Howson et al., 2017). When the Oyster Creek Nuclear Generating Station was decommissioned in 2018, its effects on Barnegat Bay’s ecosystem became apparent. The shutdown resulted in a substantial reduction in thermal pollution around the coolant water discharge area in Oyster Creek. The plant had also generated a substantial current that withdrew water from Forked River and moved it through the plant into Oyster Creek. This current caused zooplankton, fish eggs, and fish larvae to become entrained in the plant, resulting in high rates of mortality. After the closure, my results demonstrate a change in the relative densities of some very key species including the Bay Anchovy and the Atlantic Silverside, as well as fish eggs and larvae. These two fish are critically important for many coastal ecosystems, and reduced mortality due to the shutdown of OCNGS led to significant increases in their abundance. However, what is yet to be resolved is whether the increase in gelatinous zooplankton species, which also was a result of the closure, replaced the plant-induced mortality of fish and other zooplankton through predation. Eliminating the substantial thermal pollution load to Barnegat Bay reduced physiological stress on the community, however, long-term sampling is needed to determine whether the community will return to what it was in a pre-stress environment, or whether the impacts of nearly five decades of thermal pollution will linger.

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TABLES & FIGURES

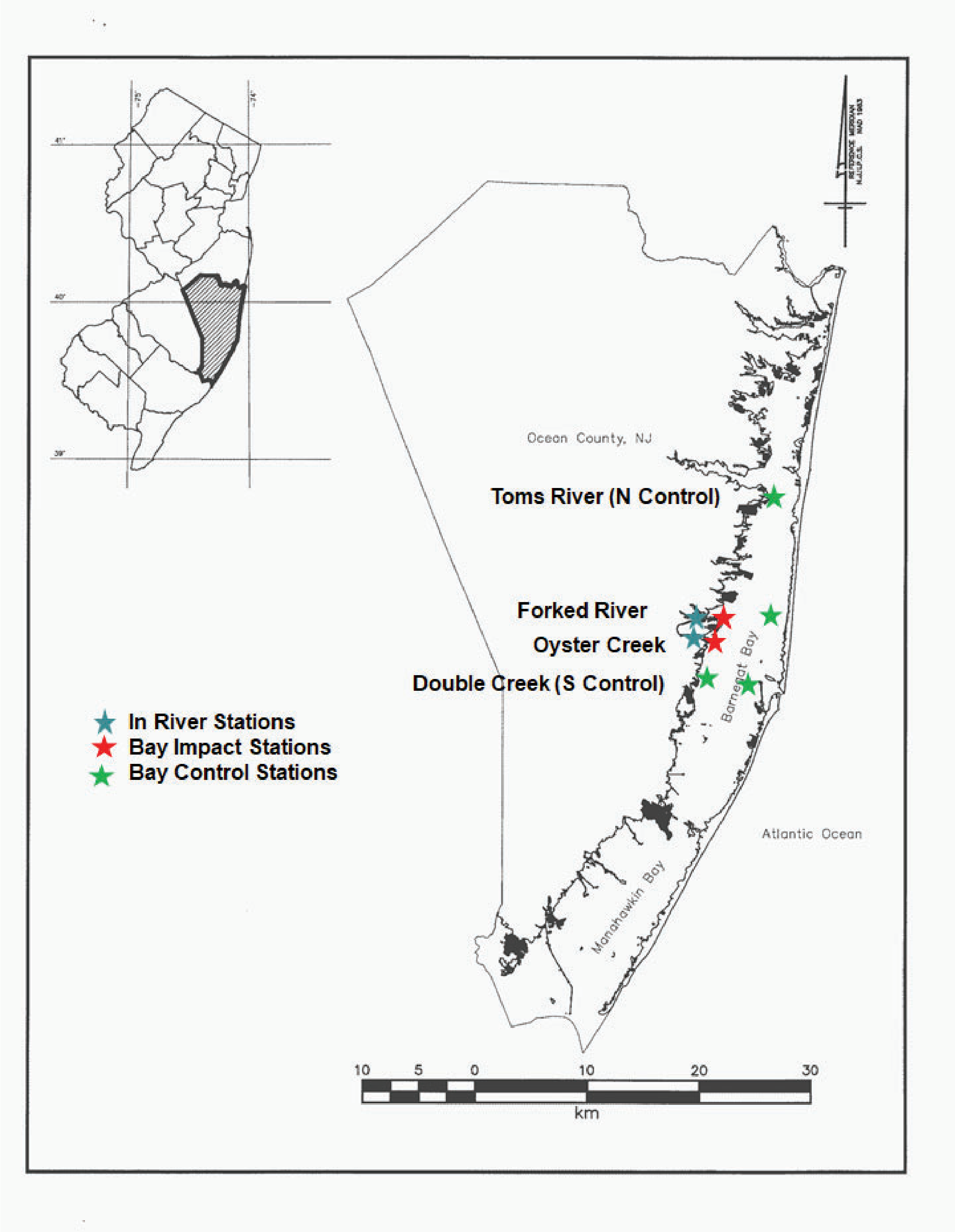

Figure 1. Location of Barnegat Bay off the coast of New Jersey and all sampling sites.

Figure 2. Map of the sampling sites in Barnegat Bay, including Oyster Creek Nuclear Generation Station. Sites marked in red were the control sites, while sites marked in green were the impact sites.

Table 1. Sampling Site Locations & Designations

Sampling Site	Abbreviation	GPS Coordinates	Site Designation
Toms River West	TRW	N39.93296, W74.13198	Control
Sunrise Beach Open Water	SB	N39.83807, W74.15535	Control
Forked River Lagoon	FRL	N39.82283, W74.18880	Impact
Forked River West	FRW	N39.82166, W74.16698	Impact
Forked River Rt.9	FRR9	N39.82065, W74.20147	Impact
Forked River East	FRE	N39.81217, W74.12657	Control
Oyster Creek Rt.9	OCR9	N39.81032, W74.24298	Impact
Oyster Creek Mouth	OCM	N39.80896, W74.16871	Impact
Double Creek East	DCE	N39.78779, W74.15613	Control
Double Creek West	DCW	N39.78574, W74.20119	Control

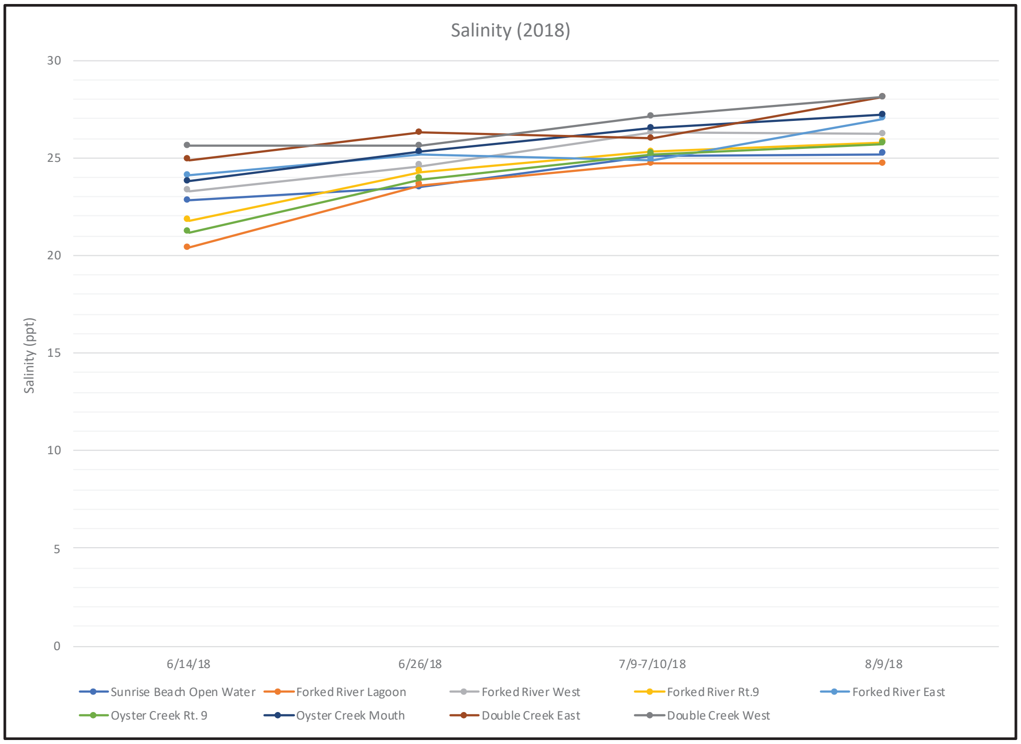

Figure 3a. Salinity values (ppt) for the four comparable sampling dates in 2018.

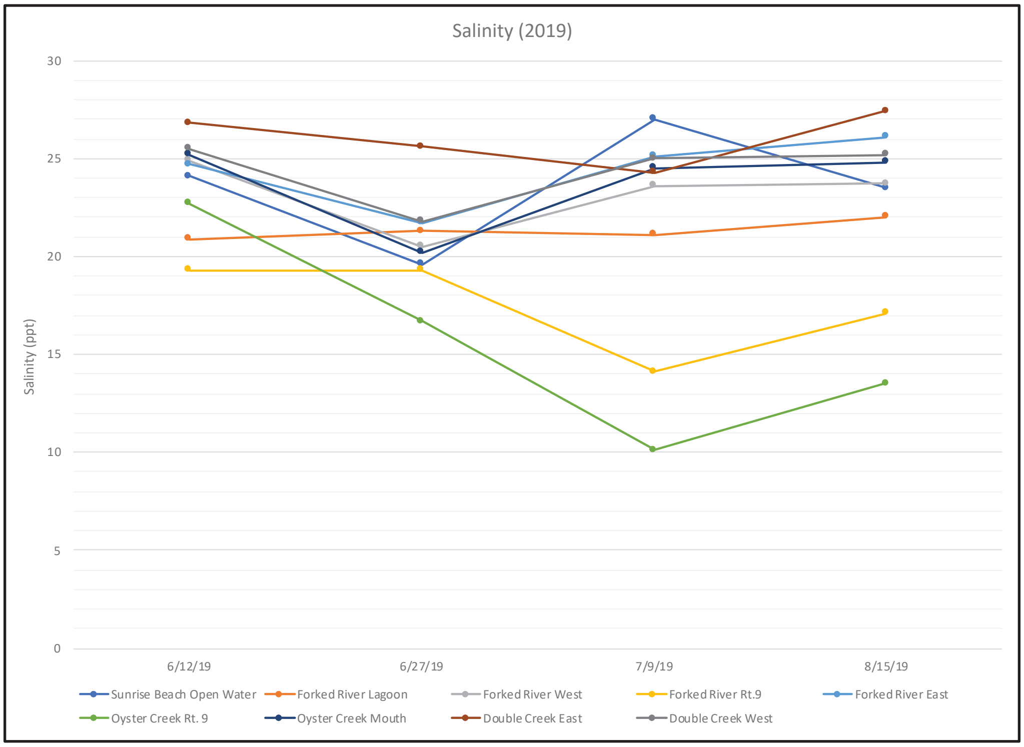

Figure 3b. Salinity values (ppt) for the four comparable sampling dates in 2019.

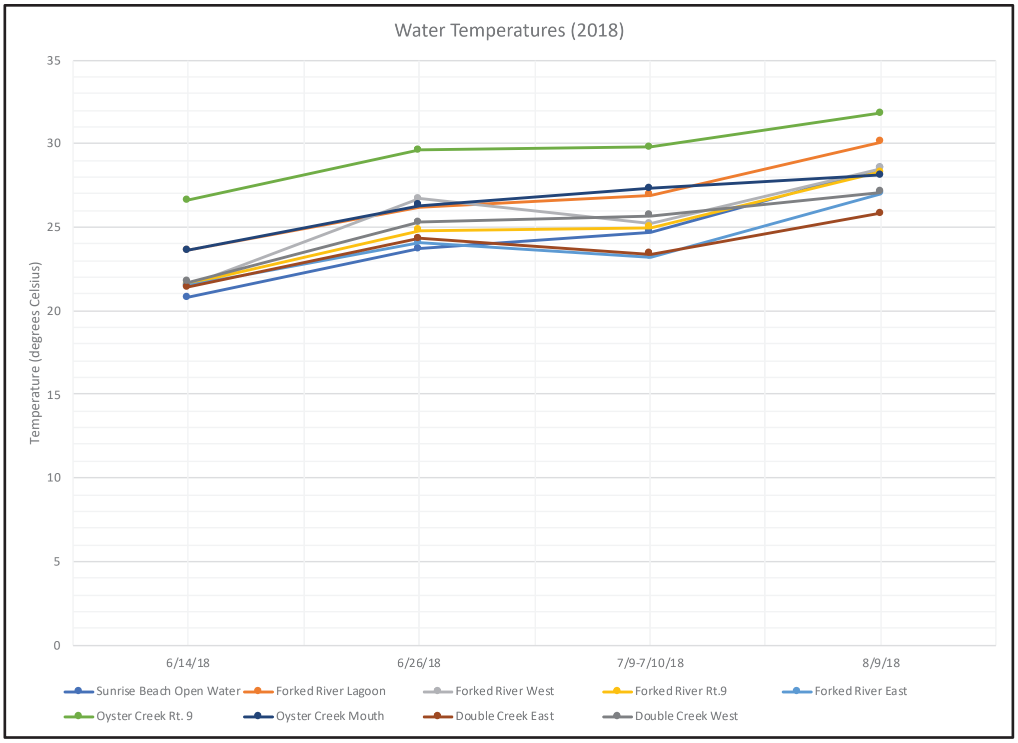

Figure 4a. Water temperature (°C) for the four comparable sampling dates in 2018.

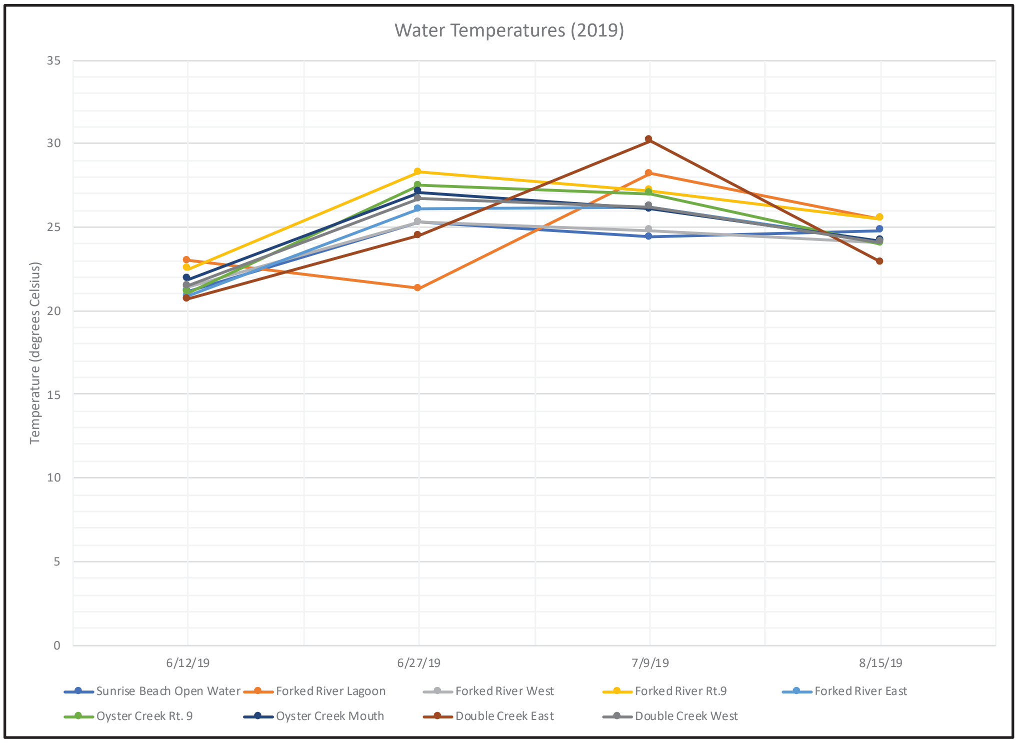

Figure 4b. Water temperature (°C) for the four comparable sampling dates in 2019.

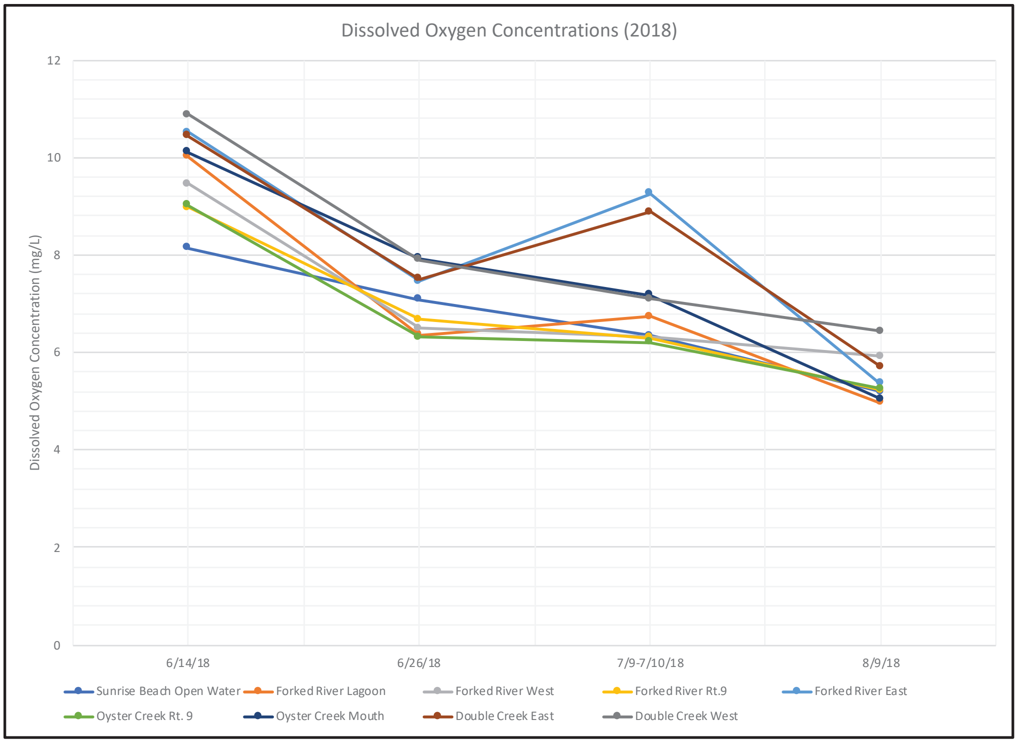

Figure 5a. Dissolved oxygen concentrations (mg/L) for the four comparable sampling dates in 2018.

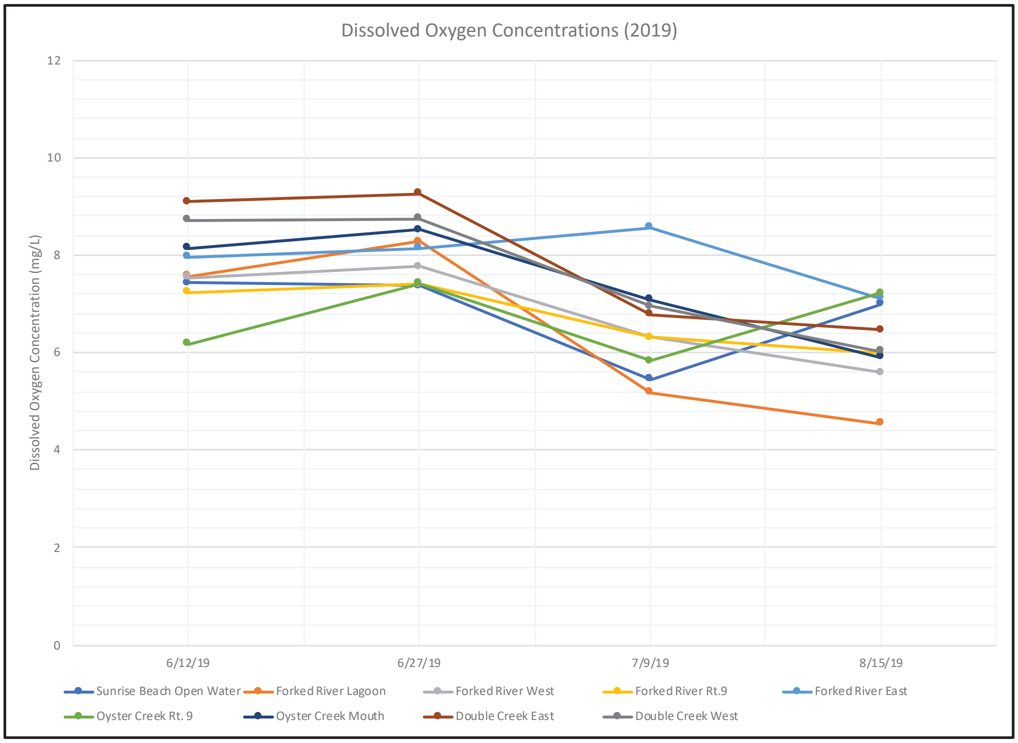

Figure 5b. Dissolved oxygen concentrations (mg/L) for the four comparable sampling dates in 2019.

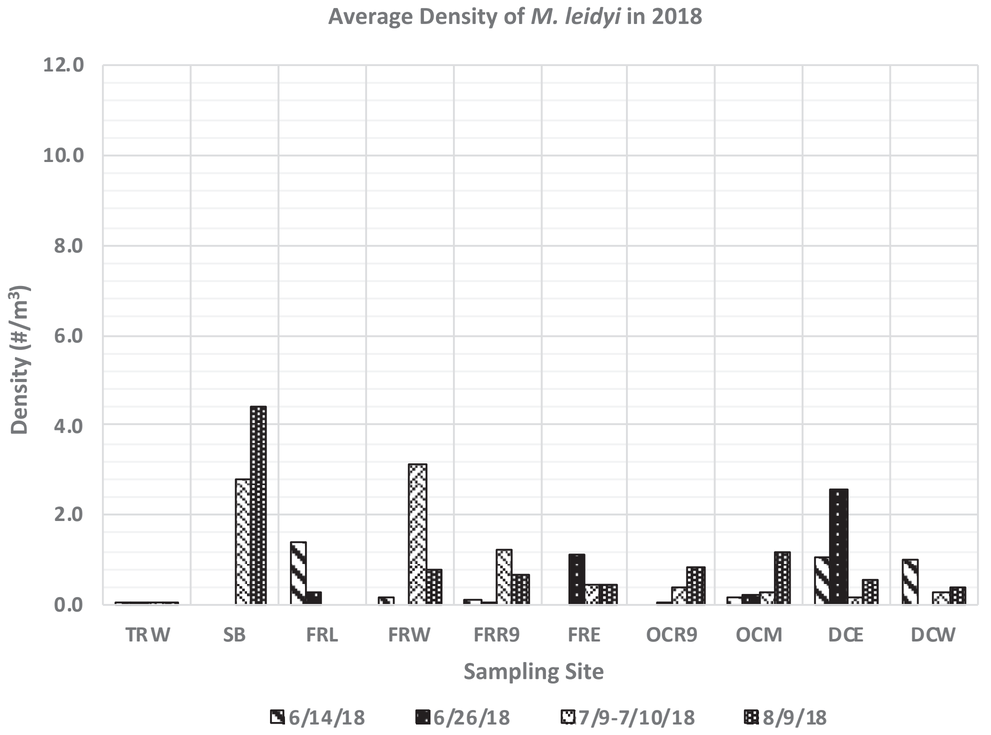

Figure 6a. Average density of *M. leidyi* at each site for each comparable sampling date in 2018.

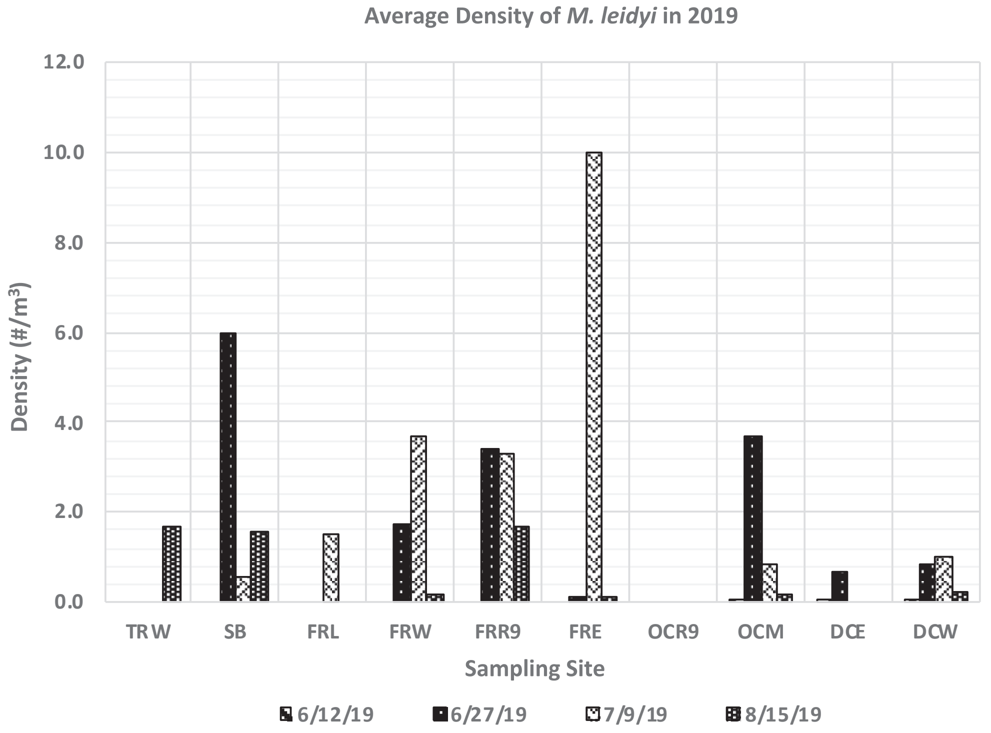

Figure 6b. Average density of *M. leidyi* at each site for each comparable sampling date in 2019.

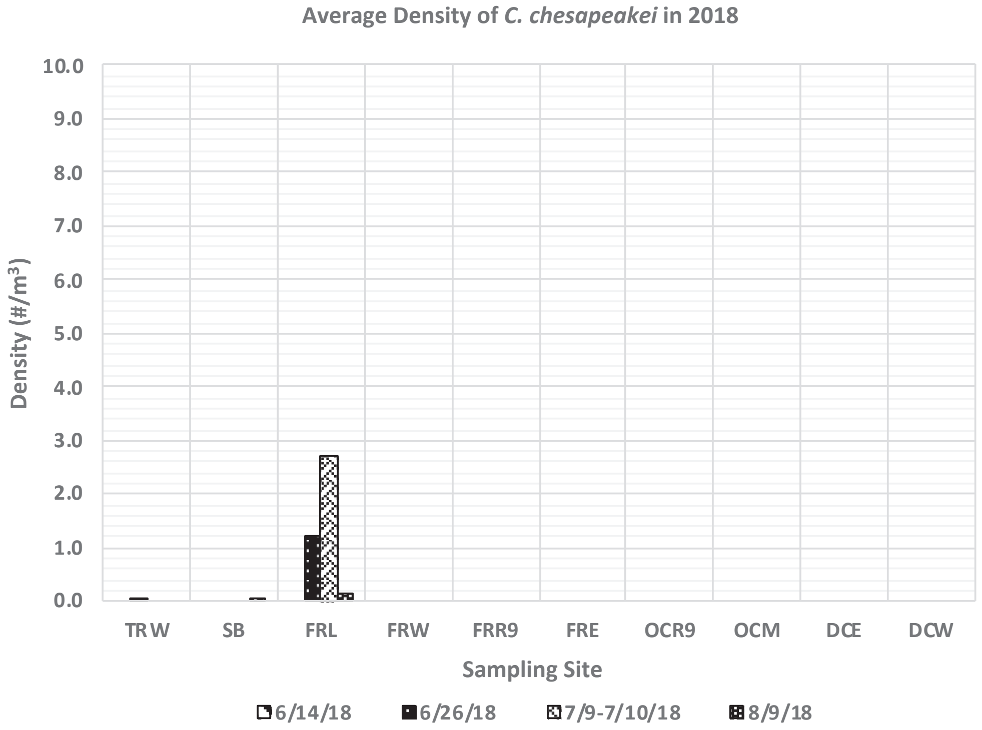

Figure 7a. Average density of *C. chesapeakei* at each site for each comparable sampling date in 2018.

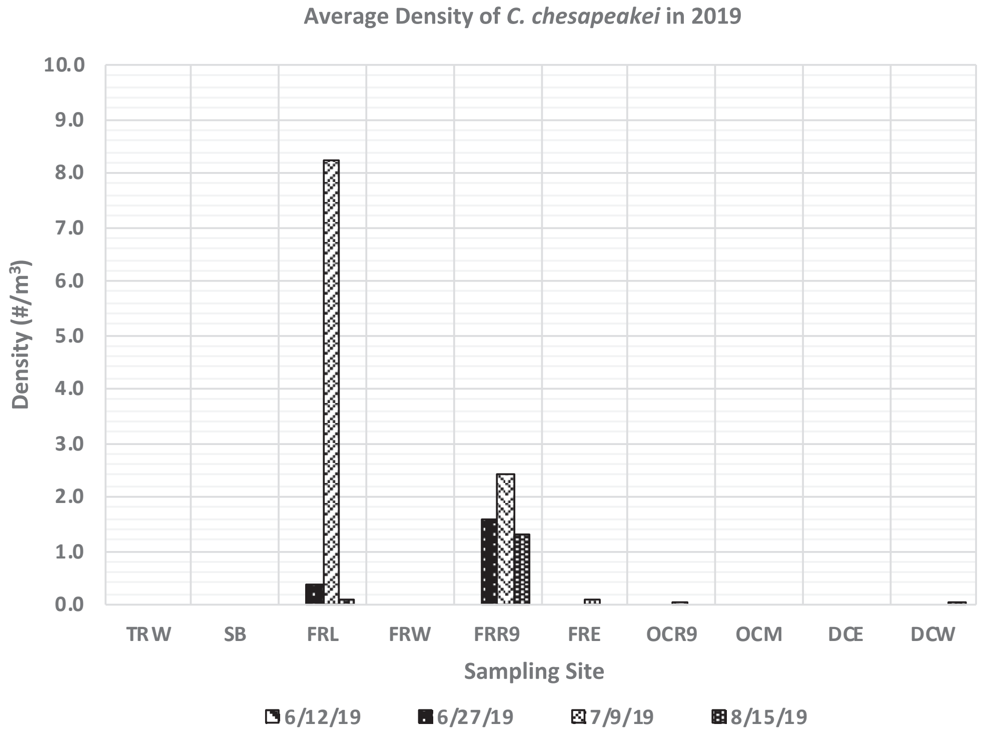

Figure 7b. Average density of *C. chesapeakei* at each site for each comparable sampling date in 2019.

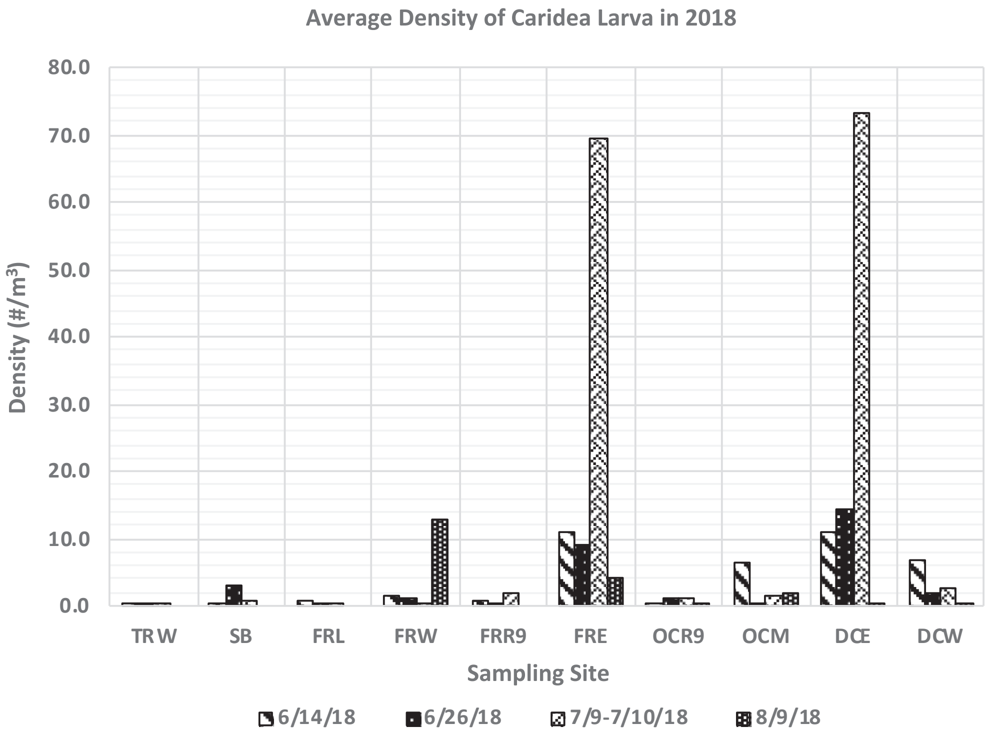

Figure 8a. Average density of Caridea larvae at each site for each comparable sampling date in 2018.

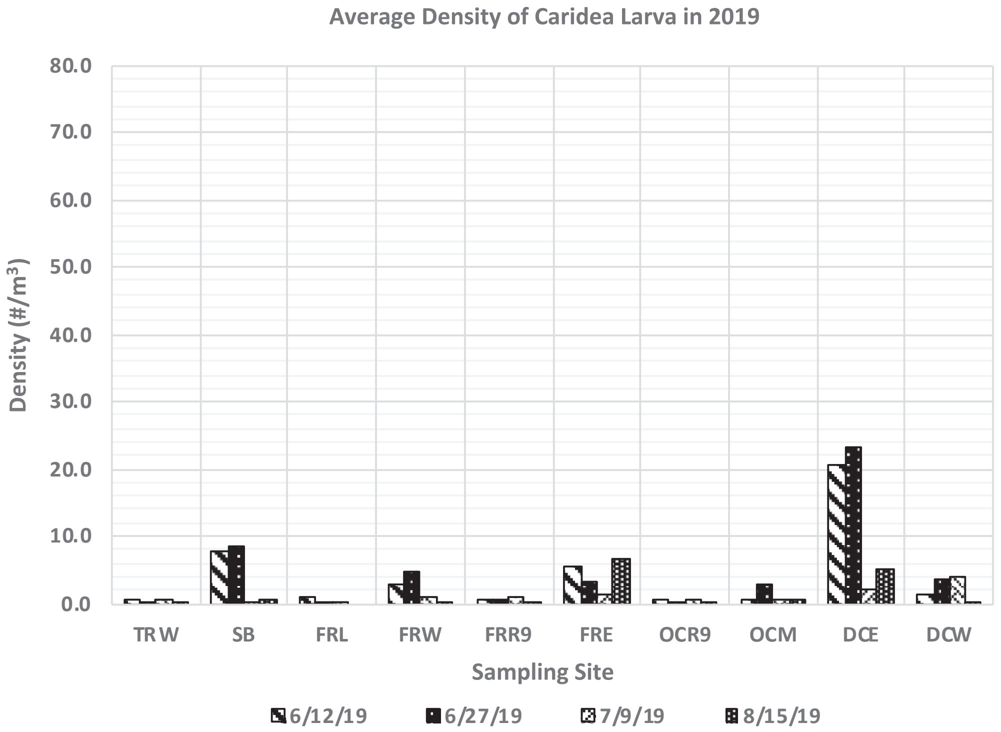

Figure 8b. Average density of Caridea larvae at each site for each comparable sampling date in 2019.

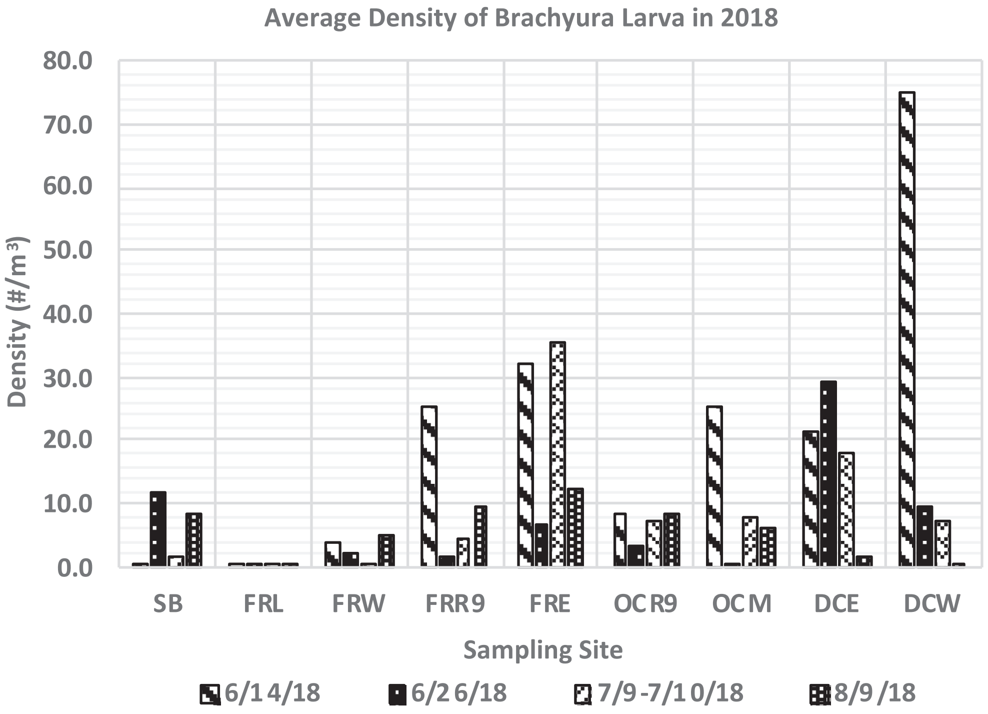

Figure 9a. Average density of Brachyura larvae at each site for each comparable sampling date in 2018.

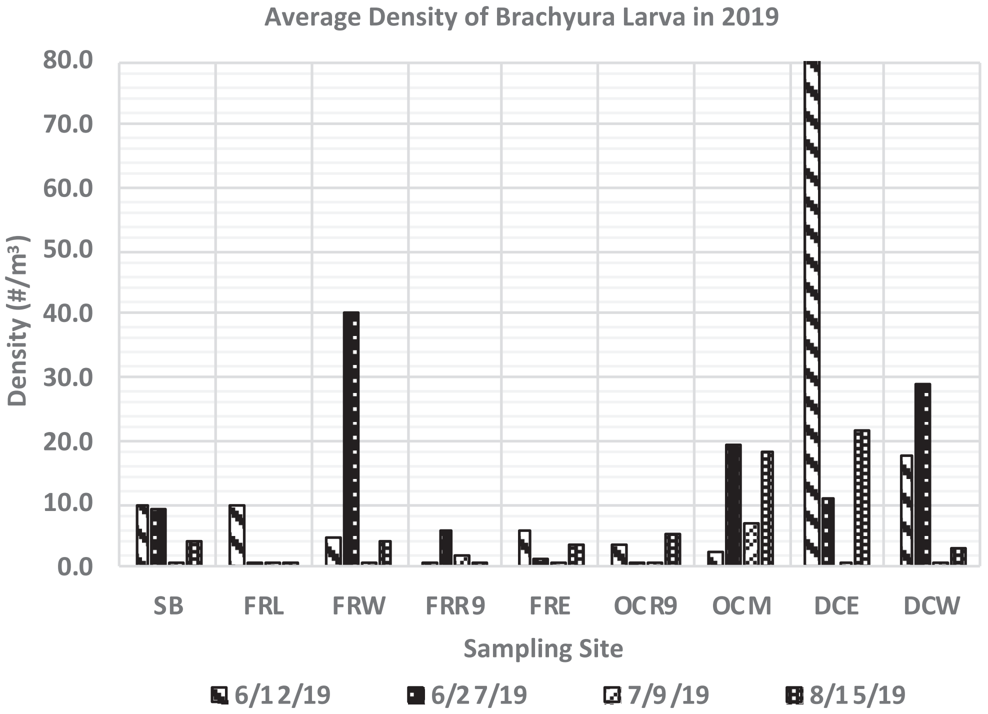

Figure 9b. Average density of Brachyura larvae at each site for each comparable sampling date in 2019.

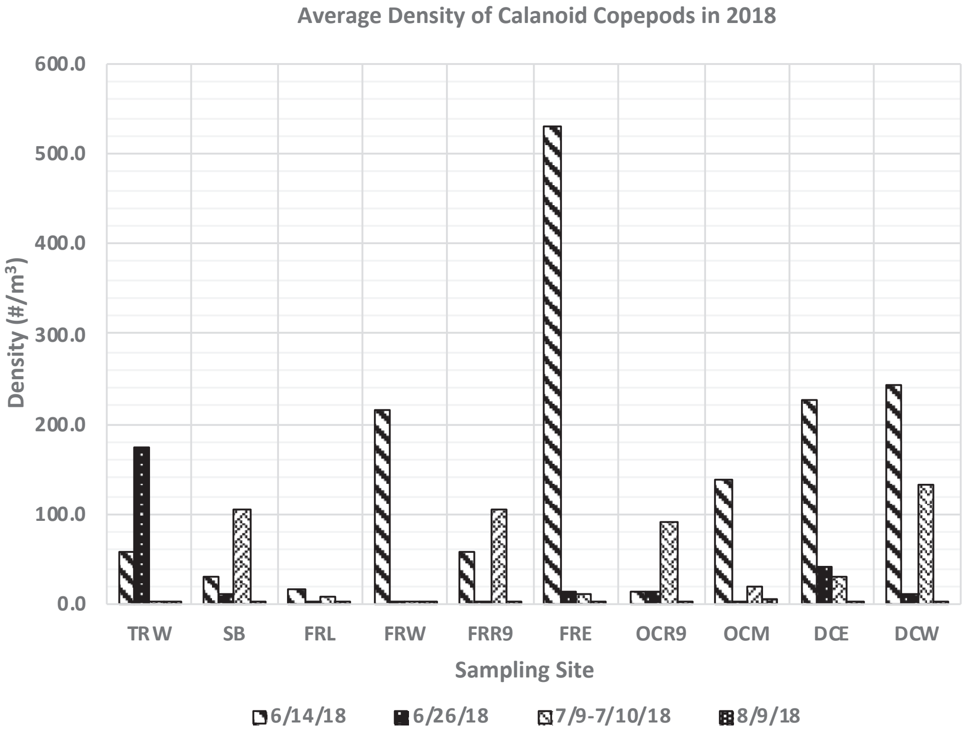

Figure 10a. Average density of Calanoida at each site for each comparable sampling date in 2018.

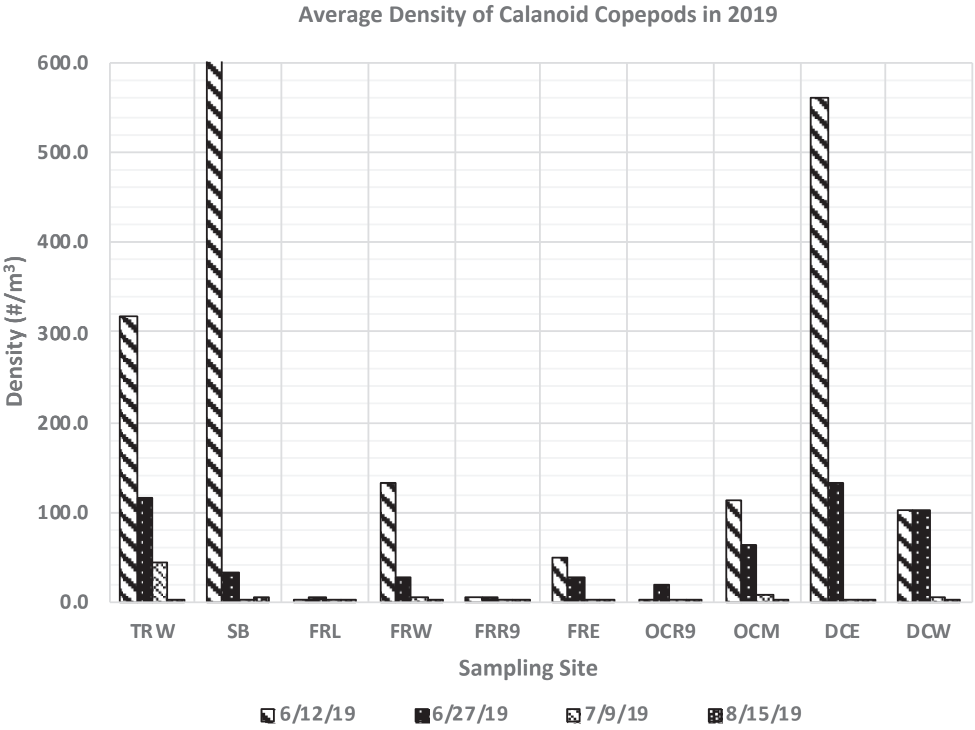

Figure 10b. Average density of Calanoida at each site for each comparable sampling date in 2019.

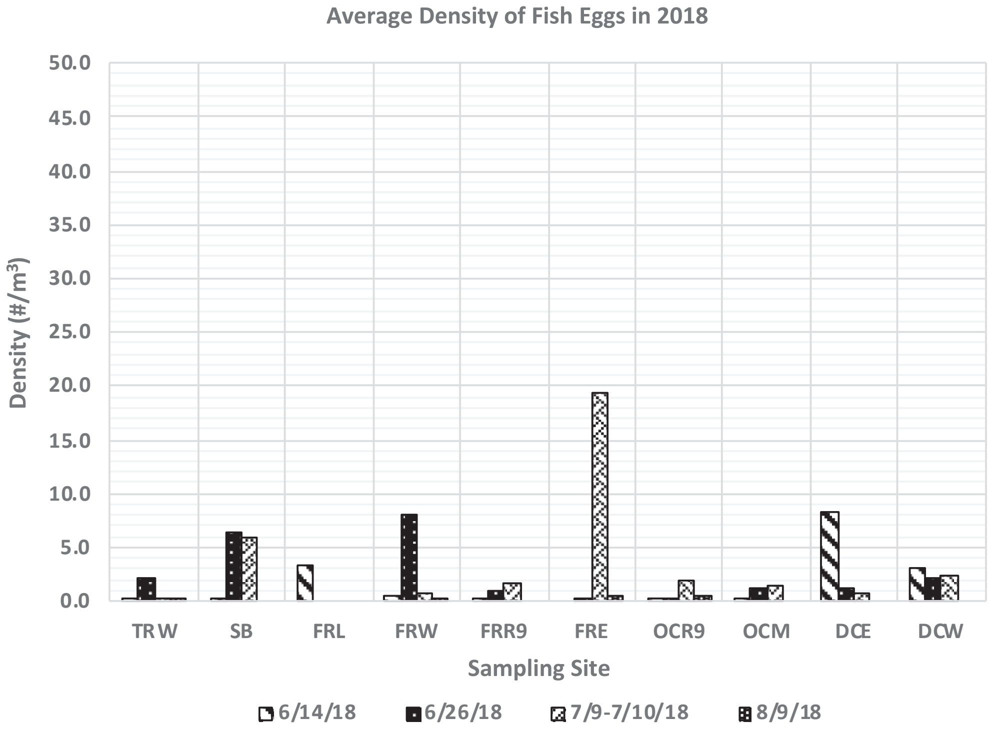

Figure 11a. Average density of fish eggs at each site for each comparable sampling date in 2018.

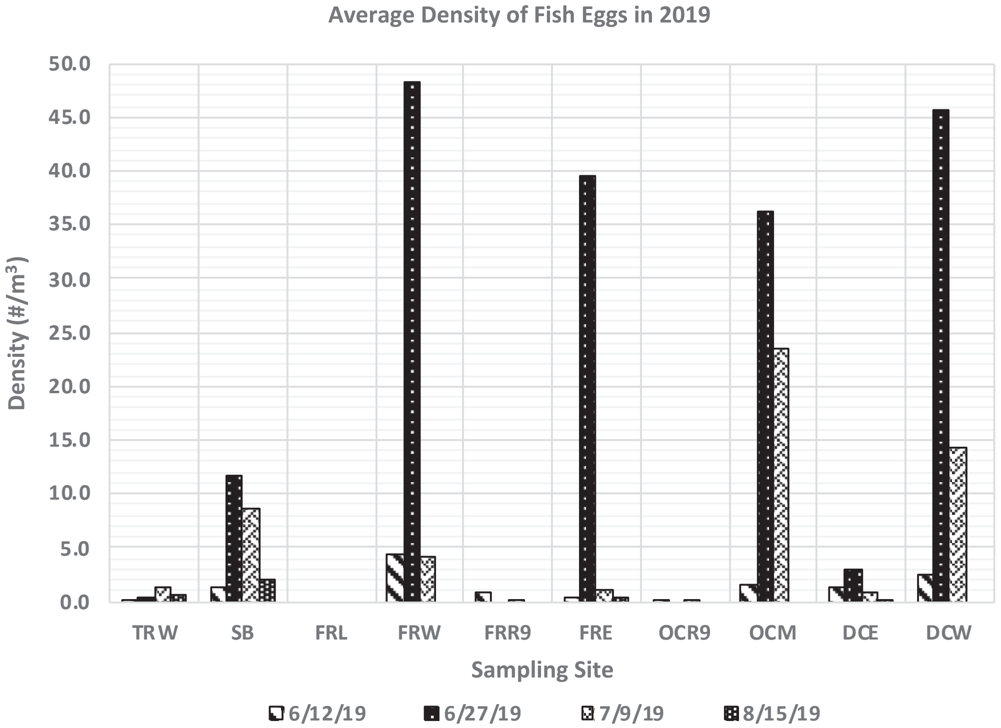

Figure 11b. Average density of fish eggs at each site for each comparable sampling date in 2019.

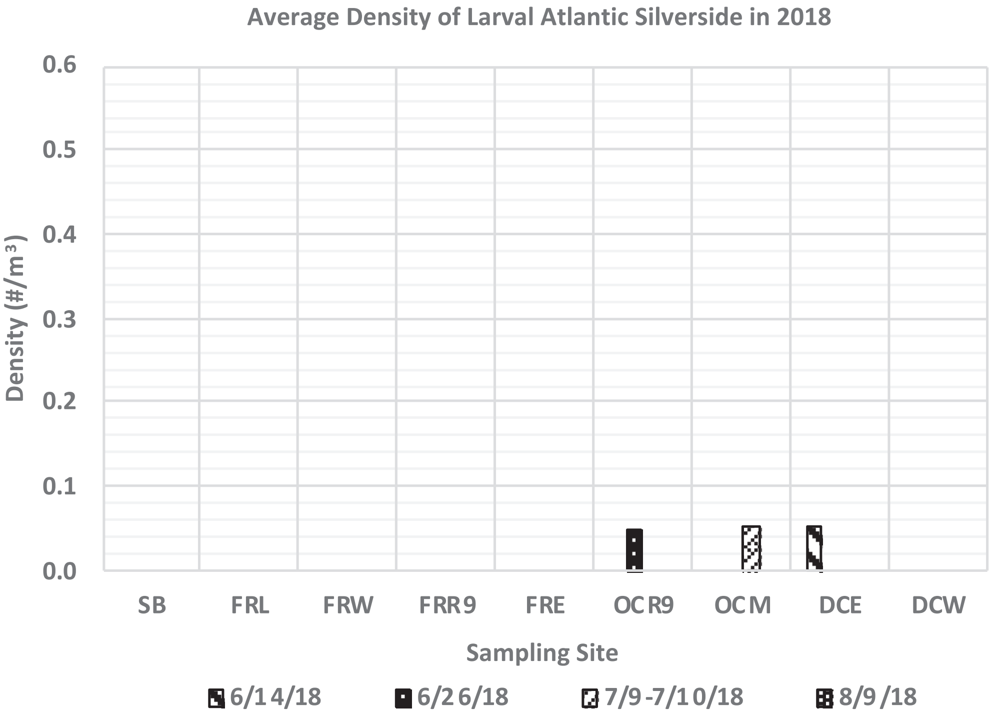

Figure 12a. Average density of Atlantic Silverside (*Menidia menidia*) larvae at each site for each comparable sampling date in 2018.

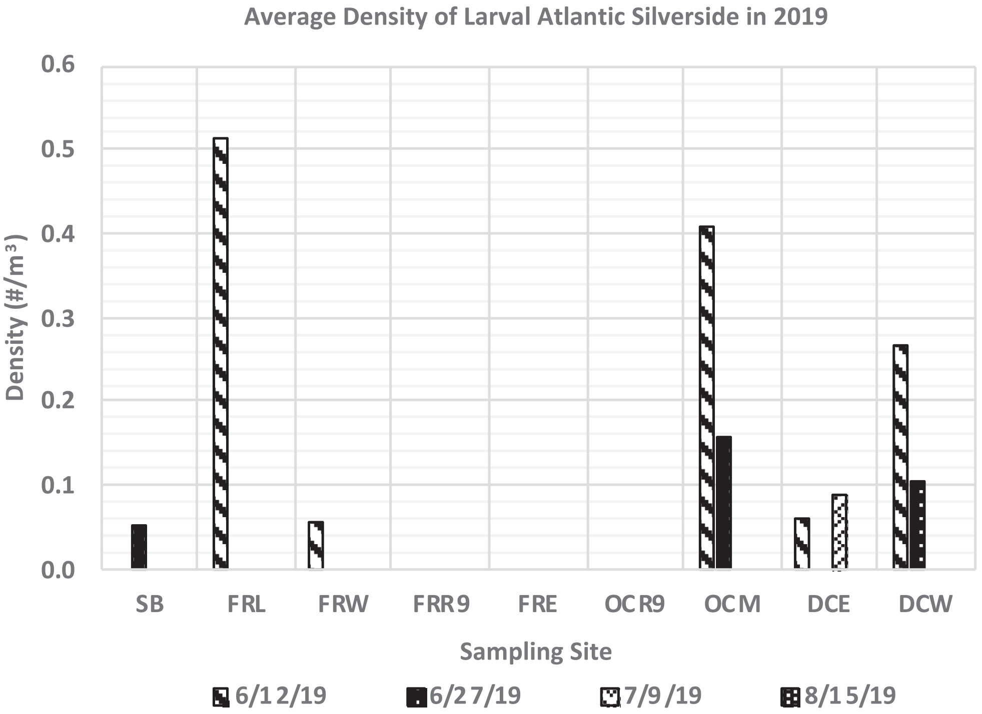

Figure 12b. Average density of Atlantic Silverside (*Menidia menidia*) larvae at each site for each comparable sampling date in 2019.

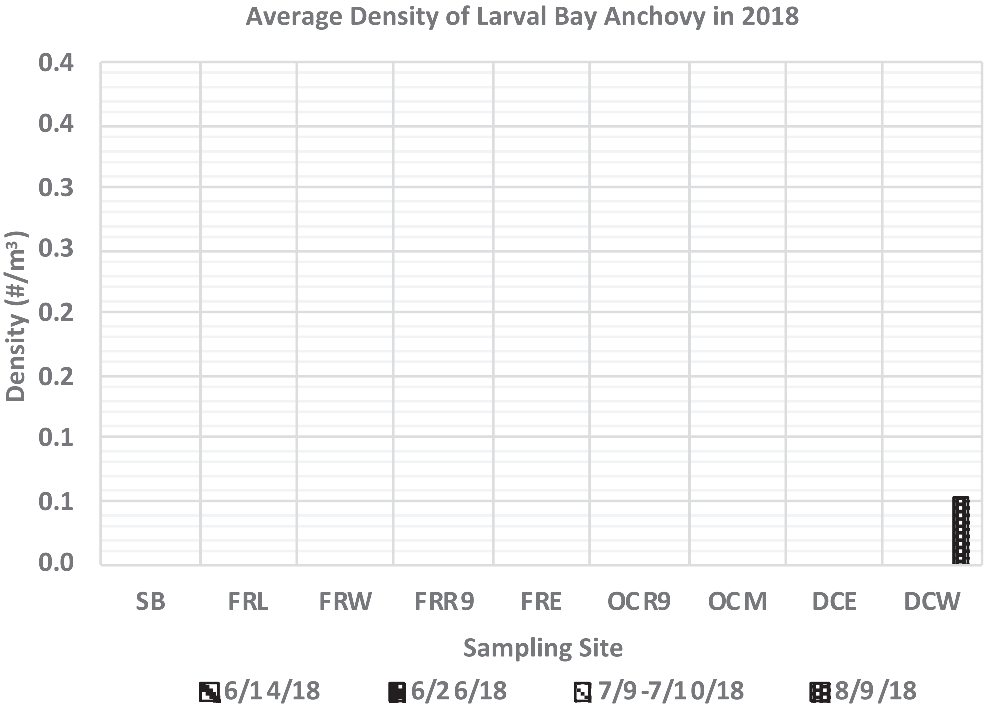

Figure 13a. Average density of Bay Anchovy (*Anchoa mitchilli*) larvae at each site for each comparable sampling date in 2018.

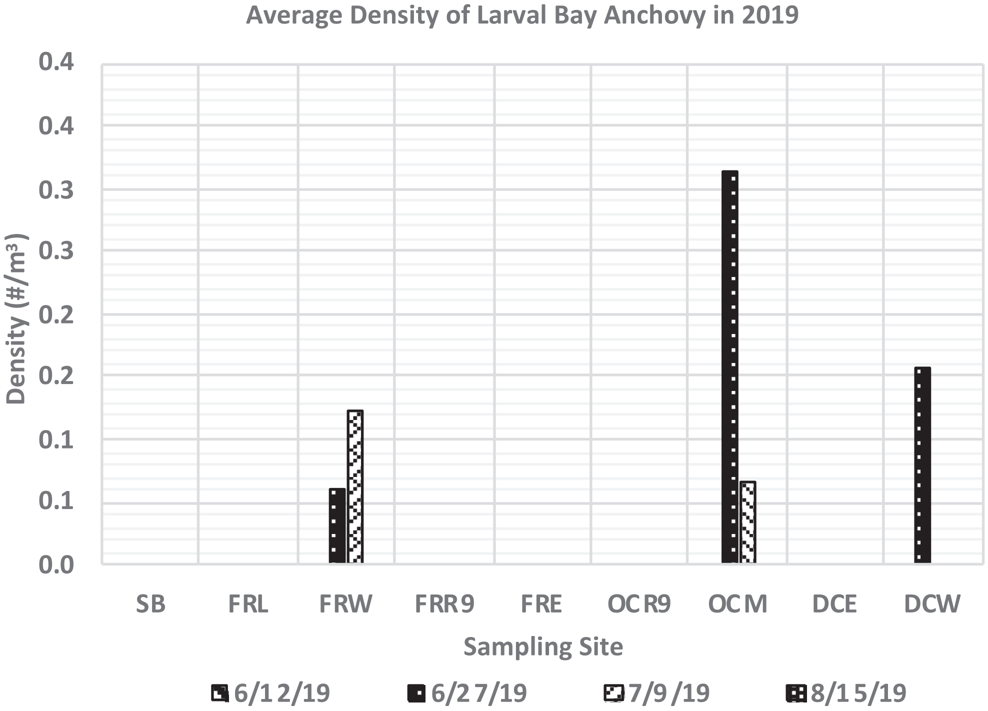

Figure 13b. Average density of Bay Anchovy (*Anchoa mitchilli*) larvae at each site for each comparable sampling date in 2019.

APPENDIX A. WATER QUALITY PARAMETER VALUES

Table 2. Water quality parameter values for each site and sampling date.

Dissolved Oxygen Concentration (mg/L)										
	TRW	**SB**	**FRL**	**FRW**	**FRR9**	**FRE**	**OCR9**	**OCM**	**DCE**	**DCW**
6/14/18	8.9	8.14	10.01	9.45	8.97	10.51	9.02	10.11	10.44	10.88
6/26/18	7.19	7.08	6.36	6.49	6.68	7.46	6.31	7.93	7.5	7.9
7/9 - 7/10/18	6.97	6.34	6.73	6.32	6.29	9.26	6.21	7.18	8.88	7.1
8/9/18	5.95	5.2	4.96	5.92	5.23	5.36	5.25	5.05	5.71	6.43
8/23/18	6.61	7.08	5.45	6.02	5.65	6.04	5.6	5.67	6.82	7.01
Dissolved Oxygen Saturation (%)										
	TRW	**SB**	**FRL**	**FRW**	**FRR9**	**FRE**	**OCR9**	**OCM**	**DCE**	**DCW**
6/14/18	103.9	102.8	131.2	120	114.2	135.2	125.7	135.6	135.5	142.5
6/26/18	87.7	93.5	91.1	90.2	89.4	99.9	92.3	108.4	100.8	108.5
7/10/18	87.2	87.6	95.7	88.4	86.7	120	93.4	103.2	118.5	98.7
8/9/18	83.4	76.4	74.5	87.1	76.7	77.5	81.8	75.7	81.4	99
8/23/18	84	97.2	78.8	82.7	77	82.1	81.2	83.1	95.3	98.3
Temperature (degrees Celsius)										
	TRW	**SB**	**FRL**	**FRW**	**FRR9**	**FRE**	**OCR9**	**OCM**	**DCE**	**DCW**
6/14/18	21.1	20.8	23.6	21.5	21.6	21.5	26.6	23.6	21.4	21.7
6/26/18	23.6	23.7	26.2	26.7	24.8	24.1	29.6	26.3	24.3	25.3
7/9 - 7/10/18	24.3	24.7	26.9	25.2	25	23.2	29.8	27.3	23.4	25.7
8/9/18	28.2	28.5	30.1	28.5	28.3	27	31.8	28.1	25.8	27.1
8/23/18	24.3	25.2	26.5	24.9	24.6	24.4	28.3	28.2	25.5	25.5
Salinity (ppt)										
	TRW	**SB**	**FRL**	**FRW**	**FRR9**	**FRE**	**OCR9**	**OCM**	**DCE**	**DCW**
6/14/18	10	22.8	20.4	23.3	21.8	24.1	21.2	23.8	24.9	25.6
6/26/18	11.4	23.5	23.6	24.6	24.3	25.2	23.9	25.3	26.3	25.6
7/9 - 7/10/18	13.1	25.1	24.7	26.3	25.3	24.9	25.2	26.5	26	27.1
8/9/18	17.1	25.2	24.7	26.2	25.8	27	25.7	27.2	28.1	28.1
8/23/18	13.2	24	25.8	26.1	25.3	26.2	24.8	24.9	26.7	26.8
Dissolved Oxygen Concentration (mg/L)										
	TRW	**SB**	**FRL**	**FRW**	**FRR9**	**FRE**	**OCR9**	**OCM**	**DCE**	**DCW**
5/29/19		7.22	6.61	7.06	5.03	7.79	6.3	7.02	6.93	7.74
6/12/19	7.89	7.43	7.57	7.53	7.23	7.96	6.17	8.14	9.09	8.72
6/27/19	7.27	7.37	8.27	7.76	7.4	8.14	7.42	8.52	9.26	8.74
7/9/19	6.45	5.45	5.18	6.31	6.31	8.56	5.83	7.09	6.78	6.94
7/25/19	6.93	6.57	4.82	6.53	6.73	8.4	5.6	7.9	9.8	7.29
8/15/19	7.4	6.99	4.55	5.58	5.98	7.11	7.22	5.9	6.46	6.03
9/13/19		6.71	5.23	6.48	6.04	6.26	6.85	5.9	8.42	6.49
Dissolved Oxygen Saturation (%)										
	TRW	**SB**	**FRL**	**FRW**	**FRR9**	**FRE**	**OCR9**	**OCM**	**DCE**	**DCW**
5/29/19		93.5	88.5	92.9	64.2	100.6	78.2	89.3	90.4	99.7
6/12/19	93.5	95.1	97.9	97.8	92.3	102	79	106.6	117.6	113.9
6/27/19	93.4	99.5	11.8	105.3	105.8	109.2	99.1	118.5	128.6	124.4
7/9/19	83.3	75.6	69.2	86.5	73.5	121.3	77.4	99.5	103.1	96.5
7/25/19	89.8	91.1	70.1	91.8	98.4	120.5	82	111.1	142.1	104.5
8/15/19	98.2	96.2	60.9	75.6	79.7	97.8	90.1	80.6	87.9	81.9
9/13/19		87.7	72	85.4	79.3	83.6	83	78.4	113.1	86.4
Temperature (degrees Celsius)										
	TRW	**SB**	**FRL**	**FRW**	**FRR9**	**FRE**	**OCR9**	**OCM**	**DCE**	**DCW**
5/29/19		22	23.2	21.7	22	21.7	20.6	20.6	20.4	21.1
6/12/19	21.3	21.2	23	21.4	22.5	20.9	21.1	21.9	20.7	21.5
6/27/19	10.6	25.3	21.3	25.3	28.3	26.1	27.5	27.1	24.5	26.7
7/9/19	25	24.4	28.2	24.8	27.2	26.2	27	26.1	30.2	26.2
7/25/19	26.6	26.5	28.3	26.4	28.6	27.2	28.2	27.1	26.5	26.2
8/15/19	25.4	24.8	25.5	24.1	25.5	24.2	24	24.2	22.9	24.1
9/13/19		22.5	24	22.1	23.2	22.8	21.6	22.2	21.3	22.8
Salinity (ppt)										
	TRW	**SB**	**FRL**	**FRW**	**FRR9**	**FRE**	**OCR9**	**OCM**	**DCE**	**DCW**
5/29/19		22	21.6	23.8	20.5	23.3	22.6	25.4	26.5	26.6
6/12/19	9.7	24.1	20.9	24.9	19.3	24.7	22.7	25.2	26.8	25.5
6/27/19	10.6	19.6	21.3	20.5	19.3	21.7	16.7	20.2	25.6	21.8
7/9/19	11.3	27	21.1	23.6	14.1	25.1	10.1	24.5	24.3	25
7/25/19	10.4	22.8	22.9	24.1	20.1	25.5	18.7	23.3	26.4	25.2
8/15/19	17.4	23.5	22	23.7	17.1	26.1	13.5	24.8	27.4	25.2
9/13/19		25.5	24.7	27.4	23.8	27.2	16.4	27.7	31.6	28.6

APPENDIX B. STATISTICAL ANALYSIS OF COVARIANCE RESULTS

Table 3. Significant results of the two-way ANCOVA for 2018 plankton tow data.

	Site (df = 9, Error = 123)		Date (df = 1, Error = 123)	
Species	**F-value**	**P-value**	**F-value**	**P-value**
M. leidyi	2.39	0.0156		
C. chesapeakei	2.47	0.0125		
Turritopsis sp.			11.16	0.0011
Obelia sp.			5.58	0.0198
Nemopsis sp.	2.54	0.0104		
Amphipoda	2.28	0.0212		
Calanoida			25.06	<0.0001
Caridea Larva	2.37	0.0167		
Brachyura Larva	2.72	0.0064	13.05	0.0004
Polychaeta	2.37	0.0167	4.25	0.0414

Table 4. Significant results of the two-way ANCOVA on 2019 plankton tow data.

	Site (df = 9, Error = 193)		Date (df = 1, Error = 193)	
Species	**F-value**	**P-value**	**F-value**	**P-value**
M. leidyi	2.59	0.0076	41.25	<0.0001
C. chesapeakei	3.91	0.0001		
Turritopsis sp.			7.49	0.0068
Bougainvillia sp.			5.16	0.0242
Obelia sp.			3.92	0.0493
Nemopsis sp.			5.76	0.0174
Pleurobrachia pileus			8.03	0.0051
Amphipoda	3.18	0.0013		
Calanoida	3.12	0.0016	5.37	0.0215
Harpacticoida			5.25	0.0230
Ostracoda	2.91	0.0030		
Fish Eggs	3.26	0.0010	15.61	0.0001
Fish Larva	2.99	0.0023	28.50	<0.0001
Caridea Larva	5.15	<0.0001	9.70	0.0021
Brachyura Larva	3.45	0.0006	4.77	0.0302
Megalopa Brachyura Larva	2.75	0.0049		
Mysida			15.12	0.0001
Polychaeta	4.18	<0.0001		
Ascidiacea Larva	9.68	<0.0001	36.26	<0.0001
Thalia sp.	3.02	0.0021		

Table 5. Significant results of the 3-way ANCOVA for all plankton tow data, not including TRW.

	Site (df = 8, Error = 205)		**Date (df = 1, Error = 205)**		**Year (df = 1, Error = 205)**	
Species	**F-value**	**P-value**	**F-value**	**P-value**	**F-value**	**P-value**
C. chesapeakei	5.38	<0.0001				
Turritopsis sp.			9.61	0.0022		
Bougainvillia sp.	2.93	0.0040	10.72	0.0012		
Obelia sp.			9.53	0.0023	4.74	0.0305
Aequora sp.	3.22	0.0016			5.46	0.0204
Nemopsis sp.	2.29	0.0225	29.10	<0.0001		
M. leidyi	3.10	0.0025				
Pleurobrachia pileus			7.76	0.0058	4.31	0.0391
Menidia menidia Larva			7.92	0.0054	5.22	0.0234
Anchoa mitchilli Larva					4.24	0.0408
Bairdiella chrysoura Larva			7.16	0.0081	3.98	0.0475
Fish Larva	2.80	0.0057	35.87	<0.0001		
Fish Eggs	3.47	0.0009			14.16	0.0002
Calanoida	2.93	0.0040	14.43	0.0002		
Caridea Larva	4.10	0.0001				
Brachyura Larva	4.15	0.0001	12.08	0.0006		
Megalopa Brachyura Larva	2.66	0.0084			5.25	0.0229
Ascidiacea Larva	3.85	0.0003	18.78	<0.0001	14.73	0.0002
Thalia sp.	3.16	0.0021	6.08	0.0145		

APPENDIX C. LEAST SQUARES MEANS RESULTS

Table 6. Average densities of taxa exhibiting significant differences among sites in 2018 plankton tow samples. Differing letters next to the density values indicate significant differences in means among sites for taxa.

	TRW	SB	FRL	FRW	FRR9	FRE	OCR9	OCM	DCE	DCW
*M. leidyi**	0.03 a	1.45 bc	0.41 a	0.91 abc	0.42 a	1.66 bc	0.29 a	0.47 ac	0.94 abc	0.53 ac
*C. chesapeakei**	0.01 a	0.01 a	0.87 b	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a
*Nemopsis sp.**	0.04 a	0.45 b	0.00 a	0.01 a	0.01 a	0.15 a	0.06 a	0.12 a	0.02 a	0.03 a
Amphipods*	0.04 a	0.03 a	0.08 a	1.18 a	0.16 a	1.03 a	0.70 a	0.32 a	3.26 b	0.37 a
Caridea Larva*	0.18 a	0.92 a	0.31 a	4.52 a	2.65 a	23.02 b	2.98 a	6.21 ab	20.02 b	2.88 a
Brachyura Larva**	1.71 d	4.70 cd	0.51 d	3.01 d	8.93 abcd	16.86 ab	7.04 bcd	9.17 abcd	14.68 abc	19.34 a
*Polychaetae**	0.06 a	0.00 a	0.00 a	0.04 a	0.05 a	0.35 ab	0.60 b	0.22 ab	0.05 a	0.03 a

Significance: *p<0.05, **p<0.01

Table 7. Average densities of taxa exhibiting significant differences among sites in 2019 plankton tow samples. Differing letters next to the density values indicate significant differences in means among sites for taxa.

	TRW	SB	FRL	FRW	FRR9	FRE	OCR9	OCM	DCE	DCW
*M. leidyi***	0.36 a	3.30 bc	0.35 a	4.13 c	3.14 bc	3.16 bc	2.00 abc	1.26 ab	0.90 abc	0.58 a
*C. chesapeakei****	0.00 a	0.00 a	1.37 b	0.00 a	0.89 b	0.06 a	0.01 a	0.00 a	0.00 a	0.01 a
*Nemopsis sp.**	0.25 ab	0.10 a	0.03 a	0.42 b	0.11 a	0.06 a	0.01 a	0.25 ab	0.25 ab	0.20 ab
Amphipods**	0.21 a	2.08 a	0.09 a	0.39 a	0.01 a	4.68 a	0.17 a	0.12 a	25.23 b	0.17 a
Calanoida**	96.37 a	611.07 b	1.99 a	68.36 a	11.10 a	52.10 a	8.51 a	53.15 a	181.72 a	48.80 a
Ostracoda**	0.01 a	0.23 a	0.00 a	0.02 a	0.01 a	0.12 a	0.07 a	0.28 a	3.08 b	0.67 a
Fish Egg**	0.49 c	5.81 abc	0.00 c	8.52 a	2.32 bc	7.98 ab	0.44 c	9.98 a	4.02 abc	10.09 a
Fish Larva**	0.04 c	0.11 b	0.12 b	0.14 b	0.01 c	0.19 b	0.00 c	0.31 b	0.75 a	0.47 ab
Caridea Larva***	0.33 a	3.33 a	0.23 a	2.36 a	0.43 a	5.86 a	0.47 a	1.13 a	47.23 b	2.46 a
Brachyura Larva***	6.13 a	5.16 a	1.75 a	8.36 a	1.36 a	3.58 a	1.72 a	7.85 a	57.24 b	7.25 a
Megalopa Brachyura Larva**	0.00 a	0.02 a	0.39 bc	0.02 a	0.00 a	0.12 ab	0.02 a	0.05 a	0.52 c	0.02 a
Polychaeta***	0.04 a	0.09 a	0.00 a	0.08 a	0.00 a	0.78 b	0.01 a	0.08 a	0.96 b	0.06 a
Ascidiacea Larva***	0.03 a	0.09 a	0.00 a	0.24 a	0.00 a	0.56 a	0.02 a	1.55 b	1.65 b	0.20 a
*Thalia sp.***	0.01 a	0.00 a	0.00 a	0.00 a	0.01 a	0.02 a	0.00 a	0.00 a	2.34 b	0.05 a

Significance: *p<0.05, **p<0.01, ***p<0.001

Table 8. Average densities of taxa exhibiting significant differences among sites in the comparison between 2018 and 2019 plankton tow samples. Differing letters next to the density values indicate significant differences in means among sites for taxa.

	TRW	SB	FRL	FRW	FRR9	FRE	OCR9	OCM	DCE	DCW
Unidentified Hydrozoans*	0.04 a	0.04 a	0.03 a	0.05 a	0.03 a	0.19 a	0.01 a	0.02 a	0.06 a	0.66 b
*C. chesapeakei****	0.01 a	0.01 a	1.60 b	0.00 a	0.67 c	0.01 a	0.01 a	0.00 a	0.00 a	0.01 a
*Bougainvillia sp.***	0.01 a	0.17 b	0.00 a	0.00 a	0.02 a	0.02 a	0.00 a	0.04 a	0.00 a	0.07 a
*Aequora sp.***	0.00 a	0.00 a	0.00 a	0.01 a	0.00 a	0.00 a	0.00 a	0.00 a	0.01 a	0.05 b
*Nemopsis sp.**	0.18 abc	0.36 b	0.02 c	0.37 b	0.09 ac	0.12 ac	0.06 ac	0.28 ab	0.10 ac	0.24 abc
*M. leidyi****	0.24 d	1.92 a	0.40 bcd	1.21 abd	1.31 ab	2.16 a	0.16 cd	0.82 bcd	0.65 bcd	0.47 bcd
Amphipoda*	0.13 a	1.74 a	0.10 a	3.99 a	0.13 a	1.10 a	1.10 a	0.42 a	19.46 b	0.29 a
Fish Larva**	0.10 ab	0.21 ab	0.12 ab	0.10 ab	0.04 b	0.20 ab	0.05 ab	0.23 a	0.16 ab	0.42 c
Fish Eggs***	0.63 a	4.51 ab	0.40 a	8.26 b	0.49 a	7.66 b	0.37 a	8.03 b	1.94 a	8.76 b
Calanoida**	89.57 a	521.82 b	4.67 s	48.68 a	22.32 a	79.73 a	18.67 a	44.34 a	124.31 a	74.63 a
*Evadne sp.****	0.02 a	0.00 a	0.00 a	0.00 a	0.00 a	0.24 a	0.00 a	0.00 a	12.41 b	0.01 a
Cirripedia Larva**	0.42 b	0.01 a	0.01 a	0.01 a	0.00 a	0.05 a	0.00 a	0.00 a	0.01 a	0.04 a
Caridea Larva***	0.31 a	2.64 a	0.34 a	3.15 a	0.72 a	13.77 b	0.62 a	1.89 a	18.73 b	2.69 a
Brachyura Larva***	4.84 a	5.70 a	1.60 a	7.63 a	6.18 a	12.27 a	4.65 a	10.88 a	56.89 b	17.66 a
Megalopa Brachyura Larva**	0.00 a	0.00 a	0.32 b	0.02 a	0.00 a	0.00 a	0.01 a	0.02 a	0.08 a	0.00 a
Ascidiacea Larva***	0.02 a	0.08 a	0.00 a	0.10 a	0.00 a	0.29 ab	0.01 a	0.68 bc	0.79 c	0.02 a
*Thalia sp.***	0.01 a	0.00 a	0.00 a	0.00 a	0.00 a	0.02 a	0.00 a	0.00 a	2.05 b	0.05 a

Significance: *p<0.05, **p<0.01, ***p<0.001

APPENDIX D. SPECIES CORRELATION RESULTS

Table 9a. Correlation analysis for plankton tows in 2018.

	NEM	UNEPH	CCEPH	RAT	PLEUR	PHOX	MEL	COR	IDOP	IDOB	COPE	HARP	FEGG	FL	SHRL	CRL	HYD	PYCNO	POLY	NEMA
CC		0.237**	0.308***																	
TTOP					0.504***															
BOUG	0.431***													0.507***		0.162*				
OBELIA											0.262**			0.172*						
AEQ				0.259**																0.245**
NEM											0.305***			0.411***						
RATH											0.217**					0.564***				0.970***
PLEUR														0.181*						
ML									0.170*											
AORID						0.161*	0.919***		0.257**				0.439***		0.367***			0.294***	0.220**	
PHOX								0.350***							0.435***		0.227**			
MEL									0.278***				0.267***					0.320***	0.187*	
AMPTH									0.311***											
CAPREL											0.263**		0.290***							
ERICH									0.252**	0.16911*										
IDOBAL												0.385***	0.284***		0.199*	0.199*				
COPE														0.227**		0.425***				0.281***
HARP													0.430***		0.281***	0.463***				
FEGG															0.491***	0.390***				
SHRL																0.347***				
CRL																				0.555***

Significance: *p<0.05, **p<0.01, ***p<0.001

(Abbreviations: CC = *C. chesapeakei*, TTOP = *Turritopsis sp.*, BOUG = *Bougainvillia sp.*, OBELIA = *Obelia sp.*, AEQ = *Aequora sp.,* NEM = *Nemopsis sp.*, UNEPH = Unidentified ephyrae, CCEPH = *C. chesapeakei* ephyrae, RATH = *Rathkea sp.*, PLEUR = *Pleurobrachia pileus*, ML = *M. leidyi*, AORID = Aoridae, PHOX = Phoxocephalidae, MEL = Melitidae, COR = Corophidae, AMPH = Amphithoidae, CAPREL = Caprellidae, ERICH = *Erisconella sp.*, IDOP = *Idotea* phosphorea, IDOBAL = *Idotea Baltica*, COPE = Calanoida, HARP = Harpacticoida, FEGG = Fish Egg, FL = Fish Larva, SHRL = Caridea Larva, CRL = Brachyura Larva, HYD = *Hydrobia sp.*, PYCNO = Pycnogonida, POLY = Polychaeta, NEMA = Nematoda)

Table 9b. Correlation analysis for plankton tows in 2019.

	TTOP	NEM	PLEUR	CCEPH	COPE	HARP	OSTRO	FEGG	FL	SHRL	CRL	MEGA	MYSID	POLY	ASCLARV
ML	0.275***														
CC				0.894***								0.483***			
TTOP			0.152*												
BOUG		0.193**			0.621***								0.168*		
OBELIA							0.897***		0.750***	0.534***			0.613***		0.395***
NEM					0.138*			0.371***							
CCEPH												0.453***			
AMP						0.158*						0.188**		0.549***	
COPE											0.138*		0.257***		
HARP									0.274***	0.389***				0.302***	
OSTRO									0.759***	0.661***			0.570***		0.367***
FEGG									0.209**	0.200**					
FL										0.720***			0.535***		0.466***
SHRL													0.364***		0.382***
CRL															0.340***
MEGA														0.469***	
MYSID															0.282***

Significance: *p<0.05, **p<0.01, ***p<0.001

(Abbreviations: ML = *M. leidyi*, CC = *C. chesapeakei*, TTOP = *Turritopsis sp.*, BOUG = *Bougainvillia sp.*, OBELIA = *Obelia sp.*, NEM = *Nemopsis sp.*, CCEPH = *C. chesapeakei* ephyrae, , COR = Corophidae, AMP = Ampeliscidae, COPE = Calanoida, HARP = Harpacticoida, OSTRO = Ostracoda, FEGG = Fish Egg, FL = Fish Larva, SHRL = Caridea Larva, CRL = Brachyura Larva, MEGA = Megalopa Brachyura Larva, MYSID = Mysida, POLY = Polychaeta, ASCLARV = Ascidiacea Larva)

APPENDIX E. ORGANISM DENSITY TABLES

Table 10a. Average density ± standard deviation for every taxonomic group at each sampling site on 6-14-2018.

Site Name	TRW	DCE	SB	OCM	OCR9	DCW	FRL	FRE	FRW	FRR9
Unidentified Hydrozoans	0±0	0±0	0±0	0±0	0±0	0.232±0.263	0.148±0.256	0±0	0±0	0.153±0.265
Bougainvillia sp.	0±0	0±0	0.619±1.071	0.196±0.224	0±0	0.411±0.37	0±0	0.108±0.094	0±0	0±0
Obelia sp.	0±0	0.05±0.087	0±0	0.05±0.086	0±0	0.057±0.1	0±0	0.108±0.094	0.347±0.352	0.211±0.245
Aequora sp.	0±0	0±0	0±0	0±0	0±0	0.115±0.1	0±0	0±0	0±0	0±0
Clytia sp.	0±0	0.042±0.073	0±0	0±0	0±0	0±0	0±0	0±0	0.038±0.065	0±0
Nemopsis spp.	0±0	0.084±0.146	2.046±0.958	0.44±0.761	0.228±0.076	0.517±0.896	0±0	0.597±0.359	0±0	0.051±0.088
Rathkea sp.	0±0	0±0	0±0	0±0	0±0	0.172±0.299	0±0	0±0	0±0	0±0
Mnemiopsis leidyi	0.042±0.073	1.077±0.81	0±0	0.147±0.147	0±0	0.993±0.227	1.389±0.829	5.021±3.047	0.187±0.162	0.102±0.176
Unidentified Ephyra	0±0	0.042±0.073	0.264±0.174	0.049±0.085	0±0	0.115±0.199	11.841±8.225	0.056±0.096	0.047±0.081	0±0
Unidentified Hydroids	0±0	0±0	0±0	0±0	0±0	0.119±0.207	0±0	0±0	0.075±0.131	0.051±0.088
***Bougainvillia sp.* Hydroids**	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.047±0.081	0±0
***Clytia sp.* Hydroid**	0±0	0±0	0±0	0±0	0±0	0.06±0.103	0±0	0±0	0±0	0±0
Aoridae	0±0	0.421±0.385	0±0	0.05±0.086	0.184±0.216	0.057±0.1	0±0	0.161±0.158	0±0	0.053±0.092
Ampeliscidae	0±0	0.042±0.073	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Melitidae	0.094±0.163	0.177±0.191	0.052±0.089	0.098±0.169	0.234±0.215	0.347±0.455	0±0	0.161±0.158	0±0	0.051±0.088
Corophiidae	0±0	0.042±0.073	0±0	0.098±0.169	0.612±1.059	0±0	0±0	0±0	0±0	0.051±0.088
Caprellidae	0.094±0.163	10.024±2.147	0±0	0.981±1.078	0.899±0.647	0.287±0.263	0±0	0±0	0±0	0.259±0.235
Amphipoda (Total)	0.188±0.326	10.706±2.35	0.052±0.089	1.227±1.382	1.93±1.393	0.692±0.749	0±0	0.322±0.011	0±0	0.414±0.236
Erichsonella sp.	0±0	0.084±0.073	0±0	0.098±0.169	0.091±0.079	0±0	0±0	0.053±0.091	0±0	0.204±0.353
Idotea phosphorea	0±0	0±0	0.052±0.089	0.147±0.147	0.656±0.708	0±0	0±0	0.161±0.158	0±0	0±0
Idotea balthica	0±0	0.169±0.292	0.052±0.089	0.05±0.086	0.349±0.605	0.06±0.103	0±0	0.053±0.091	0.094±0.162	0±0
Sygnathus fuscus	0±0	0.042±0.073	0±0	0.05±0.086	0±0	0.06±0.103	0±0	0.105±0.182	0±0	0±0
Anchoa mitchilli	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.051±0.088
Unidentified Fish	0±0	0±0	0±0	0±0	0.094±0.162	0±0	0±0	0±0	0±0	0±0
Fish (Total)	0±0	0.042±0.073	0±0	0.05±0.086	0.094±0.162	0.06±0.103	0±0	0.105±0.182	0±0	0.051±0.088
Anguilla rostrata	0±0	0±0	0.052±0.089	0±0	0±0	0±0	0±0	0±0	0±0	0±0
***Sygnathus fuscus* Larva**	0±0	0.101±0.175	0±0	0±0	0±0	0±0	0±0	0.053±0.091	0±0	0±0
***Menidia* Larva**	0.047±0.082	0.05±0.087	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0
***Sphoeroides maculatus* Larva**	0±0	0±0	0±0	0±0	0±0	0.06±0.103	0±0	0±0	0±0	0±0
Unidentified Fish Larva	0.126±0.126	0.235±0.227	0.825±1.297	0.394±0.225	0.044±0.076	0.115±0.1	0.125±0.216	0.535±0.396	0.281±0.372	0±0
Fish Larva (Total)	0.173±0.069	0.387±0.468	0.825±1.297	0.394±0.225	0.044±0.076	0.175±0.004	0.125±0.216	0.588±0.324	0.281±0.372	0±0
Fish Eggs	0.278±0.377	8.204±10.718	0.103±0.179	0.247±0.228	0.087±0.151	3.121±1.501	3.222±1.523	0±0	0.414±0.363	0.359±0.351
Snail eggs	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.051±0.088
Unidentified Egg Sack	0±0	0±0	0±0	0±0	0±0	0.23±0.398	0±0	0±0	0±0	0±0
Calanoida	56.911±36.693	225.727±215.802	31.106±15.895	139.096±64.203	14.66±8.138	242.799±127.261	15.354±5.186	529.091±499.187	215.687±73.032	57.112±15.8
Harpacticoida	0±0	0.421±0.73	0.103±0.179	0.147±0.254	0±0	0.637±0.256	0±0	0±0	0±0	0±0

Siphonostomatoida	0±0	0.05±0.087	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Tanaidacea	0±0	0±0	0±0	0.147±0.254	0±0	0±0	0±0	0±0	0±0	0±0
Cyathura sp.	0±0	0±0	0±0	0±0	0.047±0.081	0±0	0±0	0±0	0±0	0±0
Evadne sp.	0.094±0.163	0.202±0.349	0±0	0±0	0±0	0.057±0.1	0±0	0±0	0±0	0±0
Ostracoda	0±0	0.042±0.073	0±0	0±0	0.044±0.076	0.115±0.199	0±0	0±0	0±0	0±0
Cirripedia	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.105±0.182	0±0	0±0
Cirripedia Larva	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.056±0.096	0±0	0±0
Caridea Larva	0.478±0.047	11.137±7.908	0.412±0.472	6.488±5.343	0.141±0.141	6.822±6.797	0.936±0.962	11.039±3.898	1.669±1.37	0.896±1.033
Brachyura Larva	2.479±1.927	21.206±15.184	0.333±0.345	25.188±12.028	8.307±7.223	74.839±35.424	0.509±0.398	32.274±9.455	4.084±1.06	25.219±13.244
Squillidae	0±0	0.169±0.193	0±0	0.049±0.085	0.047±0.081	0±0	0±0	0.266±0.327	0.047±0.081	0±0
Palaemonetes sp.	0±0	0.126±0.219	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Callinectes sapidus	0±0	0±0	0±0	0.049±0.085	0.047±0.081	0±0	0±0	0±0	0±0	0±0
Upogebia affinis	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.153±0.265
Gemma	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.053±0.091	0±0	0±0
Crepidula fornicata	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.056±0.096	0±0	0±0
Hydrobia sp.	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.051±0.088
Diptera Larva	0±0	0±0	0±0	0±0	0±0	0.057±0.1	0±0	0±0	0±0	0±0
Diptera	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.051±0.088
Pycnogonida	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.105±0.182	0±0	0±0
Polychaeta	0±0	0.093±0.081	0±0	0.147±0.254	2.482±2.261	0.06±0.103	0±0	0.319±0.153	0±0	0.211±0.245
Nematoda	0±0	0.05±0.087	0±0	0.05±0.086	0±0	1.379±2.388	0±0	0.056±0.096	0±0	0±0
Ascidiacea	0±0	0±0	0±0	0.098±0.169	0±0	0±0	0±0	0±0	0±0	0±0
Ascidiacea Larva	0±0	0.252±0.437	0±0	0±0	0.047±0.081	0±0	0±0	0.105±0.182	0±0	0±0

Table 10b. Average density ± standard deviation for every taxonomic group at each sampling site on 6-26-2018.

Site Name	TRW	DCE	FRR9	OCM	SB	OCR9	DCW	FRE	FRW	FRL
Unidentified Hydrozoans	0±0	0±0	0±0	0±0	0±0	0.046±0.08	0±0	0±0	0±0	0±0
Chrysaora chesapeakei	0.047±0.082	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	1.206±1.471
Bougainvillia sp.	0.046±0.08	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Obelia sp.	0±0	0±0	0±0	0±0	0±0	0±0	0.056±0.096	0±0	0±0	0±0
Aequora sp.	0±0	0.05±0.086	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Nemopsis spp.	0.236±0.295	0±0	0±0	0±0	0±0	0.046±0.08	0±0	0±0	0.098±0.17	0±0
Mnemiopsis leidyi	0.047±0.082	2.573±1.843	0.085±0.073	0.229±0.198	0±0	0.046±0.08	0±0	1.092±1.336	0±0	0.309±0.268
Unidentified Ephyra	0.331±0.357	0.106±0.092	0.217±0.262	0±0	0.058±0.1	0.049±0.085	0.278±0.481	0±0	0±0	8.441±11.775
***Bougainvillia sp.* Hydroids**	0±0	0.397±0.688	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Halecium muricatum	0±0	0±0	0±0	0±0	0±0	0±0	0.167±0.289	0±0	0±0	0±0
Aoridae	0±0	0±0	0.042±0.073	0±0	0.05±0.087	0.049±0.085	0.111±0.192	0.055±0.096	6.698±9.233	0±0
Melitidae	0±0	0.05±0.086	0±0	0.229±0.397	0±0	0.231±0.401	0±0	0.155±0.268	21.47±23.16	0.052±0.089
Amphithoidae	0±0	0±0	0±0	0.573±0.992	0±0	0.049±0.085	0±0	0.276±0.478	0.485±0.716	0±0
Corophiidae	0.047±0.082	0±0	0.048±0.083	0.172±0.298	0±0	2.081±1.908	0±0	0.103±0.179	0±0	0±0

Gammaridae	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	1.308±2.265	0±0
Caprellidae	0.094±0.081	0±0	0.187±0.222	0.172±0.298	0±0	0.62±0.546	0.16±0.277	0.103±0.179	0.677±0.178	0.112±0.193
Amphipoda (Total)	0.141±0.142	0.05±0.086	0.277±0.289	1.145±1.559	0.05±0.087	3.031±2.724	0.271±0.246	0.693±0.602	30.637±30.913	0.163±0.167
Erichsonella sp.	0±0	0.113±0.195	0.096±0.167	0±0	0±0	0.046±0.08	0.271±0.246	0.103±0.089	0.236±0.291	0±0
Idotea phosphorea	0±0	10.179±14.764	0.769±1.333	4.353±7.097	0.108±0.094	0±0	0.111±0.192	0.6±0.787	6.474±1.396	0.052±0.089
Idotea balthica	0±0	0±0	0.296±0.264	0.229±0.397	0.058±0.1	0.231±0.289	0.215±0.243	0.517±0.895	0±0	0±0
Sphaeromatidae spp.	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.056±0.097
Cassidinidae ovalis	0±0	0±0	0±0	0±0	0±0	0.098±0.17	0±0	0±0	0±0	0±0
Strongylura marina	0±0	0±0	0±0	0.057±0.099	0±0	0±0	0±0	0±0	0±0	0±0
Unidentified Fish	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.374±0.647	0±0
Fish (Total)	0±0	0±0	0±0	0.057±0.099	0±0	0±0	0±0	0±0	0.374±0.647	0±0
***Menidia* Larva**	0±0	0±0	0±0	0±0	0±0	0.049±0.085	0±0	0±0	0±0	0±0
***Gobiosoma bosc* Larva**	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.056±0.097
Unidentified Fish Larva	0.094±0.081	0.106±0.092	0.169±0.293	0±0	0.556±0.275	0.095±0.083	0.273±0.253	0.207±0.358	0.049±0.085	0±0
Fish Larva (Total)	0.094±0.081	0.106±0.092	0.169±0.293	0±0	0.556±0.275	0.144±0.147	0.273±0.253	0.207±0.358	0.049±0.085	0.056±0.097
Fish Eggs	2.059±0.822	1.196±1.126	0.85±0.516	1.318±0.359	6.311±3.61	0.329±0.348	2.232±0.838	0.052±0.089	8.133±7.195	0±0
Unidentified Egg Sack	0±0	0±0	0.048±0.083	0±0	0±0	0.046±0.08	0±0	0.155±0.268	0±0	0±0
Calanoida	174.506±121.302	40.947±19.54	1.798±1.787	2.062±2.7	11.148±8.944	13.848±2.414	11.351±5.993	14.168±11.204	1.139±0.966	2.395±2.278
Harpacticoida	0±0	0±0	0±0	0±0	0±0	0.278±0.481	0±0	0±0	0.294±0.389	0±0
Evadne sp.	0.095±0.164	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Diastylis sp.	0±0	0±0	0.048±0.083	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Penilia avirostris	0±0	0±0	0±0	0±0	0±0	0.046±0.08	0±0	0±0	0±0	0±0
Cirripedia	0±0	0±0	0±0	0.057±0.099	0±0	0±0	0±0	0±0	0±0	0±0
Cirripedia Larva	0.14±0.139	0.05±0.086	0±0	0±0	0±0	0±0	0.278±0.481	0±0	0±0	0.056±0.097
Leucon americanus	0±0	0±0	0±0	0±0	0±0	0.049±0.085	0±0	0±0	0±0	0±0
Caridea Larva	0.282±0.284	14.265±1.921	0.127±0.22	0.172±0.172	3.136±2.263	1.157±1.348	2.095±2.474	9.168±2.706	1.323±1.256	0.326±0.335
Brachyura Larva	1.699±1.131	29.554±17.378	1.889±2.64	0.63±0.603	11.986±16.168	3.452±2.838	9.506±4.977	6.621±2.699	2.352±2.219	0.537±0.466
Squillidae	0±0	0.225±0.391	0±0	0±0	0.637±1.103	0±0	0±0	0±0	0±0	0±0
Upogebia affinis	0±0	0±0	0.048±0.083	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Gastropod Larva	0±0	0±0	0±0	0±0	0±0	0±0	0.611±1.059	0±0	0±0	0±0
Crepidula fornicata	0±0	0.05±0.086	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Nudibranchia	0±0	0±0	0.048±0.083	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Pycnogonida	0±0	0±0	0±0	0.057±0.099	0±0	0.049±0.085	0±0	0±0	0.098±0.17	0±0
Polychaeta	0.33±0.218	0.099±0.172	0±0	0±0	0±0	0.324±0.561	0±0	0.207±0.237	0.539±0.594	0±0
Nematoda	0.236±0.41	0±0	0±0	0±0	0±0	0.185±0.321	0.053±0.092	0±0	0.098±0.17	0±0
Myrianida sp.	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.155±0.268	0±0	0±0
Zoothamnium sp.	0±0	0±0	0±0	0±0	0±0	0.879±1.523	0±0	0±0	0±0	0±0

Table 10c. Average density ± standard deviation for every taxonomic group at each sampling site on 7-9-2018 & 7-10-2018.

Site Name	FRE	DCE	SB	TRW	DCW	FRR9	FRL	FRW	OCM	OCR9
Unidentified Hydrozoans	0.06±0.104	0±0	0.059±0.102	0±0	0.067±0.116	0±0	0.063±0.108	0±0	0.051±0.088	0.052±0.09
Chrysaora chesapeakei	0±0	0±0	0±0	0±0	0±0	0±0	2.697±4.018	0±0	0±0	0±0
Turritopsis sp.	0.06±0.104	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Bougainvillia sp.	0±0	0±0	0.306±0.53	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Obelia sp.	0±0	0±0	0±0	0±0	0.067±0.116	0±0	0±0	0±0	0±0	0±0
Clytia sp.	0±0	0±0	0±0	0±0	0±0	0.049±0.084	0±0	0±0	0±0	0±0
Nemopsis spp.	0.105±0.181	0±0	0.181±0.184	0±0	0.067±0.116	0±0	0±0	0±0	0±0	0.115±0.101
Mnemiopsis leidyi	0.466±0.132	0.194±0.223	2.799±1.499	0.058±0.101	0.268±0.232	1.237±1.352	0±0	3.135±0.542	0.28±0.117	0.396±0.214
***C. chesapeakei* Ephyra**	0±0	0±0	0±0	0±0	0±0	0.146±0.253	39.08±44.561	0±0	0±0	0±0
Unidentified Ephyra	0±0	0±0	0±0	0.058±0.101	0±0	0±0	21.32±36.928	0±0	0±0	0.314±0.544
Aoridae	2.53±3.627	1.925±3.208	0±0	0±0	0.202±0.349	0±0	0.065±0.112	0±0	0.203±0.352	0.333±0.313
Phoxocephalidae	0±0	0.152±0.263	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.156±0.156
Melitidae	0.301±0.522	2.991±5.181	0±0	0±0	0.067±0.116	0.275±0.476	0±0	0±0	0.203±0.352	0.104±0.09
Amphithoidae	0.209±0.362	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.356±0.616	0.156±0.269
Corophiidae	0.12±0.209	0.406±0.703	0±0	0±0	0.067±0.116	0±0	0±0	0±0	0±0	1.607±1.394
Gammaridae	0.06±0.104	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Caprellidae	0.06±0.104	0±0	0±0	0±0	0.537±0.583	0±0	0±0	0±0	0.102±0.176	0.166±0.157
Amphipoda (Total)	3.281±3.764	5.474±9.355	0±0	0±0	0.873±0.996	0.275±0.476	0.065±0.112	0±0	0.864±1.496	2.521±1.738
Erichsonella sp.	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.064±0.111	0±0
Idotea phosphorea	1.92±1.704	0.704±0.868	0±0	0.138±0.239	0.201±0.201	0.117±0.106	0.065±0.112	0±0	0.191±0.332	0±0
Idotea balthica	0.482±0.835	0.194±0.337	0±0	0±0	0±0	0±0	0±0	0±0	0.203±0.233	0.063±0.109
Anchoa mitchilli	0±0	0±0	0±0	0.058±0.101	0±0	0±0	0±0	0±0	0±0	0±0
Peprilus triacanthus	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.051±0.088	0±0
Fish (Total)	0±0	0±0	0±0	0.058±0.101	0±0	0±0	0±0	0±0	0.051±0.088	0±0
***Menidia* Larva**	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.051±0.088	0±0
***Peprilus triacanthus* Larva**	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.051±0.088	0±0
Unidentified Fish Larva	0.181±0.313	0.097±0.168	0.061±0.106	0.127±0.111	0.134±0.232	0.069±0.119	0±0	0.074±0.129	0.102±0.088	0.052±0.09
Fish Larva (Total)	0.181±0.313	0.097±0.168	0.061±0.106	0.127±0.111	0.134±0.232	0.069±0.119	0±0	0.074±0.129	0.203±0.176	0.052±0.09
Fish Eggs	19.394±16.935	0.687±0.416	5.876±1.772	0.174±0.174	2.282±1.878	1.782±0.308	0±0	0.737±0.784	1.387±0.328	1.924±0.545
Calanoida	11.624±10.116	30.35±24.236	106.14±102.42	3.941±2.288	131.582±95.852	103.725±98.235	9.426±3.547	2.95±3.063	19.662±3.966	91.16±23.273
Harpacticoida	1.265±2.191	0.389±0.673	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Ostracoda	0±0	0±0	0±0	0±0	0±0	0.137±0.238	0±0	0±0	0±0	0±0
Caridea Larva	69.497±60.086	73.229±103.357	0.673±0.868	0.196±0.208	2.816±1.129	2.008±1.035	0.063±0.108	0.514±0.461	1.693±0.693	1.184±0.486
Brachyura Larva	35.716±39.225	18.03±4.05	1.827±2.577	1.459±1.234	7.036±4.798	4.219±1.535	0.19±0.188	0.435±0.572	8.009±3.564	7.168±1.516
Hippolyte sp.	0±0	0±0	0±0	0±0	0.067±0.116	0±0	0±0	0±0	0±0	0±0
Upogebia affinis	0±0	0±0	0±0	0±0	0±0	0.292±0.506	0±0	0±0	0.051±0.088	0±0
Limulidae Larva	0.06±0.104	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Nudibranchia	0±0	0±0	0±0	0±0	0±0	0.069±0.119	0±0	0±0	0±0	0±0
Polychaeta	0.301±0.522	0.051±0.088	0±0	0±0	0±0	0.069±0.119	0±0	0±0	0.574±0.995	0±0

Nematoda	0±0	0±0	0±0	0±0	0.067±0.116	0±0	0±0	0±0	0±0	0±0
Ascidiacea Larva	0±0	0.254±0.439	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0

Table 10d. Average density ± standard deviation for every taxonomic group at each sampling site on 8-9-2018.

Site Name	SB	FRL	FRR9	FRW	FRE	TRW	DCE	DCW	OCR9	OCM
Unidentified Hydrozoans	0±0	0±0	0.104±0.18	0.364±0.631	1.05±1.176	0±0	0±0	0.053±0.091	0±0	0.068±0.118
Chrysaora chesapeakei	0.056±0.097	0.163±0.024	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Turritopsis sp.	0±0	0±0	0±0	0±0	0.191±0.332	0±0	0.235±0.406	0.053±0.091	0±0	0±0
Obelia sp.	0±0	0±0	0±0	0±0	0.119±0.104	0±0	0±0	0.053±0.091	0±0	0±0
Aequora sp.	0±0	0±0	0±0	0.056±0.097	0±0	0±0	0±0	0.264±0.242	0±0	0±0
Sea Anemone (Actiniara)	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.063±0.108	0±0
Mnemiopsis leidyi	4.44±2.517	0±0	0.652±0.4	0.762±0.94	0.468±0.124	0.052±0.09	0.578±0.08	0.398±0.396	0.827±0.229	1.185±0.831
Unidentified Ephyra	0±0	0.113±0.1	0±0	0.073±0.126	0±0	0±0	0±0	0±0	0±0	0±0
Aoridae	0±0	0.05±0.086	0.052±0.09	0±0	0.34±0.434	0±0	0±0	0±0	0±0	0±0
Melitidae	0±0	0±0	0±0	0±0	0.166±0.287	0±0	0±0	0±0	0±0	0±0
Lillibjordae	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.046±0.079	0.068±0.118
Amphithoidae	0±0	0±0	0±0	0±0	0.174±0.015	0±0	0±0	0±0	0±0	0±0
Corophiidae	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.046±0.079	0±0
Caprellidae	0±0	0.05±0.086	0±0	0±0	0.064±0.111	0±0	0±0	0±0	0.063±0.108	0±0
Amphipoda (Total)	0±0	0.099±0.172	0.052±0.09	0±0	0.744±0.222	0±0	0±0	0±0	0.154±0.14	0.068±0.118
Idotea phosphorea	0±0	0±0	0.052±0.09	0±0	0.128±0.221	0±0	0±0	0±0	0±0	0±0
***Gobiosoma bosc* Larva**	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.053±0.091	0.063±0.108	0±0
***Anchoa mitchilli* Larva**	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.053±0.091	0±0	0±0
Unidentified Fish Larva	0±0	0±0	0±0	0±0	0±0	0.234±0.206	0±0	0.045±0.078	0.063±0.108	0±0
Fish Larva (Total)	0±0	0±0	0±0	0±0	0±0	0.234±0.206	0±0	0.15±0.159	0.125±0.217	0±0
Fish Eggs	0±0	0±0	0±0	0.146±0.252	0.497±0.497	0.065±0.113	0±0	0±0	0.376±0.651	0±0
Calanoida	0.051±0.088	0.771±0.749	0.165±0.157	0.947±1.455	0.468±0.265	1.471±1.335	0.176±0.305	0.105±0.183	3.254±2.833	6.534±8.027
Harpacticoida	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.135±0.233	0.228±0.396	0.05±0.086
Tanaidacea	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.493±0.855	0±0	0±0
Unidentified Cladoceran	0±0	0.064±0.11	0±0	0±0	0±0	0.065±0.113	0±0	0±0	0±0	0±0
Ostracoda	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.05±0.086
Caridea Larva	0±0	0±0	0±0	12.822±13.609	4.121±0.296	0±0	0.411±0.711	0.398±0.396	0.25±0.434	1.874±1.51
Brachyura Larva	8.211±3.964	0.248±0.429	9.268±9.697	4.927±8.533	12.403±7.097	3.385±3.696	1.634±1.885	0.264±0.242	8.339±0.922	6.26±4.882
Squillidae	0±0	0±0	0±0	0±0	0.064±0.111	0±0	0±0	0±0	0±0	0±0
Bittium sp.	0±0	0±0	0±0	0±0	0.055±0.096	0±0	0±0	0±0	0±0	0±0
Pycnogonida	0±0	0±0	0±0	0±0	0.055±0.096	0.13±0.113	0±0	0±0	0±0	0±0
Polychaeta	0±0	0±0	0±0	0±0	0.349±0.333	0±0	0±0	0±0	0±0	0±0

Table 10e. Average density ± standard deviation for every taxonomic group at each sampling site on 8-23-2018.

Site Name	OCR9	FRR9	FRE	FRW	FRL	TRW	DCW	DCE	SB	OCM
Unidentified Hydrozoans	0.101±0.175	0±0	0.062±0.107	0.542±0.779	0±0	0±0	0.335±0.419	0±0	0.157±0.271	0.048±0.083
Turritopsis sp.	0±0	0.19±0.186	0±0	0.366±0.359	0±0	0±0	0.067±0.116	0±0	0.207±0.24	0±0
Obelia sp.	0.051±0.088	0±0	0.062±0.107	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Mnemiopsis leidyi	0.105±0.091	0.268±0.232	0.886±0.614	0.12±0.207	0.22±0.252	0±0	0.67±0.232	0.247±0.126	0±0	0.581±0.667
Pleurobrachia pileus	0±0	0±0	0±0	0.06±0.104	0±0	0±0	0±0	0±0	0±0	0±0
***C. chesapeakei* Ephyra**	0.053±0.091	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Unidentified Hydroids	0±0	0±0	0±0	0±0	0±0	0±0	0.067±0.116	0±0	0±0	0±0
Aoridae	0±0	0±0	0.169±0.293	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Phoxocephalidae	0±0	0±0	0.042±0.073	0±0	0±0	0±0	0±0	0±0	0±0	0.145±0.25
Melitidae	0.105±0.091	0±0	0.166±0.034	0±0	0±0	0.054±0.093	0±0	0±0	0±0	0.062±0.108
Amphithoidae	0.053±0.091	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Corophiidae	0.105±0.182	0.067±0.116	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Caprellidae	0.105±0.182	0.124±0.214	0±0	0±0	0±0	0.05±0.087	0±0	0±0	0±0	0±0
Amphipoda (Total)	0.368±0.507	0.19±0.186	0.377±0.332	0±0	0±0	0.104±0.09	0±0	0±0	0±0	0.207±0.218
Erichsonella sp.	0±0	0±0	0.123±0.214	0±0	0.06±0.105	0±0	0±0	0±0	0±0	0±0
Unidentified Fish	0±0	0.201±0.348	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Fish (Total)	0±0	0.201±0.348	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Unidentified Fish Larva	0±0	0.268±0.307	0±0	0.478±0.414	0±0	0.05±0.087	0.067±0.116	0.131±0.226	0.052±0.09	0±0
Fish Larva (Total)	0±0	0.268±0.307	0±0	0.478±0.414	0±0	0.05±0.087	0.067±0.116	0.131±0.226	0.052±0.09	0±0
Calanoida	1.774±1.196	2.342±2.257	0.334±0.318	0.665±0.674	0.121±0.209	3.421±5.795	0.134±0.232	0.676±0.438	0.1±0.174	3.084±2.911
Harpacticoida	1.012±1.754	0.134±0.232	0±0	0.06±0.104	0±0	0.101±0.175	0±0	0.116±0.202	0±0	0±0
Evadne sp.	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.058±0.101	0±0	0±0
Unidentified Cladoceran	0±0	0±0	0.123±0.214	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Oxyurostylis smithi	0±0	0±0	0±0	0±0	0±0	0.05±0.087	0±0	0±0	0±0	0±0
Ostracoda	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.327±0.566	0±0	0±0
Cirripedia Larva	0±0	0±0	0±0	0.063±0.11	0±0	0±0	0±0	0.065±0.113	0±0	0.048±0.083
Caridea Larva	0±0	0±0	10.722±7.864	5.022±8.544	0.055±0.095	1.174±1.904	0.134±0.232	0.189±0.197	0.157±0.271	0.062±0.108
Brachyura Larva	19.221±9.898	13.857±4.575	3.035±1.314	2.723±3.345	0.467±0.454	0.659±0.743	0±0	3.75±2.867	0.829±0.638	11.082±8.118
Hydrobia sp.	0.683±0.924	0.134±0.232	0.432±0.747	0±0	0±0	0±0	0±0	0±0	0±0	0.4±0.538
Pycnogonida	0.053±0.091	0.252±0.282	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Polychaeta	0.053±0.091	0±0	0.682±0.277	0.063±0.11	0±0	0±0	0±0	0±0	0±0	0±0
Nematoda	0±0	0±0	0.062±0.107	0±0	0±0	0±0	0±0	0±0	0±0	0±0

Table 11a. Average density ± standard deviation for every taxonomic group at each sampling site on 5-29-2019.

Site Name	OCM	OCR9	FRL	FRR9	FRW	SB	FRE	DCE	DCW
Unidentified Hydrozoans	0.047±0.082	0±0	0±0	0.044±0.076	0.146±0.013	0.053±0.091	0±0	0.328±0.567	0±0
Bougainvillia sp.	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.055±0.095	0±0
Obelia sp.	0±0	0±0	0±0	0±0	0±0	0±0	0±0	1.227±1.718	0±0
Aequora sp.	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.224±0.388	0±0
Nemopsis spp.	0±0	0±0	0±0	0.048±0.084	0.054±0.093	0.106±0.183	0±0	0±0	0±0
C. chesapeakei Ephyra	0±0	0±0	0±0	0±0	0.046±0.08	0±0	0.056±0.098	0±0	0±0
Unidentified Ephyra	0±0	0±0	1.689±0.588	0.946±0.326	0.146±0.139	0±0	0±0	0±0	0.055±0.096
Unidentified Hydroids	0±0	0±0	0±0	0±0	0±0	0±0	0.056±0.098	0±0	0±0
Aoridae	0±0	0±0	0±0	0±0	0±0	0±0	1.916±3.183	0.221±0.192	0±0
Ampeliscidae	0±0	0±0	0±0	0±0	0±0	0±0	0.165±0.007	0.109±0.095	0.208±0.36
Phoxocephalidae	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.448±0.775	0±0
Melitidae	0±0	0±0	0±0	0±0	0±0	0±0	2.005±1.011	1.043±0.405	0.104±0.18
Lillibjordae	0±0	0±0	0±0	0±0	0±0	0±0	0.726±0.842	0.109±0.189	0±0
Amphithoidae	0±0	0±0	0±0	0±0	0.046±0.08	0±0	1.242±1.866	0.164±0.284	0±0
Lysilanissadae	0±0	0±0	0±0	0±0	0±0	0±0	0.056±0.098	0±0	0±0
Corophiidae	0±0	0±0	0±0	0±0	0±0	0±0	0.504±0.345	0.056±0.097	0±0
Gammaridae	0±0	0±0	0.107±0.093	0±0	0±0	0±0	0.791±1.225	0.056±0.097	0±0
Caprellidae	0±0	0±0	0±0	0±0	0±0	0±0	5.105±2.407	1.699±1.107	0.315±0.151
Amphipoda (Total)	0±0	0±0	0.107±0.093	0±0	0.046±0.08	0±0	12.51±7.679	3.905±1.192	0.627±0.558
Erichsonella sp.	0±0	0±0	0±0	0±0	0±0	0±0	0.104±0.181	0±0	0±0
Idotea balthica	0±0	0±0	0±0	0±0	0.046±0.08	0±0	0±0	0.055±0.095	0±0
Sygnathus fuscus	0±0	0±0	0±0	0±0	0.054±0.093	0±0	0.109±0.094	0±0	0±0
Anchoa mitchilli	0±0	0±0	0±0	0±0	0±0	0±0	0.056±0.098	0±0	0±0
Gobiosoma bosc	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.056±0.097	0±0
Fish (Total)	0±0	0±0	0±0	0±0	0.054±0.093	0±0	0.165±0.007	0.056±0.097	0±0
Sygnathus fuscus Larva	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.111±0.096	0±0
Gobiosoma bosc Larva	0.637±0.442	0±0	0±0	0±0	0.146±0.139	0±0	0.056±0.098	0.273±0.25	0.052±0.09
Sphoeroides maculatus Larva	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.055±0.095	0±0
Anchoa mitchilli Larva	0±0	0±0	0±0	0±0	0.108±0.187	0±0	0±0	0.28±0.485	0.104±0.18
Bairdiella chrysoura Larva	0.095±0.165	0.091±0.158	0.05±0.087	0±0	0.092±0.08	0±0	0±0	1.866±0.949	0.156±0.27
Morone americana Larva	0±0	0±0	0±0	0±0	0±0	0±0	0.161±0.157	0.055±0.095	0±0
Unidentified Fish Larva	0±0	0.182±0.316	0±0	0±0	0±0	0.246±0.238	0.5±0.182	1.841±2.627	0.325±0.332
Fish Larva (Total)	0.732±0.605	0.274±0.274	0.05±0.087	0±0	0.347±0.183	0.246±0.238	0.717±0.115	4.48±2.403	0.637±0.313
Fish Eggs	2.007±1.473	2.798±1.563	0±0	15.326±13.241	1.755±1.844	10.286±5.156	8.284±2.965	22.226±1.076	2.148±1.381
Snail eggs	0±0	0±0	0±0	0±0	0.054±0.093	0±0	0.282±0.489	0±0	0±0
Calanoida	53.651±35.751	30.523±37.725	2.123±0.827	58.154±70.437	18.404±5.981	24.922±13.53	161.746±33.351	355.182±163.088	16.747±14.621
Harpacticoida	0±0	0±0	0±0	0±0	0±0	0±0	1.016±1.76	0.819±1.279	0±0
Podon sp.	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.164±0.284	0±0

Evadne sp.	0±0	0±0	0±0	0±0	0±0	0±0	0±0	8.189±14.183	0.052±0.09
Unidentified Cladoceran	0.095±0.165	0±0	0±0	0±0	0±0	0±0	0±0	2.469±3.062	0.052±0.09
Diastylis sp.	0±0	0±0	0.057±0.098	0±0	0±0	0±0	0.052±0.09	0±0	0±0
Ostracoda	0.047±0.082	0.519±0.181	0±0	0.044±0.076	0±0	0±0	0±0	16.602±15.182	0.939±1.214
Cirripedia	0±0	0±0	0±0	0±0	0±0	0±0	0.052±0.09	0±0	0±0
Cirripedia Larva	0.051±0.089	0.046±0.079	0±0	0±0	0.046±0.08	0±0	0±0	1.765±0.371	0.052±0.09
Caridea Larva	1.852±0.463	0.759±1.315	0.107±0.093	0.224±0.149	1.163±0.824	1.354±1.187	6.323±1.813	263.329±53.936	4.824±2.128
Brachyura Larva	6.594±3.697	1.19±0.707	0.214±0.186	0.048±0.084	0.416±0.367	2.324±2.068	4.052±1.313	10.7±2.454	0.523±0.497
Mysida	0±0	0±0	0±0	0.044±0.076	0±0	0.176±0.304	0.339±0.339	1.504±1.898	0.332±0.576
Palaemonetes sp.	0±0	0±0	0±0	0±0	0±0	0±0	0.113±0.196	0.055±0.095	0±0
Littorina sp.	1.377±2.386	0±0	0±0	0±0	0.108±0.187	0±0	3.088±2.684	17.858±8.47	0±0
***Littorina sp.* Larva**	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.312±0.54
Gastropod Larva	0.463±0.802	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Diptera Larva	0±0	0.091±0.158	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Pycnogonida	0±0	0±0	0±0	0±0	0±0	0±0	0.052±0.09	0±0	0±0
Polychaeta	0.051±0.089	0±0	0±0	0±0	0±0	0.053±0.091	1.581±2.593	0.111±0.096	0.104±0.09
Ascidiacea Larva	4.943±0.677	0.046±0.079	0±0	0±0	0.616±0.43	0.044±0.076	0.782±0.406	3.921±1.412	1.067±0.963
Ascidiacea (Juvenile)	0±0	0±0	0±0	0±0	0±0	0±0	0.157±0.271	0±0	0±0
Thalia sp.	0±0	0±0	0±0	0.048±0.084	0±0	0±0	0±0	0±0	0±0

Table 11b. Average density ± standard deviation for every taxonomic group at each sampling site on 6-12-2019.

Site Name	TRW	SB	FRE	FRW	FRR9	FRL	OCR9	OCM	DCE	DCW
Unidentified Hydrozoans	0.314±0.314	0±0	0.319±0.292	0.055±0.095	0±0	0±0	0±0	0.052±0.09	0±0	0±0
Bougainvillia sp.	0±0	0.37±0.251	0.053±0.092	0±0	0.057±0.099	0±0	0±0	0.104±0.18	0±0	0.054±0.093
Obelia sp.	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.259±0.325	0±0	0±0
Nemopsis spp.	0.882±0.394	0.566±0.497	0±0	1.188±0.745	0.057±0.099	0±0	0±0	0.57±0.738	0.179±0.006	0.537±0.465
Rathkea sp.	0±0	0±0	0.128±0.221	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Amphinema dinema	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.052±0.09	0±0	0±0
Mnemiopsis leidyi	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.051±0.089	0.058±0.101	0.054±0.093
***C. chesapeakei* Ephyra**	0±0	0.086±0.149	0±0	0±0	0±0	0.16±0.174	0±0	0.052±0.09	0±0	0±0
Aoridae	0.044±0.076	0.154±0.154	0±0	0.055±0.095	0±0	0.136±0.236	0±0	0±0	0.124±0.215	0±0
Melitidae	0.105±0.181	0.086±0.149	0.181±0.192	0.055±0.095	0±0	0.045±0.079	0.08±0.138	0±0	0.182±0.186	0±0
Amphithoidae	0±0	0±0	0.107±0.185	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Lysilanissadae	0±0	0.043±0.075	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Corophiidae	0±0	0.086±0.149	0±0	0±0	0±0	0±0	0±0	0±0	0.058±0.101	0±0
Gammaridae	0±0	0±0	0.32±0.555	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Caprellidae	0.044±0.076	1.057±0.777	0±0	0±0	0±0	0.045±0.079	0±0	0±0	3.008±1.759	0.161±0.279
Amphipoda (Total)	0.192±0.168	1.427±1.027	0.608±0.747	0.11±0.095	0±0	0.227±0.393	0.08±0.138	0±0	3.373±2.007	0.161±0.279
Erichsonella sp.	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.058±0.101	0±0
Idotea balthica	0±0	0±0	0.053±0.092	0±0	0±0	0±0	0±0	0±0	0.058±0.101	0±0
Politolana concharum	0±0	0±0	0.053±0.092	0.055±0.095	0±0	0±0	0±0	0±0	0.175±0.304	0±0

Sygnathus fuscus	0±0	0±0	0.128±0.11	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Gobiosoma bosc	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.051±0.089	0±0	0±0
Fish (Total)	0±0	0±0	0.128±0.11	0±0	0±0	0±0	0±0	0.051±0.089	0±0	0±0
***Anguilla rostrata* Larva**	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.107±0.186
***Sygnathus fuscus* Larva**	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.052±0.09	0±0	0±0
***Menidia* Larva**	0±0	0±0	0±0	0.055±0.095	0±0	0.512±0.742	0±0	0.41±0.71	0.062±0.107	0.268±0.465
***Gobiosoma bosc* Larva**	0±0	0±0	0.171±0.161	0.055±0.095	0±0	0.287±0.498	0±0	0±0	0.058±0.101	0.054±0.093
***Bairdiella chrysoura* Larva**	0±0	0±0	0.128±0.221	0.055±0.095	0±0	0±0	0±0	0±0	0.241±0.209	0±0
Unidentified Fish Larva	0±0	0.206±0.357	0.053±0.092	0±0	0±0	0±0	0±0	0.104±0.18	0±0	1.708±1.51
Fish Larva (Total)	0±0	0.206±0.357	0.351±0.308	0.165±0.165	0±0	0.799±0.711	0±0	0.566±0.621	0.361±0.313	2.03±0.971
Fish Eggs	0.052±0.091	1.374±0.428	0.331±0.418	4.287±2.633	0.809±0.08	0±0	0.044±0.076	1.55±0.94	1.432±0.048	2.583±1.306
Snail eggs	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.161±0.279
Unidentified Egg Sack	0±0	0.103±0.089	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Calanoida	318.418±38.988	3985.195±1222.858	48.755±18.456	131.675±21	6.404±5.319	3.046±3.035	1.488±0.269	112.902±47.713	559.774±214.194	101.32±77.054
Harpacticoida	0.42±0.396	0±0	0±0	0±0	0±0	0.057±0.1	0±0	0±0	0±0	0±0
Caligus sp.	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.052±0.09	0±0	0±0
Podon sp.	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.058±0.101	0±0
Evadne sp.	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.292±0.507	0±0
Unidentified Cladoceran	0±0	0±0	0±0	0±0	0±0	0.227±0.393	0±0	0±0	0.124±0.215	0±0
Ostracoda	0±0	0±0	0±0	0.055±0.095	0±0	0±0	0±0	0.052±0.09	0.365±0.372	0.161±0.161
Cirripedia	0±0	0±0	0.053±0.092	0±0	0±0	0±0	0±0	0±0	0±0	0.054±0.093
Cirripedia Larva	0.044±0.076	0.051±0.089	0.319±0.552	0.046±0.079	0±0	0±0	0±0	0±0	0±0	0±0
Monstrilla helgolandica	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.052±0.09	0.058±0.101	0±0
Caridea Larva	0.541±0.392	7.736±5.07	5.568±6.845	2.962±1.508	0.749±0.388	0.887±0.67	0.76±0.807	0.724±0.632	20.449±3.94	1.328±0.686
Brachyura Larva	21.584±3.16	9.636±6.741	5.949±5.781	4.653±3.503	0.573±0.842	9.625±2.318	3.48±1.409	2.482±1.908	351.968±102.36	17.462±7.154
Megalopa Brachyura Larva	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.051±0.089	0.354±0.462	0±0
Mysida	0.052±0.091	0.859±0.569	0±0	0±0	1.702±1.62	0.057±0.1	0±0	0.41±0.71	0.303±0.282	0.215±0.246
Mysida Larva	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.877±1.52	0±0
Squillidae	0±0	0.051±0.089	0±0	0.055±0.095	0±0	0.057±0.1	0±0	0±0	0±0	0±0
Littorina sp.	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.052±0.09	0±0	0±0
Gastropod Larva	0±0	0±0	0.064±0.11	0±0	0±0	0±0	0±0	0±0	0±0	0±0
***C. fornicata* Larva**	0±0	0±0	0±0	0.055±0.095	0±0	0±0	0±0	0±0	0±0	0±0
Pycnogonida	0.044±0.076	0.327±0.284	0.064±0.11	0.046±0.079	0±0	0±0	0±0	0.104±0.18	0±0	0±0
Polychaeta	0.105±0.181	0±0	0±0	0.366±0.419	0±0	0±0	0±0	0±0	0.186±0.322	0±0
Nematoda	0±0	1.42±2.46	0±0	0.823±1.425	0±0	0±0	0±0	0±0	0±0	0.054±0.093
Ascidiacea Larva	0±0	0.404±0.433	2.117±2.316	0.585±0.552	0±0	0±0	0±0	5.152±0.352	3.714±1.399	0.054±0.093

Table 11c. Average density ± standard deviation for every taxonomic group at each sampling site on 6-27-2019.

Site Name	TRW	SB	FRW	FRR9	FRL	OCR9	OCM	DCW	DCE	FRE
Unidentified Hydrozoans	0±0	0.29±0.502	0±0	0±0	0±0	0±0	0±0	0±0	0.056±0.096	0±0
Chrysaora chesapeakei	0±0	0±0	0±0	1.587±0.613	0.396±0.562	0±0	0±0	0±0	0±0	0±0
Bougainvillia sp.	0±0	0.05±0.087	0±0	0±0	0±0	0±0	0±0	0.106±0.183	0±0	0±0
Nemopsis spp.	0.328±0.237	0.05±0.087	1.671±1.096	0.586±0.476	0.182±0.315	0.051±0.089	1.205±0.775	0.633±0.837	0.432±0.747	0.257±0.09
Mnemiopsis leidyi	0±0	5.983±4.661	1.74±0.706	3.433±2.335	0±0	0±0	3.665±1.108	0.833±0.558	0.691±0.043	0.129±0.112
***C. chesapeakei* Ephyra**	0±0	0±0	0±0	0.104±0.18	0±0	0±0	0±0	0±0	0±0	0±0
Unidentified Ephyra	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.053±0.091	0±0	0±0
Unidentified Hydroids	0±0	0±0	0±0	0±0	0±0	0.1±0.173	0±0	0±0	0±0	0±0
Aoridae	0±0	0±0	0±0	0±0	0±0	0.484±0.838	0±0	0±0	0.062±0.107	0.06±0.104
Phoxocephalidae	0±0	0±0	0±0	0±0	0±0	0.512±0.886	0±0	0±0	0±0	0±0
Melitidae	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.222±0.385	0±0
Lillibjordae	0±0	0±0	0±0	0±0	0.049±0.086	0±0	0±0	0±0	0.24±0.285	0±0
Amphithoidae	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.185±0.32	0±0
Corophiidae	0±0	0±0	0±0	0±0	0±0	0±0	0.053±0.091	0±0	0.296±0.279	0±0
Gammaridae	0.067±0.116	0±0	0±0	0±0	0±0	0±0	0±0	0±0	1.418±2.456	0±0
Caprellidae	0±0	0.101±0.087	0.364±0.63	0±0	0±0	0±0	0±0	0±0	5.802±8.77	0.627±0.562
Amphipoda (Total)	0.067±0.116	0.101±0.087	0.364±0.63	0±0	0.049±0.086	0.921±0.812	0.053±0.091	0±0	8.225±11.98	0.687±0.665
Erichsonella sp.	0±0	0±0	0.061±0.105	0±0	0±0	0±0	0±0	0.053±0.091	0±0	0±0
Idotea balthica	0±0	0±0	0±0	0±0	0.049±0.086	0±0	0±0	0.053±0.091	0.179±0.185	0.129±0.112
Sygnathus fuscus	0±0	0±0	0.061±0.105	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Fish (Total)	0±0	0±0	0.061±0.105	0±0	0±0	0±0	0±0	0±0	0±0	0±0
***Anguilla rostrata* Larva**	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.053±0.091	0±0	0±0
***Menidia* Larva**	0.067±0.116	0.05±0.087	0±0	0±0	0±0	0±0	0.158±0.273	0.106±0.091	0±0	0±0
***Gobiosoma bosc* Larva**	0±0	0±0	0±0	0±0	0±0	0±0	0.052±0.091	0±0	0±0	0±0
***Anchoa mitchilli* Larva**	0±0	0±0	0.061±0.105	0±0	0±0	0±0	0.314±0.415	0.156±0.158	0±0	0±0
Unidentified Fish Larva	0.067±0.116	0±0	0.061±0.105	0.052±0.09	0±0	0±0	0.105±0.181	0.264±0.329	0±0	0.197±0.014
Fish Larva (Total)	0.134±0.116	0.05±0.087	0.121±0.21	0.052±0.09	0±0	0±0	0.628±0.415	0.525±0.333	0±0	0.197±0.014
Fish Eggs	0.462±0.648	11.741±12.029	48.165±7.212	0±0	0±0	0±0	36.182±4.058	45.628±7.507	2.985±1.736	39.592±1.913
Snail eggs	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.053±0.091	0±0	0±0
Calanoida	114.955±39.721	34.127±19.851	27.985±20.518	5.888±2.023	4.506±0.456	20.205±11.808	63.942±34.962	103.263±82.27	132.85±114.406	27.954±16.567
Harpacticoida	0.121±0.21	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.069±0.119
Caligus sp.	0±0	0±0	0±0	0±0	0.099±0.171	0±0	0.052±0.091	0±0	0±0	0±0
Evadne sp.	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.333±0.577	0±0
Unidentified Cladoceran	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.37±0.641	0±0
Ostracoda	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.053±0.091	1.726±2.99	0.257±0.224
Cirripedia	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.06±0.104
Caridea Larva	0.328±0.237	8.371±3.23	4.885±4.56	0.785±0.258	0.297±0.257	0.365±0.224	2.989±2.597	3.588±1.427	23.089±4.939	3.079±1.233
Brachyura Larva	1.074±0.817	9.183±6.503	39.997±34.443	5.589±3.02	0.677±0.605	0.705±0.226	19.535±2.854	28.816±13.674	10.589±7.437	1.296±0.421
Megalopa Brachyura Larva	0±0	0±0	0±0	0±0	0±0	0±0	0.105±0.182	0±0	0±0	0±0

Mysida	0±0	0±0	0±0	0.052±0.09	0±0	0±0	0±0	0±0	0±0	0±0
Mysida Larva	0±0	0±0	0±0	0±0	0±0	0.051±0.089	0±0	0±0	0±0	0±0
Squillidae	0±0	0.151±0.262	0.061±0.105	0±0	0±0	0±0	0.157±0.157	0.053±0.091	0.062±0.107	0±0
Crepidula fornicata	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.056±0.096	0±0
***C. fornicata* Larva**	0±0	0±0	0.061±0.105	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Doridella sp.	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.062±0.107	0.06±0.104
Pycnogonida	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.069±0.119
Polychaeta	0±0	0±0	0±0	0±0	0±0	0.051±0.089	0±0	0.051±0.087	0.062±0.107	0.06±0.104
Ascidiacea Larva	0.134±0.231	0.116±0.201	0±0	0±0	0±0	0.06±0.105	0.052±0.091	0±0	1.4±2.007	0±0

Table 11d. Average density ± standard deviation for every taxonomic group at each sampling site on 7-9-2019.

Site Name	**TRW**	**SB**	**FRW**	**FRR9**	**FRL**	**OCR9**	**OCM**	**DCW**	**DCE**	**FRE**
Unidentified Hydrozoans	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.365±0.633	0±0
Chrysaora chesapeakei	0±0	0±0	0±0	2.433±2.003	8.242±4.872	0.067±0.116	0±0	0±0	0±0	0.079±0.137
Turritopsis sp.	0±0	0.05±0.086	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Bougainvillia sp.	0±0	0±0	0±0	0.099±0.171	0±0	0±0	0±0	0±0	0±0	0±0
Cyanea sp	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.089±0.154	0±0
Nemopsis spp.	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.089±0.154	0±0
Sea Anemone (Actiniara)	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.054±0.093	0±0	0±0
Mnemiopsis leidyi	0±0	0.57±0.109	3.709±0.626	3.276±2.564	1.53±0.955	0±0	0.843±0.455	0.993±1.102	0±0	10.005±7.261
***C. chesapeakei* Ephyra**	0±0	0±0	0±0	0.099±0.171	1.821±1.988	0±0	0±0	0±0	0±0	0±0
Unidentified Hydroids	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.365±0.633	0±0
***Bougainvillia sp.* Hydroids**	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.177±0.307	0±0
***Sarsia tubulosa* Hydroids**	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.089±0.154	0±0
Aoridae	0.078±0.135	0.05±0.086	0±0	0±0	0±0	0.056±0.096	0±0	0.108±0.186	1.554±2.348	0.173±0.3
Ampeliscidae	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.079±0.137	0±0	0±0
Phoxocephalidae	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.177±0.154	0±0
Melitidae	0±0	0.749±1.048	0±0	0±0	0±0	0±0	0±0	0±0	6.56±6.517	0.607±1.051
Lillibjordae	0±0	0.05±0.086	0±0	0±0	0±0	0±0	0±0	0±0	1.022±0.959	0±0
Amphithoidae	0±0	0.05±0.086	0±0	0±0	0.066±0.114	0.056±0.096	0±0	0±0	1.554±2.11	0.433±0.751
Corophiidae	0±0	0±0	0±0	0±0	0±0	0.056±0.096	0±0	0.079±0.137	0.887±1.536	0.087±0.15
Gammaridae	0.123±0.213	0.299±0.519	0±0	0±0	0.113±0.195	0±0	0±0	0±0	2.086±3.267	0.347±0.601
Caprellidae	0.061±0.106	2.845±4.928	0±0	0±0	0±0	0±0	0±0	0±0	17.899±23.562	0.576±0.296
Calliopius laeviusculus	0±0	0.05±0.086	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Amphipoda (Total)	0.262±0.277	4.093±5.961	0±0	0±0	0.178±0.17	0.167±0.167	0±0	0.266±0.243	127.759±132.012	2.223±3.039
Erichsonella sp.	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.177±0.307	0±0
Idotea balthica	0±0	0.1±0.173	0±0	0±0	0±0	0±0	0±0	0.161±0.161	0.245±0.268	0±0
Cassidinidae ovalis	0.155±0.269	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Sygnathus fuscus	0±0	0±0	0±0	0±0	0±0	0.111±0.096	0±0	0±0	0±0	0±0

Menidia	0±0	0±0	0±0	0±0	0.066±0.114	0±0	0±0	0±0	0±0	0±0
Fish (Total)	0±0	0±0	0±0	0±0	0.066±0.114	0.111±0.096	0±0	0±0	0±0	0±0
Hippocampus sp	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.054±0.093	0±0	0±0
***Menidia* Larva**	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.089±0.154	0±0
***Gobiosoma bosc* Larva**	0.078±0.135	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0
***Anchoa mitchilli* Larva**	0±0	0±0	0.123±0.213	0±0	0±0	0±0	0.065±0.113	0±0	0±0	0±0
Fish Larva (Total)	0.078±0.135	0±0	0.123±0.213	0±0	0±0	0±0	0.065±0.113	0±0	0.365±0.633	0.087±0.15
Fish Eggs	1.423±0.701	8.724±1.035	4.212±1.648	0.099±0.171	0±0	0.178±0.168	23.537±1.183	14.249±4.153	0.887±1.312	1.073±0.93
Calanoida	43.48±20.824	2.433±3.07	5.651±8.566	1.833±2.528	0.93±0.388	3.701±1.52	8.646±8.879	4.192±5.028	1.064±1.407	2.224±1.724
Harpacticoida	0.389±0.673	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.177±0.307	0±0
Caligus sp.	0±0	0.05±0.086	0±0	0±0	0±0	0±0	0±0	0±0	0.089±0.154	0±0
Unidentified Cladoceran	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.443±0.768	0±0
Ostracoda	0±0	1.547±2.68	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Cirripedia	0±0	0.898±1.556	0±0	0±0	0±0	0±0	0±0	0±0	0.089±0.154	0±0
Cirripedia Larva	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.054±0.093	0±0	0±0
Argulus sp.	0±0	0±0	0±0	0±0	0.056±0.098	0±0	0±0	0±0	0±0	0±0
Caridea Larva	0.479±0.252	0.299±0.299	0.845±0.454	1.041±1.177	0.178±0.17	0.769±0.418	0.518±0.228	4.139±1.924	2.175±2.117	1.23±0.657
Brachyura Larva	6.225±2.461	0.223±0.225	0.76±0.555	1.885±2.019	0.169±0.169	0.413±0.084	6.968±11.233	0.586±0.327	0.443±0.406	0.553±0.957
Megalopa Brachyura Larva	0±0	0±0	0±0	0±0	2.582±1.076	0.067±0.116	0±0	0±0	0.177±0.307	0±0
Mysida	0±0	0±0	0±0	0.099±0.171	0±0	0±0	0±0	0±0	0±0	0±0
Mysida Larva	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.177±0.307	0.26±0.45
Gemma	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.975±1.689	0±0
Bivalve Larva	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	4.433±7.678	0±0
Crepidula fornicata	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.266±0.461	0.087±0.15
Doridella sp.	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.068±0.118	0±0
Crassostrea virginica	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.068±0.118	0±0
Polychaeta	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	2.796±2.459	0±0
Nematoda	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.087±0.15
Unidentified Annelid	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.089±0.154	0±0
Ascidiacea Larva	0±0	0.1±0.086	0.214±0.371	0±0	0±0	0±0	0.259±0.299	0.079±0.137	0.621±0.855	0±0
Ascidiacea (Juvenile)	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.266±0.461	0±0

Table 11e. Average density ± standard deviation for every taxonomic group at each sampling site on 7-25-2019.

Site Name	TRW	SB	FRW	FRR9	FRL	OCR9	OCM	DCW	DCE	FRE
Chrysaora chesapeakei	0±0	0±0	0±0	0.871±0.613	0.857±0.487	0±0	0±0	0±0	0±0	0±0
Aurelia sp.	0±0	0±0	0±0	0.057±0.099	0±0	0±0	0±0	0±0	0±0	0±0
Nemopsis spp.	0.062±0.107	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Diadumene lineata	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.123±0.212
Mnemiopsis leidyi	0.114±0.099	1.2±0.286	0.171±0.171	0.057±0.099	0±0	11.09±4.673	0.373±0.403	1.338±2.011	0±0	0.184±0.184

Aoridae	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	4.196±7.086	1.097±1.094
Ampeliscidae	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.07±0.121	0±0
Phoxocephalidae	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.15±0.26	0±0
Melitidae	0±0	0±0	0±0	0±0	0±0	0±0	0.107±0.185	0±0	5.305±5.52	3.419±0.994
Lillibjordae	0.062±0.107	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.075±0.13	0.073±0.126
Amphithoidae	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.675±1.169	0.207±0.22
Lysilanissadae	0.062±0.107	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Corophiidae	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.9±1.191	1.544±1.363
Gammaridae	0±0	0.07±0.121	0±0	0±0	0±0	0±0	0±0	0±0	0.15±0.13	1.479±1.569
Caprellidae	0.185±0.32	0.057±0.098	0±0	0±0	0±0	0±0	0.053±0.092	0±0	21.16±19.071	8.056±1.652
Photidae	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.075±0.13	0±0
Talitridae	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.075±0.13	0.437±0.758
Amphipoda (Total)	0.308±0.534	0.127±0.112	0±0	0±0	0±0	0±0	0.16±0.277	0±0	32.832±32.79	16.313±2.686
Erichsonella sp.	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.825±1.429	0±0
Idotea phosphorea	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.054±0.093	0.825±0.723	0.368±0.486
Idotea balthica	0±0	0±0	0.057±0.099	0±0	0±0	0±0	0±0	0±0	0.29±0.251	1.307±0.215
Strongylura marina	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.061±0.106
Fish (Total)	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.061±0.106
***Anchoa mitchilli* Larva**	0±0	0.057±0.098	0.057±0.099	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Unidentified Fish Larva	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.075±0.13	0±0
Fish Larva (Total)	0±0	0.057±0.098	0.057±0.099	0±0	0±0	0±0	0±0	0±0	0.075±0.13	0±0
Fish Eggs	0±0	6.617±0.324	1.198±1.041	0±0	0±0	0±0	6.568±2.033	5.995±1.586	0.505±0.445	6.134±3.23
Calanoida	2.117±1.203	54.664±45.724	65.424±69.202	3.561±4.787	1.382±1.33	1.116±0.934	4.373±3.845	16.289±13.918	20.395±11.533	37.865±30.06
Harpacticoida	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.075±0.13	0±0
Caligus sp.	0±0	0±0	0±0	0±0	0.055±0.096	0±0	0±0	0±0	0±0	0±0
Tanaidacea	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.123±0.212
Podon sp.	0±0	0±0	0.171±0.296	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Evadne sp.	0±0	0.56±0.971	1.369±1.292	0±0	0±0	0±0	0.646±0.731	0.578±1.001	2.193±2.879	2.084±2.576
Ostracoda	0±0	0.057±0.098	0.057±0.099	0±0	0±0	0±0	0.213±0.37	2.303±3.989	2.55±4.224	0.061±0.106
Cirripedia	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.123±0.212
Caridea Larva	0.104±0.18	2.049±0.881	0.399±0.692	0±0	0.111±0.096	0.155±0.269	0±0	0.236±0.206	10.267±1.246	15.773±9.331
Brachyura Larva	0.941±0.565	1.473±1.32	2.234±1.869	0.636±0.349	0.387±0.533	0.858±0.425	0.32±0.423	0.054±0.093	2.438±1.884	9.054±3.706
Megalopa Brachyura Larva	0±0	0±0	0±0	0±0	0.118±0.204	0.052±0.09	0±0	0.064±0.111	3.035±1.415	0.866±0.475
Mysida Larva	0±0	0.057±0.098	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Monoplacophora	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.061±0.106
Gemma	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.75±1.299	0.061±0.106
Gastropod Larva	0±0	0.057±0.098	0.171±0.296	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Mussel Larva	0±0	0±0	0±0	0±0	0±0	0±0	0.107±0.185	0±0	0±0	0±0
Crepidula fornicata	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.061±0.106
Diptera Larva	0±0	0±0	0±0	0.057±0.099	0±0	0±0	0±0	0±0	0±0	0±0
Pycnogonida	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.075±0.13	0.073±0.126

Polychaeta	0±0	0.057±0.098	0±0	0±0	0±0	0±0	0±0	0±0	3.451±3.279	3.373±0.11
Polychaeta Larva	0±0	0±0	0±0	0±0	0±0	0±0	0.055±0.096	0±0	0±0	0±0
Ascidiacea Larva	0±0	0±0	0.114±0.099	0±0	0±0	0±0	0.164±0.166	0.064±0.111	0.8±0.499	0.756±0.672

Table 11f. Average density ± standard deviation for every taxonomic group at each sampling site on 8-15-2019.

Site Name	FRW	FRR9	FRL	OCR9	OCM	DCW	DCE	FRE	TRW	SB
Unidentified Hydrozoans	0±0	0±0	0±0	0±0	0±0	4.965±4.335	0.057±0.098	0.071±0.123	0±0	0±0
Chrysaora chesapeakei	0±0	1.305±0.589	0.118±0.205	0±0	0±0	0.061±0.105	0±0	0±0	0±0	0±0
Turritopsis sp.	0.167±0.29	0±0	0.064±0.112	0±0	0±0	0.728±1.262	0.057±0.098	0.498±0.863	0±0	0.133±0.231
Nemopsis spp.	0±0	0±0	0±0	0±0	0±0	0.195±0.184	0±0	0±0	0±0	0±0
Mnemiopsis leidyi	0.153±0.169	1.667±0.917	0±0	0±0	0.194±0.337	0.222±0.385	0±0	0.128±0.221	1.691±0.691	1.578±0.338
Pleurobrachia pileus	0±0	0.06±0.104	0.059±0.102	0±0	0±0	0.182±0.315	0.147±0.255	0.66±0.67	0.137±0.119	0±0
Aoridae	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.066±0.114	0±0
Phoxocephalidae	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.066±0.114	0.056±0.097
Melitidae	0.264±0.324	0±0	0±0	0±0	0±0	0.061±0.105	0.13±0.115	0.142±0.246	0±0	0.123±0.107
Corophiidae	0.042±0.072	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.224±0.389
Gammaridae	0.112±0.193	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.072±0.124	0±0
Caprellidae	0.418±0.222	0±0	0±0	0±0	0±0	0±0	0±0	0.128±0.221	0±0	7.771±12.943
Amphipoda (Total)	0.836±0.165	0±0	0±0	0±0	0±0	0.061±0.105	0.13±0.115	0.27±0.235	0.203±0.198	8.174±13.471
Idotea balthica	0.112±0.097	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Hippocampus sp	0±0	0±0	0±0	0±0	0±0	0±0	0.057±0.098	0.071±0.123	0±0	0±0
***Gobiosoma bosc* Larva**	0±0	0±0	0±0	0±0	0±0	0.074±0.128	0±0	0±0	0±0	0±0
Fish Larva (Total)	0±0	0±0	0±0	0±0	0±0	0.074±0.128	0±0	0±0	0±0	0±0
Fish Eggs	0±0	0±0	0±0	0±0	0±0	0±0	0.13±0.115	0.334±0.298	0.532±0.292	1.946±0.21
Snail eggs	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.067±0.115
Calanoida	3.414±1.089	1.598±0.486	0.914±0.358	1.037±1.199	1.855±0.949	2.407±1.974	3.573±1.487	3.535±1.122	2.873±1.811	4.362±3.882
Podon sp.	0±0	0±0	0±0	0±0	0±0	0±0	0.622±0.934	0±0	0±0	0±0
Evadne sp.	0±0	0±0	0±0	0±0	0±0	0±0	98.438±21.077	1.923±1.827	0±0	0±0
Ostracoda	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.066±0.114	0±0
Cirripedia Larva	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	3.165±1.764	0.067±0.115
Caridea Larva	0.195±0.174	0.117±0.102	0±0	0.345±0.174	0.646±0.144	0.344±0.334	5.048±0.401	6.484±3.548	0.197±0.197	0.515±0.574
Brachyura Larva	3.83±2.348	0.771±0.581	0.838±0.528	5.302±4.593	18.005±8.937	2.777±1.635	21.681±1.656	3.312±3.67	0.818±0.369	4.168±4.138
Megalopa Brachyura Larva	0.139±0.127	0±0	0±0	0±0	0±0	0±0	0.073±0.127	0±0	0±0	0±0
Pycnogonida	0±0	0±0	0.059±0.102	0.057±0.099	0±0	0±0	0±0	0±0	0±0	0.112±0.194
Polychaeta	0.042±0.072	0±0	0±0	0±0	0±0	0±0	0.13±0.115	0.285±0.493	0.072±0.124	0.056±0.097
Nematoda	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.071±0.123	0±0	0±0
Ascidiacea Larva	0±0	0±0	0±0	0±0	0±0	0±0	0.113±0.196	0.135±0.117	0±0	0±0
Thalia sp.	0±0	0±0	0±0	0±0	0±0	0.37±0.463	16.372±4.892	0.128±0.221	0.066±0.114	0±0

Table 11g. Average density ± standard deviation for every taxonomic group at each sampling site on 9-13-2019.

Site Name	OCM	OCR9	FRL	FRR9	FRW	SB	FRE	DCE	DCW
Unidentified Hydrozoans	4.496±0.355	0±0	0±0	0±0	2.133±1.422	0±0	6.203±6.108	3.115±5.045	0.945±0.885
Chrysaora chesapeakei	0±0	0±0	0±0	0±0	0±0	0±0	0.341±0.591	0±0	0±0
Turritopsis sp.	0±0	0.043±0.075	0±0	0±0	1.215±2.104	0±0	0±0	0.365±0.482	0±0
Bougainvillia sp.	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.061±0.105	0±0
Obelia sp.	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.13±0.225
Clytia sp.	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.334±0.431	0±0
Nemopsis spp.	0±0	0±0	0±0	0.046±0.08	0±0	0±0	0.171±0.296	1.033±1.79	0±0
Mnemiopsis leidyi	3.708±3.053	2.884±0.987	0.945±0.694	13.54±3.363	23.135±2.606	13.774±6.52	11.698±6.153	5.562±4.827	0.609±0.159
Pleurobrachia pileus	0.065±0.112	0.086±0.149	0±0	0±0	0.061±0.105	0.065±0.113	0±0	0±0	1.039±1.8
Aoridae	0.065±0.112	0±0	0±0	0±0	0.061±0.106	0±0	0±0	0±0	0±0
Ampeliscidae	0±0	0±0	0±0	0±0	0.061±0.105	0±0	0±0	0±0	0±0
Melitidae	0.177±0.17	0±0	0±0	0±0	1.218±0.424	0.196±0.339	0.171±0.296	0.243±0.421	0.103±0.178
Corophiidae	0.056±0.097	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Gammaridae	0±0	0±0	0±0	0±0	0.061±0.106	0.065±0.113	0±0	0±0	0±0
Caprellidae	0.364±0.158	0±0	0.06±0.104	0.046±0.08	0±0	0.364±0.395	0±0	0.122±0.105	0±0
Amphipoda (Total)	0.662±0.319	0±0	0.06±0.104	0.046±0.08	1.401±0.424	0.625±0.274	0.171±0.296	0.365±0.482	0.103±0.178
Erichsonella sp.	0.065±0.112	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Idotea balthica	0.251±0.121	0±0	0±0	0±0	0.183±0.183	0±0	0±0	0±0	0±0
Hippocampus sp	0±0	0±0	0±0	0±0	0.061±0.106	0.065±0.113	0±0	0±0	0±0
Menidia **Larva**	0±0	0.043±0.075	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Gobiosoma bosc **Larva**	0.195±0.195	0.043±0.075	0±0	0±0	0±0	0.196±0.196	0±0	0±0	0.052±0.089
Anchoa mitchilli **Larva**	0±0	0±0	0±0	0±0	0.182±0.316	0±0	0±0	0±0	0±0
Fish Larva (Total)	0.195±0.195	0.086±0.149	0±0	0±0	0.182±0.316	0.196±0.196	0±0	0±0	0.052±0.089
Fish Eggs	0±0	0.043±0.075	0±0	0±0	0±0	0±0	0.085±0.148	0±0	0±0
Calanoida	126.683±14.385	1.514±1.394	1.051±1.03	0.295±0.279	225.976±50.81	171.813±59.752	82.625±87.879	199.207±133.49	97.357±14.311
Harpacticoida	0±0	0±0	0±0	0±0	0±0	0±0	0.171±0.296	0±0	0±0
Caligus sp.	0.113±0.195	0.043±0.075	0±0	0±0	0±0	0.392±0.339	0±0	0±0	0±0
Podon sp.	0.121±0.106	0±0	0±0	0±0	0±0	0±0	0±0	0.061±0.105	0.325±0.563
Evadne sp.	1.467±1.365	0±0	0±0	0±0	0.183±0.183	0±0	0.341±0.591	2.021±1.534	0.921±1.103
Diastylis sp.	0.913±0.454	0±0	0±0	0±0	1.888±0.531	0.672±0.523	0±0	0±0	0±0
Ostracoda	1.614±1.266	0±0	0±0	0±0	0.061±0.106	0±0	0.512±0.677	0.342±0.592	1.234±2.138
Cythermorpha sp.	0±0	0±0	0±0	0±0	0.182±0.316	0±0	0±0	0±0	0±0
Penilia avirostris	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.428±0.498
Cirripedia Larva	0.956±0.867	0.086±0.149	0±0	0±0	0.731±0.002	0±0	0±0	0±0	0.766±1.025
Caridea Larva	1.181±0.326	0.129±0.129	0.047±0.081	0.101±0.088	6.087±2.347	2.994±1.319	2.674±1.965	6.269±2.575	2.78±1.747
Brachyura Larva	1.021±0.831	0.098±0.087	0.306±0.283	0±0	6.641±2.444	9.112±3.028	0.853±1.478	2.88±0.605	0.531±0.123
Megalopa Brachyura Larva	0.195±0.337	0±0	0±0	0±0	0±0	0.131±0.113	0±0	0±0	0.103±0.178
Mysida	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.061±0.105	0.052±0.089
Squillidae	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.065±0.113

Pycnogonida	0.234±0.256	0±0	0±0	0±0	0.427±0.423	0.662±0.296	0.226±0.212	0.061±0.105	0.116±0.103
Polychaeta	0.511±0.416	0±0	0±0	0±0	0.183±0.183	0.438±0.42	0.171±0.296	0±0	0.285±0.155
Nematoda	0.065±0.112	0±0	0±0	0±0	0±0	0±0	0.085±0.148	0±0	0±0
Oligochaeta	0±0	0±0	0±0	0±0	0±0	0.261±0.452	0±0	0±0	0±0
Ascidiacea Larva	0.26±0.45	0±0	0±0	0±0	0.121±0.21	0±0	0.156±0.137	1.011±1.446	0.155±0.268
Ophiuroidea	0.056±0.097	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Porifera	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0.137±0.237	0±0