Megabenthic assemblages in the lower bathyal (700 – 3000 m) on the New England and Corner Rise Seamounts, Northwest Atlantic

Abby E. Lapointe[1], Les Watling[1], Scott C. France[2], Peter J. Auster[3]

[1]Department of Biology, University of Hawaii at Manoa, 216 Edmondson Hall, Honolulu, HI 96822, United States, abbylap@hawaii.edu, watling@hawaii.edu

[2] Department of Biology, University of Louisiana at Lafayette, P.O. Box 42451, Lafayette, LA 70504, United States, scott.france@louisiana.edu

[3] Department of Marine Sciences, University of Connecticut & Mystic Aquarium, 1080 Shennecossett Rd., Groton, CT 06340, United States, peter.auster@uconn.edu

Highlights

The New England and Corner Rise Seamount groups in the Northwest Atlantic do not have similar megabenthic assemblages even though the two are part of the same seamount chain

Megabenthos assemblage composition is correlated with latitude and water depth

Megabenthos assemblages are determined, at the regional scale, by the physical characteristics of the water masses

Abstract

Using a combination of data obtained from high-definition still images, video, and specimens collected during human-occupied submersible and remotely-operated vehicle dives spanning the period 2003 to 2014, we provide the first detailed characterization of the megabenthic assemblages in the lower bathyal on the New England and Corner Rise Seamounts in the Northwest Atlantic. Over all, the New England Seamounts east from Retriever to Nashville have a more diverse megabenthic fauna than Corner Rise, but the lowest diversity was observed on the three seamounts located closest to the continental margin. The megabenthic assemblage structure varies both within and across seamounts, and hierarchical cluster analysis revealed groups dependent on location (as measured by longitude) and depth, with substrate composition an additional but less significant factor at the regional scale. We conclude that the megabenthos assemblages in the bathyal Northwest Atlantic are determined, at the regional scale, by the water masses in which they reside.

Keywords

Seamounts; megabenthos; deep-sea corals; submersible; remotely operated vehicle; water mass

1. Introduction

Seamounts comprise a significant component of the hard substrate areas in the lower bathyal (700 – 3000 m) and although estimates of the exact number of seamounts vary significantly depending on the methodology and thresholds used, one robust assessment concludes that there are at least 14,000 seamounts globally (Kitchingman and Lai, 2004). Seamounts have been found to be hot spots of biomass and biodiversity in the deep sea (Samadi et al., 2006; Rowden et al., 2010), and deep-sea corals on seamounts form complex structures that provide habitat to a diversity of organisms, including invertebrates and fishes, with some abundant species economically valuable (Watling et al., 2011). Seamounts are threatened by several anthropogenic activities, the most widespread being bottom trawling by commercial fisheries, which can occur to depths of ~ 1800 m (Haedrich et al., 2001; Ramirez-Llodra et al., 2011). The detrimental impacts of trawling on seamount fauna have been well documented (Koslow et al., 2001; Clark and O'Driscoll, 2003; Waller et al. 2007; Althaus et al., 2009; Clark and Rowden, 2009; and others), and more recent studies have also been undertaken to examine the possible impacts of proposed mining of seafloor massive sulfide (SMS) and cobalt-rich manganese crusts (Schlacher et al., 2014; Boschen et al., 2016). Consequently, an increased understanding of variation in seamount community composition and regional biodiversity is imperative for developing and implementing conservation strategies.

Although numerous studies have focused on single taxonomic groups on seamounts and other hard substrate habitats in the bathyal (canyons, ridges, etc.), the literature on benthic assemblages as a whole is limited. Due to the logistic difficulties of sampling deep-sea hard substrates, much research on seamount assemblages has been based on video and still-image data obtained from underwater vehicles (i.e., towed cameras, human-occupied submersibles - HOVs, and remotely operated vehicles - ROVs), occasionally combined with genetic and morphological analyses of a limited number of collected specimens.

Here we provide the first detailed characterization of the lower bathyal (800- 3000 m) megabenthic assemblages on the seamounts of the New England and Corner Rise chains in the Northwest Atlantic. Using a combination of data obtained from high-definition still images, video, and specimens collected during HOV and ROV dives spanning the period 2003 to 2014, we examine the heterogeneity of the megabenthic assemblages both within and among seamounts, and the assemblage composition related to multiple physical parameters including depth, temperature, and salinity.

2. Methods

2.1. Study Site and Video Data

The New England and Corner Rise seamount chains in the Northwest Atlantic extend an approximate total of 1700 km from the vicinity of the Mid-Atlantic Ridge to the continental slope southeast of George's Bank (Figure 1). The New England Seamount Chain extends 1200 km from Bear Seamount in the west to Nashville Seamount in the east (Uchupi et al., 1970), while the Corner Rise Seamounts are located about 300 km east of the New England Seamounts near the boundary of the Sohm abyssal plain and Mid-Atlantic Ridge (McGregor et al., 1973).

The New England Seamounts are estimated to be of Mesozoic origin, ranging in age from about 103 to 82 million years (Duncan, 1984). The Corner Rise Seamounts are significantly younger, estimated at approximately 75 million years in the western portion and 38 million years in the east (Epp and Smoot, 1989). Both seamount groups were formed by volcanic activity over a mantle plume hotspot that formed the Monteregian Hills southeast of Montreal, Canada, about 140 mya and, due to seafloor spreading and movement of the North Atlantic plate, now resides southwest of Great Meteor Seamount east of the Mid-Atlantic Ridge (Sleep, 1990). The plume was strong during the formation of Bear Seamount; however, as the plates shifted and the direction of motion changed, the strength of the plume weakened during the formation of the Corner Rise Seamounts (Sleep, 1990).

The rough bathymetry of the New England and Corner Rise Seamounts was described in 1959, based on single-beam echo soundings using a Precision Depth Recorder that plotted depth against time (Heezen et al., 1959). McGregor et al. (1973) outlined the bathymetry of the Corner Rise Seamounts in more detail and a series of submersible dives on the New England Seamounts in 1974 provided the first visual observations and more detail about their structure and bathymetry (Houghton et. al, 1977). With the advent of multibeam sonar technology and associated Global Positioning System navigation, spatially comprehensive surveys of the ocean floor are now possible and much of the New England and Corner Rise Seamounts have been mapped (Lapointe et al., 2020) (Figure 1).

Images and specimens were obtained from a series of dives that occurred from 2003 to 2014. In 2003, the R/V *Atlantis* and submersible *Alvin* were used to dive on three seamounts under the “Mountains in the Sea I” program. The following year, the “Mountains in the Sea II” program used the NOAA Ship *Ronald H. Brown* and the ROV *Hercules* to dive on five seamounts. In 2005, additional dives were conducted using the same ship and ROV system on several additional New England seamounts and throughout the Corner Rise group as part of the “Deep Atlantic Stepping Stones” expedition. The R/V *Atlantis* and *Alvin* were also used in 2005 to dive on one additional New England seamount. Additional seamount dives occurred on the New England Seamounts as part of NOAA’s Office of Ocean Exploration Research “New England Seamount Exploration” and “Our Deepwater Backyard” programs in 2013 and 2014, respectively. Details of all dives are given in Table 1.

Analysis of the megabenthic assemblages of the seamounts was based on data compiled from collected specimens, *in-situ* still images, and video obtained on the cruises detailed in Table 1. All still images except for those in 2003 were frame captures obtained from the High-Definition (HD) video camera. Frame captures were taken at varying but close time intervals, ca. 15 seconds during transects, but at wider time intervals when vehicles were stopped to collect specimens. All recorded images were viewed in detail for each dive, supplemented by video when large gaps existed between subsequent images, or when technical issues resulted in lost image data. On all cruises, a CTD was attached to the underwater vehicle and conductivity, temperature, depth, and oxygen data were recorded every two seconds. Specimens for taxonomic identification were collected using hydraulic manipulator arms and stored in insulated bioboxes on the vehicle. To further confirm the identification of samples, we took advantage of genetic analyses provided by the France lab at the University of Louisiana at Lafayette (Thoma et al. 2009).

2.2. Megabenthic Assemblage Analysis

The presence of all attached megafauna observed, along with the date, time, number of individuals or colonies, collection ID (if applicable), depth, commensals, and substrate, were documented. Mobile or rare benthic fauna, such as holothurians, crustaceans, asteroids, and echiurids were not included in this analysis. Crinoids were also omitted due to the difficulty of separating likely species. The high resolution of the images collected from 2004 and 2005 facilitated taxon identification, verified from morphological or genetic analysis of collected specimens when available. Collected specimens were the primary source of identification of specimens in dives in 2003 due to the lower resolution of the images (i.e., still images from DVCAM format, 720 x 480 NTSC versus more recent 1080i). For the dives conducted in 2013 and 2014, no specimens were collected so identifications were based solely on high-definition images (taken at multiple angles and altitudes from the seafloor). The emphasis of the current study is on regional assemblage composition rather than ecological relationships between species, so exact counts of each species per unit area were not made. Relative species abundances were recorded but for this study, all species counts were converted to presence by depth interval (see later) for assemblage analysis. Taxa that were unidentifiable due to poor image quality or distance from the camera were noted but left out of faunal analyses. Taxa were recorded to the lowest taxonomic level possible based on information obtained from taxonomic experts, our work with several octocoral families (e.g., Watling, 2007; Mosher and Watling, 2009; Thoma et al., 2009; Simpson and Watling, 2011; Pante and Watling, 2012), the Hawaii Undersea Research Laboratory (HURL) Animal Identification Guide (soest.hawaii.edu/HURL/HURLarchive/guide.php), NOAA Benthic Deepwater Animal Identification Guide (oceanexplorer.noaa.gov/okeanos/animal_guide/animal_guide.html), and published literature. When image quality did not allow identification to species level, individuals were recorded to that of genus, e.g., *Chrysogorgia* sp. Morphologically distinct taxa that were unidentifiable by the resources listed, or those that have not yet been formally described in the literature, were assigned unique labels (e.g., white funnel sponge, etc.).

The records of megafauna observed on each seamount were combined over all dives and grouped by depth, at 100 m intervals. For the statistical analyses, the sample units are the 100 m depth intervals on each seamount or peak. Commensal species were not included as these were not identifiable in all images so would bias analyses. These data were then used to calculate the total number of megabenthos taxa observed (gamma diversity), the total of all megabenthos taxa observed in each sample unit (taxon richness), and the number of different sample units where each identified taxon was observed (range). A species accumulation curve was produced using PRIMER ver. 6 software to visualize the adequacy of sampling inclusive of all depth intervals and seamounts or peaks sampled. The curve is based on a maximum of 999 randomizations of sample order. An additional species accumulation curve, based on the Chao1 estimator of species richness, was used to assess predicted richness based on occurrence of rare species in the observed samples (Chao and Chiu 2014). We chose Chao1 from a suite of richness estimators

(Coldwell and Coddington, 1994) as the most appropriate to obtain an estimate of the lower bound of species richness (Chao, 1984) since our sample size was large and we can assume that there were rare taxa that were undetected due to the limitations of sampling.

Similarities in composition among all seamount sample units were assessed using hierarchical cluster analysis based on group-average linkage in PRIMER6. The absence of a species in the dataset does not necessarily indicate true absence as seamounts were not completely sampled. Consequently, the Bray-Curtis (=Sørensen when using presence data) resemblance measure was selected as it does not consider joint absences (Bray and Curtis, 1957). Taxa that were observed only once, and taxa observed at two or fewer sites, regardless of abundance, were removed for this analysis. The Bray-Curtis resemblance matrix was also analyzed using the non-metric multi-dimensional scaling (MDS) and used the hierarchical cluster analysis results in PRIMER6 to group sample units. SIMPROF hierarchical cluster analysis was used to estimate the probability that sample units belonged to significantly different groups.

3. Results

3.1 Megabenthic taxa.

A total of 183 taxa were recorded (Supplemental Table 1) in the 91 100 m depth interval sample units; 86 taxa were rarely seen, observed in only one or two sampling units, while 38 taxa were found in 10 or more sample units (Figure 2). The most ubiquitous taxon was the black coral genus, *Bathypathes* which was found in 58 sample units. Taxon accumulation curves based on the observed species (Sobs) and the Chao1 estimator of species richness (Figure 3) show that additional sampling in these depth intervals will likely produce more rare species, but will not influence the overall characterization of the seamount megabenthos biodiversity.

3.2. New England Seamounts

As background to the comparative assemblage analyses, we first describe the New England and Corner Rise Seamount habitats and dominant megafaunal taxa seen during the HOV and ROV dives, proceeding from west to east.

Bear Seamount. Bear is the oldest and most westerly seamount in the New England Seamount chain. The seamount rises from the continental slope inside the US Exclusive Economic Zone southeast of Georges Bank to a fairly flat summit at ~1100 m (Moore et al., 2003) (Supplemental Figure S1). Uchupi et al. (1970) described Bear Seamount as being covered by *Globigerina* sand and ooze, with basalt pebbles dispersed throughout. At our dive sites, the substrate was mainly sand with ancient carbonate gravel and exposed basalt ledge, the latter principally in areas of steep topography. Diversity on Bear Seamount was low compared to other seamounts in the New England chain, with only 18 sessile megabenthos taxa recorded. Deeper than 1700 m, the substrate was mainly a sandy plain with little exposed rock and the only species observed were white and purple urchins, likely in the genus *Phormosoma*, a single *Pennatula* sp. sea pen, a pycnogonid, hormathiid anemones, and several ophiuroids. Between 1600 – 1700 m, the octocorals Keratoisidinae C1 and *Metallogorgia melanotrichos*, as well as the black coral *Leiopathes* sp., were observed in low numbers. Areas of exposed rock were inhabited by high densities of stalked crinoids. At the depths sampled on Bear, the highest diversity was in the 1500–1600 m depth range. Keratoisidinae C1 (9 colonies) and *M. melanotrichos* (7 colonies) were the most abundant coral species, with patchy distributions of the soft coral *Anthomastus* sp., octocorals *Chrysogorgia tricaulis*, *Keratoisis grayi,* Keratoisidinae D1a, the solitary coral *Desmophyllum dianthus*, primnoid *Calyptrophora antilla*, and the black coral *Leiopathes* sp. The dominant sponge was *Euplectella* sp.

Mytilus Seamount. Mytilus Seamount, a deep, large, relatively flat-topped seamount with summit depth at 2400 m (Figure S2), was the site of the deepest samples in our study, from 2634 to 3271 m. Data for Mytilus were obtained solely from images as no specimens were collected. The first dive was on the north side of the seamount and the substrate consisted of basalt pillars, some quite steep, interspersed with ledges, sediment, and piles of rocks. The second dive was on the south side of the seamount and the substrate observed throughout the majority of the dive comprised large basalt ledges with varying levels of sedimentation. A variety of sponges, mainly hexactinellids, and some species of corals were observed deeper than 3000 m, but were not included in our analyses as the aim of the present study was to focus on the lower bathyal from 700 – 3000 m. At depths > 2800 m, the community was dominated by sponges and the unbranched primnoid *Convexella jungerseni* (Figure S2). Several large colonies of a bamboo coral, likely in the genus *Jasonisis,* as well as colonies of the black coral *Stauropathes*, the octocoral *Paragorgia* sp. cf. *johnsoni*, and colonies of a pink coral (*Corallium*?), were observed. Several colonies of an unidentifiable branched bamboo coral were also observed. The diversity shallower than 2800 m was lower than what was observed at the deeper depths, with hexactinellid sponges dominating the community. At ~2770 m on the north slope, an unknown coral in the family Chrysogorgiidae was observed that was not recorded on any of the other seamounts or peaks in the region. At ~ 2700 m on the south slope, the substrate transitions to predominantly sediment with a few exposed boulders, and the only coral taxa observed between 2600 and 2700 m were the soft coral *Anthomastus* sp., black coral *Bathypathes* sp., and a sea pen *Halipteris* sp., as well as a large fan bamboo coral (*Jasonisis* sp.?) and a probable *Corallium*, both of which were observed at deeper depths.

Physalia Seamount. Physalia is a small conical seamount (Figure S3); it was sampled at relatively deep depths, from 2378 to 2588 m, well below the summit of 1890 m. Data for Physalia were obtained solely from images. Physalia was the least diverse of all the seamounts visited, with the dives covering only 4.5 hours of bottom time. On the other hand, more images were analyzed for Physalia (418) than Mytilus (250), and a similar number of images were analyzed for Gosnold (419), both of the latter having more diversity, which suggests that the low diversity observed on this seamount is not simply an artifact of sampling effort. Fifteen megabenthos taxa were observed, all in very low abundance, with only 23 total individuals recorded. At 2588 m, the substrate was a sand and gravel slope with occasional rock outcrops, probably unstable due to periodic downslope transport as evidenced by poorly sorted gravel deposits (Lapointe et al., 2020); at around 2500 m, the substrate comprised mainly pillow lavas and capping sedimentary layers, and at depths shallower than 2457 m, the substrate transitioned back to a sandy slope (Figure S3; NOAA OER Digital Atlas, 2019). The most abundant species observed on the seamount was the octocoral *Chrysogorgia agassizi* (4 colonies). Additional corals, observed in low abundance, included the soft coral *Anthomastus* sp., the black coral *Bathypathes* sp., the bamboo coral Keratoisidinae C1, and the solitary coral *Caryophyllia* sp.

Retriever Seamount. A narrow depth range, from 1980 to 2142 m, just below the conical summit (Figure S4) at 1921 m, was sampled on Retriever Seamount. At depths > 2100 m, the substrate was a gradual sand and gravel slope with occasional boulders. The only sessile megabenthic fauna observed were two species of pennatulids, the solitary coral *Caryophyllia* sp., actiniarian anemones, and the black corals *Parantipathes larix*, *Stauropathes* sp., *and Bathypathes* sp. At just shallower than 2100 m, the substrate transitioned to primarily basalt ledge with some sand, gravel, and dead coral debris, and the megabenthic community was diverse, comprising numerous species of corals and sponges (Figure S4). Forty-five taxa were recorded on this seamount, including the westernmost occurrence of the large chrysogorgiid, *Iridogorgia magnispiralis*. Interestingly, the dive on the northern flank in 2004, between 1900 and 2100 m, occurred in a megabenthic community heavily dominated by the octocoral *Acanthogorgia armata,* which was not observed during the 2014 dive at the same depth range on the southern flank. On both flanks, the octocoral *Metallogorgia melanotrichos* was common, although more abundant on the southern flank, and the dominant sponge was *Hertwigia* sp.

Picket Seamount. Picket is a relatively small, conical seamount with a summit depth of ~1900 m. Only the east to southeast slope was surveyed from 2086 m to just below the summit. A total of 29 taxa were recorded. The substrate at the depths sampled consisted primarily of basalt ledge with areas of fossil coral and sandy slope. Between 1900 and 2000 m, the community was dominated by the undescribed bramble-like bamboo coral Keratoisidinae D2f, which was quite dense and blanketed the substrate in certain areas (Figure S5). It is possible that this coral will be found on other seamounts throughout the Northwest Atlantic; however, among genotyped corals, the mtMutS haplotype *kerD2f* was unique to Picket, and image data alone was not sufficient to determine which of the several bramble-like bamboo species are occurring on other seamounts. The precious corals *Corallium bayeri* and *C. niobe* were also common at these depths, as well as the octocorals *Metallogorgia melanotrichos* and *Acanthogorgia armata* in patchy distributions. The most abundant sponges were *Hertwigia* sp. and *Farrea* sp. Deeper than 2000 m, the number of individuals decreased but the taxa observed were similar. The unbranched bamboo coral Keratoisidinae C1 and precious coral *Corallium bathyrubrum* were recorded at > 2000 m, although no specimens of these taxa were collected in the 1900–2000 m depth range. The relatively poor image quality on many portions of this dive prevented an identification of all fauna encountered unless they were very close to the camera, easily identifiable from the images, or specimens were collected to aid in identifications. Therefore, it is possible that some of these species also occur at depths shallower than 2000 m.

Balanus Seamount. Also conical in shape but larger at the base than the previous two seamounts (Fig Sx), Balanus rises to a summit depth of ~1444 m. Sampling occurred entirely on the flanks during the two dives. The substrate on Balanus Seamount was mainly basalt ledge, boulders with sand and gravel, and areas of high densities of fossil *Desmophyllum dianthus* (Figure S6). Forty megabenthos taxa were recorded, with the highest diversity in the 1700–1800 m depth range, where 12 species of corals were observed. From 1500 to 1700 m, the substrate contained more sand and basalt boulders and the megabenthic community was dominated by the unbranched bamboo coral Keratoisidinae C1 and sponges in the genus *Euplectella*. Ten taxa were recorded at these depths. Deeper than 1700 m, the community composition changed and a diverse assemblage of benthic megafauna was observed (39 species recorded), dominated by the precious coral *Corallium niobe*, octocorals Keratoisidinae C1, *Candidella imbricata*, and *Metallogorgia melanotrichos*, as well as sponges in the genera *Farrea* and *Hertwigia*. The diversity started to decline around 1900 m.

Kelvin Seamount. Kelvin is a very large edifice about 100 km SE of Balanus Seamount. It consists of two peaks, one about 25 km in length and the other to the ENE about 10 km long separated by a gap of 9 km. The western peak has a long flat summit about 1600 m whereas the summit of the eastern peak is about 1800m. This seamount was the most heavily surveyed (greatest bottom time and the most number of dives) and had the most specimens collected of the seamounts and peaks in the New England and Corner Rise chains, and perhaps as a result was also the most diverse. Eight dives were conducted on Kelvin, one at 3900 to 3500 m was omitted from this analysis as it was abyssal in nature. The other seven dives covered a total of 72.5 hours of bottom time, ranging in depth from 1712 to 2607 m. Two dives were conducted in 2003 by the submersible *Alvin*, on basalt outcrops from which 33 specimens were collected. The first dive by the ROV *Hercules* in 2004 was between 1700 and 1800 m along the top of a sand and gravel plateau with occasional rocks and boulders and a carbonate cap with a thin layer of manganese crust. The coral community was composed of the octocorals *Metallogorgia melanotrichos, Acanthogorgia armata*, *Paragorgia coralloides,* and *Paramuricea* sp., black corals *Stauropathes* sp., *Bathypathes* sp., and *Parantipathes larix,* and the solitary coral *Caryophyllia* sp. (Figure S7). The second dive in 2004 was conducted slightly south at deeper depths from 2245 to 2427 m. The substrate was a friable basalt ledge with large amounts of fossil coral debris. Between 2200 and 2400 m, the megabenthic community was diverse and abundant, and ten different coral taxa and several species of sponges were recorded. Around 2400 m, the community was dominated by high densities of the precious coral *Corallium bathyrubrum* and several species of sponges. The final dive in 2004 was along the northeast flank from 1931 to 2125 m. A high proportion of sand and gravel covered a basalt ledge with a carbonate cap and manganese crust. Fifteen coral taxa were observed and the community was dominated by *M. melanotrichos* (31 colonies recorded). The chrysogorgiid octocorals *Iridogorgia magnispiralis* and *I. splendens* were also common, and around 1950 m there was an abundance of *Corallium niobe*. In 2014, a nearby area on the flank of the eastern peak was sampled by *Deep Discoverer* at a similar depth range, from 1994 to 2073 m. The substrate was a sandy plain with basalt boulders and ledges scattered throughout, and the megabenthic community comprised a diverse assemblage of corals and sponges, similar to those observed in 2004. In 2005, one dive was conducted on the southwest flank, from 1829 to 2607 m. Diversity was highest between 1800 and 2200 m, but overall the megabenthic community composition was similar to other areas on the seamount. Deeper than 2200 m, diversity decreased substantially, and > 2600 m the substrate was a sandy plain and the only fauna observed were the solitary coral *Caryophyllia* sp., soft coral *Anthomastus* sp., and two species of sea pens.

Atlantis II Seamount. Atlantis II is the third of the three seamounts sampled at the deepest depths in the current study, from 2436 to 2747 m. It is an elongate, N-S trending, heavily eroded feature with a flat summit of about 1580 m (Figure S8). Data for Atlantis II were obtained solely from image data. The substrate at the depths sampled was basalt ledge and boulders with low megabenthos diversity. Between 2500 and 2700 m, the community was dominated by numerous species of sponges and the precious coral *Corallium bathyrubrum*, as well as one colony of the black coral *Bathypathes* sp., a white *Corallium* sp., and an unidentified branched bamboo coral likely in the genus *Keratoisis* (Figure S8). Deeper than 2700 m, four colonies of the octocoral *Chrysogorgia* were observed representing three species (*C. artospira, C. averta,* and *C. abludo*), which were not observed at shallower depths, as well as *Corallium bathyrubrum, Bathypathes* sp., the soft coral *Anthomastus* sp., and sponges in the genus *Bolosoma*.

Gosnold Seamount. Gosnold is a 25 km long, narrow, flat-topped seamount with a summit depth of about 1420 m. This seamount was sampled once at depths from 1847 - 2138 m, with a total of 37 megabenthos taxa recorded. Data for Gosnold were obtained solely from images as no specimens were collected. The substrate was mainly basalt, with areas of sand and gravel. Between 1800 and 1900 m, the community was dominated by the precious coral *Corallium niobe* and various species of sponges (Figure S9). The octocorals *Metallogorgia melanotrichos*, *Paragorgia coralloides*, *Paramuricea* sp., and *Iridogorgia splendens,* as well as unidentified unbranched bamboo corals and branched *Keratoisis* sp., and the black corals *Bathypathes* sp., *Telopathes magna,* and *Stauropathes* sp. were also observed. Deeper than 1900 m, the community was dominated by high densities of an unidentified bramble bamboo coral and a white *Corallium* sp., likely *C. bayeri* or *C. niobe*. Deeper than 2100 m, in addition to the white *Corallium* sp., *C. bathyrubrum* was common; *C. bathyrubrum* was not observed at shallower depths on the seamount. Hexactinellid sponges were diverse and abundant throughout the depths sampled.

Manning Seamount. The Manning seamount complex consists of a very large and one small peak on the eastern side and two larger peaks on the western side (Fig Sx). The summits of the two peaks sampled were at depths of 1312 and 1356 m. Six dives were conducted on the Manning complex from 2003 to 2005, at depths from 1321 to 1933 m. Four dives were conducted on the eastern peak of the seamount at depths from 1321 to 1734 m, and two dives were conducted on the western peak from 1421 to 1933 m. Three of the eastern peak dives were on the summit where experimental colonization blocks were places and subsequently retrieved. The megabenthic assemblages on the eastern and western peaks were noticeably different and on the western peak the assemblages also displayed distinct variation with depth. Between 1300 and 1400 m on the eastern peak, the substrate was mainly gravel with exposed basalt ledge and small patches of sand, and the community was heavily dominated by large colonies of the octocoral *Paragorgia johnsoni* (Figure S10). Other corals observed in low abundances included the scleractinians *Desmophyllum pertusa* and *Enallopsammia rostrata*, the black corals *Leiopathes, Bathypathes,* and *Parantipathes larix*, and octocorals *Anthomastus* sp., *Metallogorgia melanotrichos*, and *Thouarella grasshoffi*. The only dive that sampled at depths deeper than ≈ 1400 m on the eastern peak was conducted using the submersible *Alvin* in 2003. Because of poor image quality on this dive, collected specimens only were used for the assemblage analysis representing depths > 1400 m on the eastern peak and included *D. pertusa, E. rostrata,* and the octocorals *Paragorgia coralloides* and *M. melanotrichos.* On the western peak of Manning Seamount, between 1400 and 1500 m, the megabenthic assemblage was unlike any other observed on eastern Manning or on any other seamounts in the New England and Corner Rise chains. The substrate was biogenic sand with small stones, basalt rock and compressed ash ledges, as well as botryoidal surfaces (manganese crust) and fossil coral debris consisting of *Desmophyllum pertusa* and *D. dianthus, Enallopsammia,* and bamboo coral skeletons. The megabenthic community was densely populated with the unbranched primnoid octocoral *Calyptrophora antilla,* as well as a large fan-shaped *Calyptrophora* sp., which could not be identified to species from images and no specimens were collected. *Metallogorgia melanotrichos, D. pertusa,* and *E. rostrata* were also common at these depths, as well as sponges in the genus *Hertwigia*. *Metallogorgia melanotrichos* was observed at all depths sampled on Manning Seamount on both the eastern and western peaks, but was most abundant around 1400 m in the west. Deeper than 1500 m, the community composition changed and was dominated by *E. rostrata* and *D. pertusa*, which are most abundant around 1700 m. A diverse array of coral species was observed with patchy distributions, as well as numerous unbranched bamboo coral that could not be identified to genus from the images.

Rehoboth Seamount. Southeast of the Manning complex, Rehoboth is a ~25 km long, NE to SW trending, flat-topped seamount with a summit depth of about 1240 m (Figure S11). Two dives have been made on this seamount, one each on the NW corner and SW corners. Shallower than 1600 m, the substrate was sand and exposed ledge, with areas of fossil coral and the megabenthic community was dominated by sponges and the scleractinian corals *Enallopsammia rostrata* and *Desmophyllum pertusa*, as well as a large (40 cm length) tunicate. Deeper than 1800 m the substrate consisted of basalt rock outcrops with fossil coral debris and low levels of biogenic sand. Between 1800 and 1910 m, the community was dominated by dense colonies of the octocoral *Acanthogorgia armata,* the bamboo coral Keratoisidinae C1*,* and sponges in the genus *Hertwigia* (Figure S11). Around 1900 m, the abundance of *A. armata* declined and the community was dominated by the octocorals *Candidella imbricata,* Keratoisidinae C1*, Metallogorgia melanotrichos* and the sponge *Hertwigia*.

Nashville Seamount. Nashville is the easternmost and southernmost seamount in the New England Seamount chain. It lies about 350 km SSE of Rehoboth Seamount. It is an elongate (~80 km long by 10 km wide) structure trending from the NNW to SSE consisting of two heavily eroded peaks at the northern end and one very long (55 km) flat-topped peak with a summit depth of about 1900 m (Figure S12). Two dives were conducted near the southern end of the large section. The substrate was basalt rock ledge with sand and fossil *Desmophyllum,* and areas of sandy plain. The megabenthic community was abundant and diverse between 2100 and 2300 m, and the landscape was densely populated with colonies of the octocorals *Iridogorgia magnispiralis, Metallogorgia melanotrichos, Paramuricea* sp.*,* Keratoisidinae J3a*,* and *Calyptrophora microdentata,* and sponges in the genera *Farrea* and *Hertwigia* (Figure S12). Deeper than 2300 m, diversity decreased with increasing depth. Around 2500 m, the megabenthic community was dominated by the precious corals *Corallium bathyrubrum* and *C. bayeri,* with patchy distributions of other species in low abundance.

3.3. Corner Rise Seamounts

A gap of 465 km separates the southern end of Nashville Seamount from the western end of Corner Seamount. Three of the larger seamounts in this group were surveyed in 2005, and several of the other seamounts were mapped bathymetrically (Lapointe et al. 2020).

Corner Seamount. Corner Seamount has two main peaks, to which we gave the provisional names of Kükenthal Peak to the one at the western end and Goode Peak, which was located on the eastern end (Figure S13). The main structure of Corner Seamount is about 70 km in length; the summit of Kükenthal Peak is 16 km long by 8 km wide and is located at 680 m water depth. A gap of 18 km separates the two peaks. Goode Peak has a summit depth of about 1590 m and is about 26 km by 15 km is size. Kükenthal Peak was sampled from 713 to 922 m and then from 1217 to 1854 m and provided the shallowest community data in the present study. From 700 to about 900 m, the substrate was mainly sand and basalt ledge, with a few isolated boulders. Trawl marks scarring the sediment provide evidence of a history of commercial fishing and very few live organisms were observed (Figure S13). Only five species of corals were recorded at these depths – the octocorals *Placogorgia* sp. and *Acanella arbuscula*, the plexaurid coral *Muriceides* sp., the black coral *Parantipathes* sp., and the scleractinian *Desmophyllum pertusa*. The community was dominated by sponges. Only one colony each of *D. pertusa* and *Muriceides* sp. were seen. *Parantipathes* sp. and *A. arbuscula* were most abundant, with most colonies observed around 900 m, suggesting that these species may be early colonizers, more resilient to habitat destruction, and/or able to colonize sandy sediments. At depths deeper than 1200 m the diversity increased and overall relative biomass was highest of all the seamounts and peaks sampled at Corner Rise. From 1200 – 1300 m, the octocorals *Paramuricea* sp. and *Calyptrophora clinata* were abundant and dominated the community, with patchy distributions of other species of corals and sponges. The substrate was composed of hard caliche and areas of fossil coral rubble and biogenic sand. At around 1300 m, the abundance of *Paramuricea* sp. began to decline substantially, with only occasional colonies recorded. *Calyptrophora clinata* remained abundant and dominated the community until about 1500 m, at which point the number of colonies declined drastically. The area sampled from 1500 to 1800 m was a steep rock wall, and the only sessile megabenthic fauna observed were four colonies of the primnoid octocoral *Candidella imbricata*, three colonies of *Calyptrophora clinata*, and sponges. Deeper than 1800 m, the substrate transitioned to a plain of biogenic sand with occasional basalt boulders and ledges interspersed throughout, providing habitat for a variety of species of corals and sponges, including those observed shallower, as well as the chrysogorgiid octocorals *Chrysogorgia artospira, C. tricaulis, Iridogorgia magnispiralis,* and *Metallogorgia melanotrichos,* which were not observed shallower than 1800 m. Certain areas contained large amounts of fossil *Desmophyllum dianthus*, although only two live colonies of this species were observed.

Goode Peak on Corner Seamount contained basalt boulders and ledges, with fossil coral debris around 1900 m. At depths shallower than 1900 m, the substrate was covered with biogenic sand and sessile fauna were only observed on exposed basalt boulders (Figure S14). Diversity was low and megabenthic fauna were sparsely distributed, with only 24 taxa recorded. Sponges were the dominant megabenthic fauna, and the most abundant species was a sponge in the family Rossellidae (24 colonies recorded). The primnoid octocoral *Candidella imbricata,* precious coral *Corallium niobe*, plexaurid coral *Swiftia* sp., and the black coral *Parantipathes larix* were recorded between 1800 – 2000 m, but were not observed deeper than 2000 m. Conversely, the octocoral *Metallogorgia melanotrichos* was recorded > 2000 m, but was not observed at shallower depths. Deeper than 1900 m, the unbranched bamboo coral Keratoisidinae D1c started to appear and was most abundant around 2100 m. Additional corals observed on Goode Peak included the black coral *Bathypathes* sp., the octocorals *Paramuricea* sp. and *Chrysogorgia tricaulis*, the precious coral *Corallium niobe*, and an unidentified solitary scleractinian coral.

Caloosahatchee Seamount. Also a very elongate seamount (90 km west to east), Caloosahatchee Seamount bears two peaks, provisionally named Milne-Edwards (west) and Verrill (east) Peaks (Figures S15 and S16). Both peaks have relatively shallow summits, 939 m and 1029 m, respectively. One dive was conducted on Milne-Edwards and two on Verrill. The observed biodiversity on Milne-Edwards Peak was low. The octocoral *Acanella arbuscula* was the dominant species, being most abundant in the 1300 – 1400 m depth range. At depths shallower than 1400 m, the habitat was a sandy plain with patchy distributions of the black corals *Telopathes magna, Umbellapathes* sp. and *Bathypathes* sp., octocorals *Paramuricea* sp., *Iridogorgia fontinalis,* and *Thouarella grasshoffi,* the solitary scleractinian *Desmophyllum dianthus,* and a couple of species of unidentified sponges (Figure S15). Deeper than 1400 m, the substrate was mainly basalt ledge, with areas of dense accumulations of fossil coral debris. The coral community comprised the scleractinian *Enallopsammia rostrata,* octocorals *Metallogorgia melanotrichos, Chrysogorgia tricaulis, Iridogorgia splendens,* and *Anthomastus steenstrupi*, and the black corals *Parantipathes larix* and *Stichopathes gracilis,* all with patchy distributions and low abundance (< 4 colonies per species). At the depths sampled on Verrill Peak, a total of 33 megabenthos taxa were observed. The substrate was composed almost exclusively of biogenic sand with fossil coral debris and exposed basalt outcrops. Within the 1100 – 1400 m depth range, colonies of the octocoral *Acanella arbuscula* dominated the landscape, with abundances of twenty or more colonies per image in certain locations (Figure S16). The octocorals *Calyptrophora clinata* and *Placogorgia sp.,* and the scleractinian *Enallopsammia rostrata* were also present in this depth range, but were not observed at deeper depths on the seamount. Deeper than 1500 m, the community was noticeably different from shallower depths. *Acanella arbuscula* was recorded, but in very low abundance. Several species of sponges were observed that were not found at shallower depths, as well as the black corals *Stauropathe*s and *Parantipathes larix*, octocorals *Chrysogorgia tricaulis* and *Metallogorgia melanotrichos*, and corallimorpharians.

Yakutat Seamount. This seamount has an unusual shape, being composed of two N-S trending arms connected by a 25 km east to west section. The western arm has a summit depth of 1170 m while that of the eastern arm is 1131 m. The first dive on Yakutat Seamount was conducted on the southern part of the western arm from 1380 to 1753 m. The substrate was basalt ledge covered with high levels of biogenic sand, distinct manganese crust, botryoidal surfaces, some gravel and boulders, and fossil coral (Figure S17). At the shallower depths from 1400 to 1500 m, the benthic megafauna were congregated on exposed basalt ledge and boulders and the community was dominated by the scleractinians *Enallopsammia rostrata* and *Desmophyllum dianthus,* the black coral *Stichopathes* sp., and various species of sponges. Deeper than 1500 m, a thick layer of sand covered the substrate and the only corals observed were the black coral *Bathypathes* sp., scleractinian *D. dianthus,* octocorals *Paramuricea* sp., *Chrysogorgia* sp., *Acanella arbuscula* and *Pennatula* sp., all in low abundance. The second dive was on the southern part of the eastern arm at deeper depths from 1943 to 2312 m. The substrate was botryoidal ledge with a sand veneer, thick manganese crust, and covered in some areas by pteropod shells. Sponges dominated the communities at these depths, although a variety of corals were observed in low abundance, including the octocorals *A. arbuscula, Metallogorgia melanotrichos, Iridogorgia magnispiralis, Paramuricea* sp., *Convexella jungerseni*, *Chrysogorgia tricaulis* and *Chrysogorgia averta*, and the black corals Bathypathes sp. and *Parantipathes larix.* The third dive was conducted on the northern part of the western arm in the depth range 1425 to 1653 m. The substrate was heavy basalt ridge with thick fossil coral cover in some areas and much less biogenic sand sediment than the southern flanks. The majority of the dive was conducted in the 1500 to 1600 m depth range, with patchy distributions of the black corals *Parantipathes larix* and *Bathypathes* sp., octocorals *Paramuricea* sp., *A. arbuscula*, *Swiftia* sp., and *Chrysogorgia tricaulis*, the scleractinian *E. rostrata,* and various species of sponges, anemones, and sea pens. At depths shallower than 1500 m, the community composition changed and the community was dominated by the octocoral *Paragorgia johnsoni* and a large purple plexaurid was observed. This part of the seamount appeared to be marked by trawl door scours (Waller et al. 2007, Watling et al. 2007).

3.4. Megabenthic Assemblage Composition of the New England and Corner Rise Seamounts

The analysis of megabenthic assemblages was based on data compiled from 605 collected specimens, 38,433 *in-situ* images, supplemented when necessary from video obtained from over 400 hours of bottom time. Images were analyzed for a total of 34 dives on 17 peaks, surveying depths ranging from 713 to 3000 m. One dive on Kelvin Seamount in 2005 (Dive 8) was conducted between 3481 and 3935 m, the maximum depth on Dive 13 on Retriever Seamount in 2014 was 3881 m, and the maximum depth on both dives on Mytilus Seamount in 2013 (Dive 4 and Dive 5) were deeper than 3250 m. The data from below 3000 m on these dives were not included in the current analysis as the focus is on the lower bathyal between 700 and 3000 m. The final data set consisted of 91 sample units, with each unit representing a 100 m depth interval on each seamount. Seven of the sample units were at or near the seamount summit. Further reduction of the data set resulted from restricting the cluster analysis to the 83 sample units that occurred where the water temperatures were between 2 and 5° C; of those three were at one location on the summit of Manning NE, and one each within 100 m of the summits of Picket and Retriever. This reduction was done to exclude the very shallow samples on Kukenthal and Verrill

Peaks where water temperature rapidly increased to almost 12° C. Also, the rare and taxonomically uncertain species were removed from the data set, yielding a final group of 94 taxa that were available for the analysis of similarity.

MDS and cluster analysis of the megabenthic taxa distributions based on water temperature as an environmental factor produced four distinct groups (1) 2-3°C; (2) 3-4°C; (3) 5-6°C; and (4) 9 - 13°C (Figure 4). At depths deeper than 2600 - 2700 m, the temperature decreases to below 3°C (Figure 5). Surveys at these depths and temperature only occurred on Mytilus and Atlantis II. The majority of the seamounts surveyed in the New England chain fell within the 3–4°C temperature range. The areas surveyed on Manning and Rehoboth were slightly warmer, between 3.5 and 5°C. At Corner Rise the only location that fell exclusively in the 3–4°C temperature range was Goode Peak on Corner Seamount. Kükenthal Peak on Corner Seamount was sampled mainly at temperatures above 4°C. There is a steep temperature gradient from around 9°C to over 12°C at the shallowest depth sampled. The temperature on Milne-Edwards and Verrill Peak, and Yakutat Seamount, was mainly between 3-5°C.

Cluster analysis of all sites where the water temperature was between 2 and 5°C produced, on the basis of the SIMPROF analysis, 13 clusters (Figure 6) grouped broadly by a combination of location and depth and were mapped onto seamount locations in Figure 5. A shade plot of sample unit clusters and cluster results by species is included as Figure S18. All species analyzed were found in at least three sample units (see also Figure 2).

The western New England seamounts from Bear to Gosnold and the Corner Rise seamounts from Kükenthal Peak to Yakutat form two clearly separate groups (Figure 5). Of the seamounts between these two groups, the Manning complex and Rehoboth are very similar to each other (Assemblage J), and Nashville seamount, being much deeper, shows affinities to the western seamounts in its deeper reaches and to the eastern end of Corner Rise at slightly shallower depths.

The megabenthic assemblages on the seamounts in the western group are also sorted more or less by depth, with the exception of Assemblage A which has the greatest depth distribution (1700 to 2700 m). Assemblage D is only found from 2700 m down to the limit of our study at 3000 m. It occurred exclusively in waters colder than 3°C. Assemblage C was also found only in the deeper area, from 2200 to 2700 m, but always in water slightly above 3°C. Shallower than 2200 m there was a mix of assemblages, some known so far from only one seamount (e.g. Assemblages G and I).

At Corner Rise, the assemblages are distributed in more or less the same way, that is, sorted by temperature. Assemblage L was found in water mostly below 4°C, whereas Assemblages B and M were found in the 4-5°C water. We did not include in this cluster analysis the few sites in water temperatures above 5°C.

Overall, the New England Seamounts east from Retriever to Nashville are more diverse than the Corner Rise Seamounts. The lowest diversity was on the three seamounts located closest to the continental margin (Figure 7). With the exception of the three deepest seamounts (Mytilus, Physalia, and Atlantis II), corals were the most abundant large taxon characterizing the megabenthic assemblages. The black coral, *Bathypathes* spp., was the most commonly observed coral taxon in the region, observed in 58 sampling units. The most common of the identified sponges were *Farrea* and *Hertwigia.*

Of the octocorals, *Metallogorgia melanotrichos* was very prevalent on the New England Seamounts, being found in 32 sample units. It was also observed on Corner Rise in 11 sample units. *Acanella arbuscula* was the most common species at Corner Rise, recorded at 20 of the 36 sample units; it was also observed on the New England Seamounts, but at only 12 of 54 sample units, and was not recorded on the seamounts farthest west – Bear, Mytilus, and Physalia. *Paragorgia coralloides* and *Corallium bathyrubrum* are widespread throughout the New England Seamounts, but no colonies were recorded at Corner Rise. *Anthomastus* sp. and *Iridogorgia magnispiralis* were also common and widespread on the New England Seamounts, but only one and two specimens, respectively, were recorded at Corner Rise. *Anthomastus* sp. was observed at Yakutat Seamount, and *I. magnispiralis* was seen rarely at Kükenthal Peak and Yakutat Seamount. The primnoid *Calyptrophora clinata* was abundant in 7 sample units at Corner Rise, but this species was not observed on the New England Seamounts.

The highest taxon diversity of the megabenthic fauna was observed between 1700 and 2199 m, and diversity was lowest at the depths surveyed shallower than 1200 m, as well as depths > 2700 m. Sampling effort was minimal in the shallowest and deepest depth ranges; however, the species found per hour of bottom observation was nearly constant over all depths (Figure 8).

Only one location, Kükenthal Peak on Corner Seamount, was sampled at depths shallower than 1000 m, and this was an area that had been previously trawled by commercial fisheries (Vinnichenko 1997, Waller et al. 2007, Watling et al. 2007). The basal structures of a variety of corals and sponges were found but most were dead, although there were several small, presumably young, colonies of *Parantipathes larix* and a few colonies of the plexaurid gorgonian coral, *Placogorgia* sp., were observed (Figure S13). The latter species was not found at depths > 1200 m on the New England or Corner Rise Seamounts. The only data from the 1100 m depth range was based on less than five minutes at the end of a dive on Verrill Peak, Caloosahatchee Seamount. Between 1200 - 2299 m the assemblages are much more diverse, even considering the increased bottom time spent at those depths. Seventy-eight additional species of corals were recorded deeper than 1200 m.

Substrate is also an important factor regulating the distribution of megafauna on seamounts. With only a few exceptions, the substrate of the sample units in this study was basalt, with mixtures of biogenic sand, gravel (probably also of basaltic origin), and carbonate in the form of either fossil *Desmophyllum dianthus* and *D. pertusa*, or ancient carbonate crust (Figure S19).

The vast majority of megabenthic fauna recorded on the New England and Corner Rise Seamounts were observed attached to basalt rock substrate. However, some species were also observed living on biogenic sand, gravel, carbonate crust, and carbonate composed of fossil coral skeletons. *Bathypathes* sp., the most widely distributed coral species in the region, was observed inhabiting a variety of substrates, including basalt, sand, gravel, and carbonate.

The only taxa observed living solely in sandy substrates were species of sea pens, and some sponges and anemones. However, some species of corals that were observed on hard substrates were also frequently observed in sand, including *Bathypathes* sp., *Acanella arbuscula, Parantipathes larix,* and *Telopathes magna.* It is possible that for many of these species, the basalt was exposed at the time of settlement, and then was covered with a veneer of sand. The gravel substrate fauna was mainly anemones, sea pens, sponges, *Anthomastus* sp., *Bathypathes* sp., *Paramuricea* sp., and *Caryophyllia* sp.

Species observed on carbonate substrate that consisted of a high density of fossil coral skeletons included various species of undescribed bramble bamboo corals, *Trachythelia rudis, Placogorgia* sp., *Muriceides* sp., *Acanella arbuscula, Acanthogorgia armata, Parantipathes larix,* *Paramuricea* sp., *Metallogorgia melanotrichos, Candidella imbricata, Corallium niobe,* and *Chrysogorgia* sp.

On Kelvin Seamount at ~1700 m, essentially at or near summit depth, the substrate comprised mostly sand and gravel with occasional rocks and boulder, and a carbonate crust cap with a thin layer of manganese crust overlying it. The majority of benthic fauna was observed on the carbonate crust substrate, and these included *Metallogorgia melanotrichos, Paramuricea* sp., *Parantipathes larix, Stauropathes* sp., *Chrysogorgia* sp., *Swiftia* sp., and species of sponges, anemones, and cerianthids.

4. Discussion

The major factors correlated with the composition of the assemblages on the New England and Corner Rise seamounts are depth, temperature, position along the chain (using "longitude" as a factor in the analyses), and substrate composition. It is likely that slope, or a derivative of slope, is also an important factor (Guinotte et al., 2017) but that variable cannot easily be determined at an ecologically meaningful scale from the existing multibeam data (some dive tracks were short enough that, due to depth, they effectively covered only a few pixels in the multibeam record). Oxygen is likely not an important factor in structuring the megabenthic assemblages as the water column throughout the Northwest Atlantic is oxygen-rich, with oxygen levels of approximately 6.0 ml/L at the surface to 3.0 ml/L at 3000 m depth (NOAA World Ocean Atlas, 2013, ver. 2: www.nodc.noaa.gov/OC5/woa13/).

Total bottom time varied at the different depths surveyed. Although a pattern can be discerned between bottom time and the total number of taxa recorded, the diversity observed is not simply an artifact of sampling effort (Figure 8). For example, the bottom time at 1300–1399 m and 1900–1999 m was the same (36.5 hrs), although many fewer taxa were recorded at the shallower depth interval. At 1200–1299 m and 1300–1399 m, the hours spent on the bottom varied substantially (3 and 36.5 hrs, respectively) although the number of taxa recorded was similar. Species accumulation curves based on Chao1 estimated species numbers at intermediate and deep depths (>1300 m) were approaching an asymptote, indicating a saturation point where more sampling would not produce many more taxa, perhaps only rare species (Lapointe et al. 2019). The saturation point would probably be reached by adding more sample units rather than total bottom time. Sampling effort was lowest, in terms of both bottom time and sample units, at depths shallower than 1300 m. Most of the summits in the New England Seamounts chain are deeper than those at Corner Rise, which is a function of the greater age of the New England Seamounts.

We observed a distinct difference in the megabenthic assemblages on the deepest (>2700 m) and shallowest (<1000 m) sampling units on the seamounts and peaks in the bathyal northwest Atlantic. The shallowest depths sampled on Kükenthal Peak were characterized by the corals *Placogorgia* sp., *Muriceides* sp., *Acanella arbuscula, Parantipathes larix*, and *Desmophyllum pertusa*, all in low abundance. *Placogorgia* sp. and *Muriceides* sp. were not observed deeper than 1500 m., and *A. arbuscula, P. larix, and D. pertusa* were not observed deeper than 2500 m. The deepest depths sampled, >2700 m, did not share any of the above coral species. All of the species of corals observed deeper than 2500 m were also observed at shallower depth, some (e.g. *Bathypathes* sp. and *Paragorgia johnsoni*) being observed as shallow as 1200 m. The deepest and shallowest sites were also the least sampled, which likely contributes to the lower potential diversity. At intermediate depths, the assemblages vary depending on the west to east location along the chain, and depth (and its correlate variable, temperature).

The temperature on the majority of the New England Seamounts at depths where images or samples were taken was fairly constant, between 3 – 4°C, with only Manning and Rehoboth having dive sites shallow enough to be in the 4– 5°C range. Proceeding west to east from Manning in the New England Seamounts to Milne-Edwards Peak in Corner Rise, the surface water is warmer and extends deeper into the water column due to the influence of the Gulf Stream. However, the only area surveyed with water warmer than 6°C was Kükenthal Peak on Corner Seamount, and the only area surveyed colder than 3°C was on Mytilus Seamount. Most of the dive sites on the Corner Rise Seamounts were in water ~1°C warmer than all the New England Seamounts other than Manning and Rehoboth.

The dominant water mass covering the New England and Corner Rise Seamounts is Labrador Sea Water, which forms a Deep Western Boundary Current at the western end, but this water mass gives way to Upper North Atlantic Deep Water and then to North Atlantic Deep Water to the east and in deeper water, respectively (Talley et al. 2011). Labrador Sea Water is characterized by a typical temperature between 2.9 – 4 °C and salinity minimum of 34.84 psu, although the physical properties are variable through time and a temperature minimum of 2.8 °C has been observed at 2000 m (Talley et al., 2011).

The temperature-salinity profiles of the New England and Corner Rise Seamounts below 1100 m are shown in Figure 9. The shallow locations sampled on Kükenthal Peak were warmer and saltier, 9–12°C and 35.29 – 35.39 psu, respectively, and are likely influenced heavily by the Gulf Stream, which travels directly over Corner Rise and creates eddies that have been shown to extend downward to approximately 1000 m (Talley et al., 2011). The three seamounts sampled to the deepest depths – Mytilus, Physalia, and Atlantis II, which were all sampled deeper than 2400 m – reside solely in North Atlantic Deep Water. All three of the deepest areas surveyed had low relative diversity and abundance (and by inference biomass), with sponges dominating the communities. Overall, the Corner Rise Seamounts are warmer and saltier than the New England Seamounts, with the exception of Manning and Rehoboth, which reside in warmer water at depths shallower than 1900 m, and Goode Peak, which resides in cooler water. It is possible that Manning, Rehoboth, and most of the Corner Rise Seamounts are situated within a mixing zone containing components of Labrador Sea Water and Upper North Atlantic Deep Water. The New England Seamounts are likely influenced most strongly by Upper North Atlantic Deep water and North Atlantic Deep Water.

5. Conclusions

This study produced the first detailed characterization of the megabenthic assemblages on the New England and Corner Rise seamount chains in the Northwest Atlantic. The assemblages vary both within and across seamounts, and we observed changes in assemblages dependent on location (longitude), depth (temperature), and substrate. The New England and Corner Rise Seamounts are influenced by three main water masses, as well as the Gulf Stream in water shallower than 1000 m. Our results suggest that the composition of the megabenthic assemblages in the Northwest Atlantic on a regional scale are strongly linked to the physical characteristics of the water masses in which they reside.

Acknowledgements

We gratefully acknowledge the NOAA National Undersea Research Program and Office of Ocean Exploration and Research for the many years of support for cruises to the New England and Corner Rise Seamounts. Each cruise involved detailed mapping of the seamounts, as well as dives with submersibles and ROVs, requiring the expertise of a host of crew and technicians on the R/V *Atlantis* and NOAA Ships *Ronald H. Brown* and *Okeanos Explorer*, as well as pilots and technicians for the HOV *Alvin* and ROVs *Hercules* and *Deep Discoverer*. We sincerely appreciate the time and effort of all involved. The ROV *Hercules* was made available by the Institute for Exploration, University of Rhode Island. We also greatly appreciate the help and camaraderie of our many collaborators on these cruises, especially J. Moore, R. Waller, and T. Shank, and C. Kelley and S. Cairns for help with species identifications.

Abbreviations

BEA	Bear Seamount, New England Seamounts
PHY	Physalia Seamount, New England Seamounts
MYT	Mytilus Seamount, New England Seamounts
RET	Retriever Seamount, New England Seamounts
PIC	Picket Seamount, New England Seamounts
BAL	Balanus Seamount, New England Seamounts
KEL	Kelvin Seamount, New England Seamounts
ATL	Atlantis II Seamount, New England Seamounts
GOS	Gosnold Seamount, New England Seamounts
MAN	Manning Seamount, New England Seamounts
REH	Rehoboth Seamount, New England Seamounts
NAS	Nashville Seamount, New England Seamounts
KUK	Kükenthal Peak, Corner Seamount, Corner Rise
GOO	Goode Peak, Corner Seamount, Corner Rise

MIL Milne-Edwards Peak, Caloosahatchee Seamount, Corner Rise

VER Verrill Peak, Caloosahatchee, Corner Rise

YAK Yakutat Seamount, Corner Rise

References

Althaus, F., Williams, A., Schlacher, T.A., Kloser, R.J., Green, M.A., Barker, B.A., Bax, N.J., Brodie, P. and Schlacher-Hoenlinger, M.A., 2009. Impacts of bottom trawling on deep-coral ecosystems of seamounts are long-lasting. *Marine Ecology Progress Series*, *397*, pp.279-294.

Boschen, R.E., Rowden, A.A., Clark, M.R., Pallentin, A. and Gardner, J.P., 2016. Seafloor massive sulfide deposits support unique megafaunal assemblages: implications for seabed mining and conservation. *Marine environmental research*, *115*, pp.78-88.

Bray, J.R. and Curtis, J.T., 1957. An ordination of the upland forest communities of southern Wisconsin. *Ecological monographs*, *27*(4), pp.325-349.

Chao, A. 1984. Nonparametric estimation of the number of classes in a subpopulation. *Scandinavian Journal of Statistics 11*, pp. 265-270.

Chao, A. and Chiu, C. H. 2014. Species richness: estimation and comparison. *Wiley StatsRef: Statistics Reference Online* pp. 1-26.

Clark, M. and O'Driscoll, R., 2003. Deepwater fisheries and aspects of their impact on seamount habitat in New Zealand. *Journal of Northwest Atlantic Fishery Science*, *31*, pp.441-458.

Clark, M.R. and Rowden, A.A., 2009. Effect of deepwater trawling on the macro-invertebrate assemblages of seamounts on the Chatham Rise, New Zealand. *Deep Sea Research Part I: Oceanographic Research Papers*, *56*(9), pp.1540-1554.

Coldwell, R.K. and Coddington, J.A. 1994. Estimating terrestrial biodiversity through extrapolation. *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences*, 345(1311), pp. 101-118.

Duncan, R.A., 1984. Age progressive volcanism in the New England seamounts and the opening of the central Atlantic Ocean. *Journal of Geophysical Research: Solid Earth*, *89*(B12), pp.9980-9990.

Epp, D. and Smoot, N.C., 1989. Distribution of seamounts in the North Atlantic. Nature, 337 (6204), p. 254-257.

Guinotte, J.M., Georgian, S., Kinlan, B.P., Poti, M., and Davies, A.J., 2017. Predictive habitat modeling for deep-sea corals in US Waters. In: Hourigan, T.F., Etnoyer, P.J., Cairns, S.D. (eds.) *State of Deep-Sea Coral and Sponge Ecosystems of the United States.* NOAA Technical Memorandum NMFS-OHC-4, Silver Spring, MD. 24 pp.

Haedrich, R.L., Merrett, N.R. and O'Dea, N.R., 2001. Can ecological knowledge catch up with deep-water fishing? A North Atlantic perspective. *Fisheries Research*, *51*(2-3), pp.113-122.

Heezen, B.C., Tharp, M. and Ewing, M., 1959. The floors of the Oceans: I. The North Atlantic. *Geological Society of America Special Paper 65*, pp. 1-122.

Houghton, R.L., Heirtzler, J.R., Ballard, R.D. and Taylor, P.T., 1977. Submersible observations of the New England seamounts. *Naturwissenschaften*, *64*(7), pp.348-355.

Kitchingman, A. and Lai, S., 2004. Inferences on potential seamount locations from mid-resolution bathymetric data. *Seamounts: Biodiversity and Fisheries*, *12*, pp.7-12.

Koslow, J.A., Gowlett-Holmes, K., Lowry, J.K., O'Hara, T., Poore, G.C.B. and Williams, A., 2001. Seamount benthic macrofauna off southern Tasmania: community structure and impacts of trawling. *Marine Ecology Progress Series*, *213*, pp.111-125.

Lapointe, A. Watling, L., and Gontz, A.M. 2020. Deep-sea benthic megafaunal communities on the New England and Corner Rise Seamounts, Northwest Atlantic Ocean. *Seafloor Geomorphology as Benthic Habitat*, pp. 917-932. Elsevier. DOI: https://doi.org/10.1016/B978-0-12-814960-7.00057-9

McGregor, B.A., Betzer, P.R. and Krause, D.C., 1973. Sediments in the Atlantic Corner seamounts: Control by topography, paleo-winds, and geochemically-detected modern bottom currents. *Marine Geology*, *14*(3), pp.179-190.

Moore, J.A., Vecchione, M., Collette, B.B., Gibbons, R., Hartel, K.E., Galbraith, J.K., Turnipseed, M., Southworth, M. and Watkins, E., 2003. Biodiversity of Bear Seamount, New England seamount chain: results of exploratory trawling. *Journal of Northwest Atlantic Fishery Science*, *31*, p.363.

Mosher, C.V. and Watling, L. Partners for life: a brittle star and its octocoral host. *Marine Ecology Progress Series, 397,* pp. 81-88.

NOAA OER Digital Atlas. 2019. https://www.ncddc.noaa.gov/website/google_maps/OE/mapsOE.htm (accessed November, 2019)

Pante, E. and Watling, L. 2012. Chrysogorgia from the New England and Corner Seamounts: Atlantic-Pacific connections. *Journal of the Marine Biological Association of the United Kingdom 92*(5), pp. 911-927.

Ramirez-Llodra, E., Tyler, P.A., Baker, M.C., Bergstad, O.A., Clark, M.R., Escobar, E., Levin, L.A., Menot, L., Rowden, A.A., Smith, C.R. and Van Dover, C.L., 2011. Man and the last great wilderness: human impact on the deep sea. *PLoS One*, *6*(8), p.e22588.

Rowden, A.A., Schlacher, T.A., Williams, A., Clark, M.R., Stewart, R., Althaus, F., Bowden, D.A., Consalvey, M., Robinson, W. and Dowdney, J., 2010. A test of the seamount oasis hypothesis: seamounts support higher epibenthic megafaunal biomass than adjacent slopes. *Marine Ecology*, *31*, pp.95-106.

Samadi, S., Bottan, L., Macpherson, E., De Forges, B.R. and Boisselier, M.C., 2006. Seamount endemism questioned by the geographic distribution and population genetic structure of marine invertebrates. *Marine Biology*, *149*(6), pp.1463-1475.

Scheirer, D., Adkins, J., Yoerger, D. and Shank, T. 2003. Mapping and Collection of Deep-Sea Corals from Seamounts in the NW Atlantic. In *AGU Fall Meeting Abstracts*. https://ui.adsabs.harvard.edu/abs/2003AGUFMPP42A0859S/abstract

Schlacher, T.A., Baco, A.R., Rowden, A.A., O'Hara, T.D., Clark, M.R., Kelley, C. and Dower, J.F., 2014. Seamount benthos in a cobalt-rich crust region of the central Pacific: conservation challenges for future seabed mining. *Diversity and Distributions*, *20*(5), pp.491-502.

Simpson, A. and Watling, L. 2011. Precious corals (Coralliidae) from north-western Atlantic seamounts. *Journal of the Marine Biological Association of the United Kingdom 91*(2), pp. 369-382.

Sleep, N.H., 1990. Monteregian hotspot track: A long-lived mantle plume. *Journal of Geophysical Research: Solid Earth*, *95*(B13), pp.21983-21990.

Talley, L.D., Pickard, G.L., Emery, W.J., and Swift, J.H. 2011. *Descriptive Physical Oceanography: an Introduction*. Academic Press.

Thoma, J. N., Pante, E., Brugler, M.R., and France, S.C. 2009. Deep-sea octocorals and antipatharians show no evidence of seamount-scale endemism in the NW Atlantic. *Marine Ecology Progress Series, 397,* pp. 25-35.

Uchupi, E., Phillips, J.D. and Prada, K.E., 1970. Origin and structure of the New England seamount chain. *Deep Sea Research and Oceanographic Abstracts 17*(3),pp. 483-494. Elsevier.

Waller, R., Watling, L., Auster, P. and Shank, T., 2007. Anthropogenic impacts on the Corner Rise seamounts, north-west Atlantic Ocean. *Journal of the Marine Biological Association of the United Kingdom*, *87*(5), pp.1075-1076.

Watling, 2007. A review of the genus *Iridogorgia* (Octocorallia: Chrysogorgiidae) and its relatives, chiefly from the North Atlantic Ocean. *Journal of the Marine Biological Association of the United Kingdom 87(2), pp. 393-402.*

Watling, L., Waller, R., and Auster PJ., 2007. Corner Rise Seamounts: the impact of deep-sea fisheries. *ICES Insights* 44:10–14.

Watling, L., France, S.C., Pante, E. and Simpson, A., 2011. Biology of deep-water octocorals. *Advances in Marine Biology 60*, pp. 41-122. Academic press.

Figure Legends

Fig. 1. Bathymetric map of the New England (1-12) and Corner Rise (13-15) Seamount groups. Maps at lower left and right show locations of the dives analyzed. Where several dives are located very close together, only one dive name is shown. All dive locations are listed in Table 1.

Fig. 2. Number of sample units in which individual taxa were observed.

Fig. 3. Species accumulation curves for the combined New England and Corner Rise Seamounts. Sobs: actual observed species; Chao1: species predicted based on Chao1 estimator of species richness. Sample units are 100 m depth intervals on each seamount or peak.

Fig. 4. MDS of taxa analyzed by occurrence in water of temperature grouped by 1°C increments using the Bray-Curtis similarity measure.

Fig. 5. Contours of water temperature over the New England and Corner Rise Seamount chain (data from NOAA World Ocean Atlas, 2013, ver. 2: www.nodc.noaa.gov/OC5/woa13/) along with vertical bars showing location by longitude and depth of seamounts sampled. Bars are color

coded and labeled according to extent of megabenthic assemblages from cluster analysis (Figure 6). Asterisks denote depth of the seamount summit. See Table for abbreviations.

Fig. 6. Dendrogram showing cluster analysis results for sample units where the bottom water temperature was between 2 and 5°C. Sample units are coded by seamount acronym and numbers denoting start of 100 m depth interval (x100). Sample units are further coded according to average temperature. Significant clusters as determined by SIMPROF routine are labeled from A to M and are plotted on Figure 5.

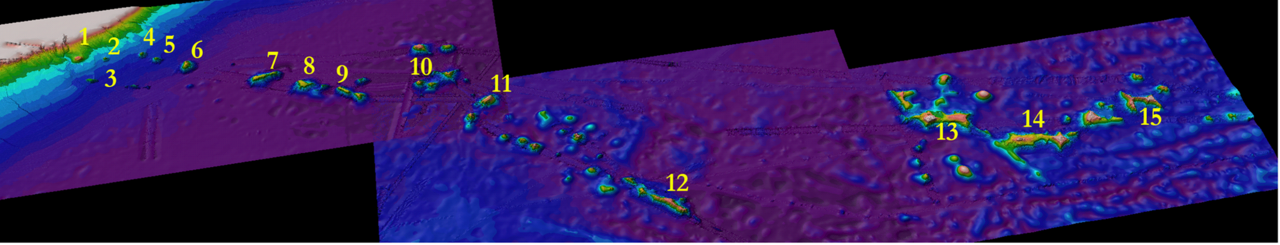
Fig. 7. Total taxa found on each seamount/peak in the New England and Corner Rise Seamounts, arranged by major taxonomic group.

Fig. 8. Total taxa, cumulative hours, and average number of taxa recorded per hour spent in each 100 m depth interval across all seamounts.

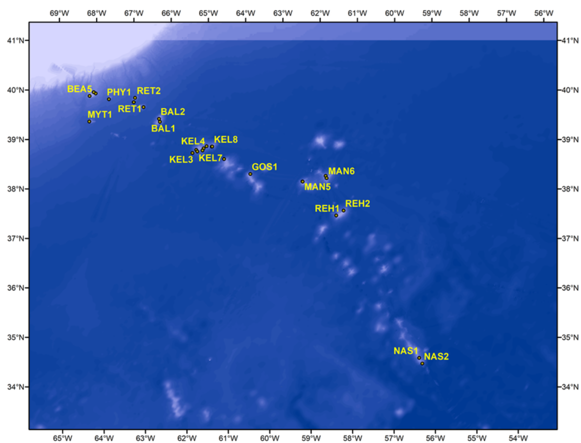
Fig. 9. Average temperature-salinity values for the HOV and ROV dives on the seamounts in New England and Corner Rise chains. Each point represents a 100 m depth interval from each seamount flank or peak. Dives that occurred on Kükenthal Peak at depths shallower than 1200 m, which all occurred in water warmer than 6ºC, are not included in the graph.

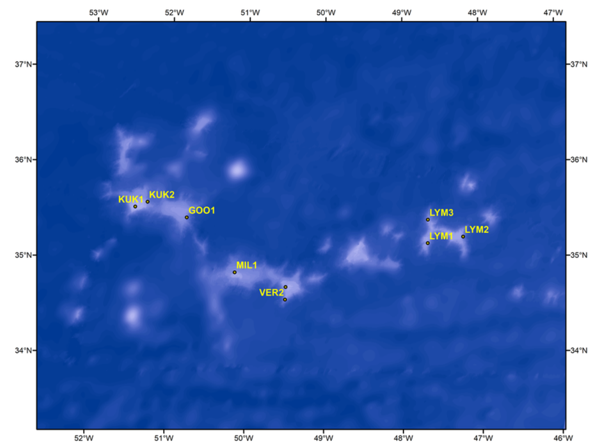
Table 1. Summary details of the HOV and ROV dives analyzed in the present study.

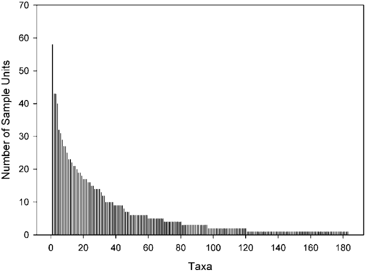
Seamount/Peak	Latitude	Longitude	Date	Dive #	Dive Name	Vehicle	Bottom time (h)	Number of Images Analyzed	Approximate summit depth (m)	Min depth sampled (m)	Max depth sampled (m)	Collected Specimens
Atlantis II	38.602	-63.325	9/27/2014	LEG3DIVE07	ATL1	*Deep Discoverer*	8.15	556	1586	2548	2700	0
Balanus	39.355	-65.359	5/22/2004	H0412	BAL1	*Hercules*	18.98	992	1444	1542	1933	20
Balanus	39.416	-65.412	9/1/2005	H0516	BAL2	*Hercules*	9.92	2593	1444	1684	1930	15
Bear	39.928	-67.346	7/17/2003	3905	BEA1	*Alvin*	5.2	0	1102	1419	1781	12
Bear	39.955	-67.413	5/11/2004	H0403	BEA4	*Hercules*	4.68	73	1102	1566	1632	5
Bear	39.877	-67.477	5/12/2004	H0404	BEA5	*Hercules*	13.75	599	1102	1395	1869	7
Goode	35.393	-51.266	8/20/2005	H0507	GOO1	*Hercules*	14.03	1590	1591	1851	2156	26
Gosnold	38.301	-62.512	9/28/2014	LEG3DIVE08	GOS1	*Deep Discoverer*	7.52	419	1429	1847	2138	0
Kelvin	38.788	-64.132	7/15/2003	3903	KEL1	*Alvin*	4.67	0	1577	1781	2073	14
Kelvin	38.861	-63.9	7/16/2003	3904	KEL2	*Alvin*	6.52	0	1577	1857	2184	19
Kelvin	38.725	-64.2017	5/17/2004	HO408	KEL3	*Hercules*	3.83	0	1577	3481	3935	2
Kelvin	38.82	-63.959	5/18/2004	H0409	KEL4	*Hercules*	5.1	307	1577	1712	1781	8
Kelvin	38.775	-63.965	5/19/2004	H0410	KEL5	*Hercules*	16	672	1577	2245	2427	11
Kelvin	38.852	-63.764	5/20/2004	H0411	KEL6	*Hercules*	13.03	584	1577	1931	2125	21
Kelvin	38.757	-64.091	8/31/2005	H0515	KEL7	*Hercules*	20.42	2104	1577	1829	2607	36
Kelvin	38.857	-63.75	9/29/2014	LEG3DIVE09	KEL8	*Deep Discoverer*	6.73	403	1577	1994	2073	0
Kukenthal	35.508	-51.959	8/21/2005	H0508	KUK1	*Hercules*	9.53	1685	688	713	922	15
Kukenthal	35.557	-51.815	8/22/2005	H0509	KUK2	*Hercules*	18.05	2157	688	1217	1831	30
Manning	38.264	-60.554	7/13/2003	3901	MAN1	*Alvin*	6.2	0	1312	1451	1734	15
Manning	38.218	-60.512	7/14/2003	3902	MAN2	*Alvin*	5.82	0	1312	1325	1415	6
Manning	38.218	-60.513	5/14/2004	H0405	MAN3	*Hercules*	13.78	512	1312	1330	1340	11
Manning	38.149	-61.102	5/15/2004	H0406	MAN4	*Hercules*	7.32	356	1356	1662	1933	22
Manning	38.147	-61.098	5/16/2004	H0407	MAN5	*Hercules*	12.67	795	1356	1421	1786	18
Manning	38.218	-60.511	8/27/2005	H0512	MAN6	*Hercules*	16.86	2954	1312	1321	1337	29
Milne-Edwards	34.818	-50.506	8/17/2005	H0504	MIL1	*Hercules*	11.23	1440	939	1280	1690	25
Mytilus	39.385	-67.144	8/4/2013	LEG2DIVE04	MYT1	*Deep Discoverer*	6.42	399	2269	2703	3271	0
Mytilus	39.361	-67.205	8/5/2013	LEG2DIVE05	MYT2	*Deep Discoverer*	7.4	250	2269	2634	3262	0
Nashville	34.583	-56.843	8/24/2005	H0510	NAS1	*Hercules*	13.67	1147	1931	2100	2253	25
Nashville	34.47	-56.729	8/25/2005	H0511	NAS2	*Hercules*	13.27	1968	1931	2097	2567	20
Physalia	39.811	-66.932	10/1/2014	LEG3DIVE11	PHY1	*Deep Discoverer*	4.5	418	1893	2378	2579	0
Picket	39.652	-65.942	10/28/2005	4162	PIC1	*Alvin*	5.53	1400	1902	1944	2086	18
Rehoboth	37.461	-59.952	8/28/2005	H0513	REH1	*Hercules*	12.78	1538	1240	1805	1936	35
Rehoboth	37.561	-59.807	8/29/2005	H0514	REH2	*Hercules*	12.33	794	1240	1350	1686	33
Retriever	39.751	-66.249	5/23/2004	H0413	RET1	*Hercules*	26.75	598	1921	1980	2055	23
Retriever	39.839	-66.259	9/25/2014	LEG3DIVE05	RET2	*Deep Discoverer*	8.23	506	1921	2004	2140	0
Verrill	34.664	-49.82	8/18/2005	H0505	VER1	*Hercules*	6.17	740	1029	1098	1688	12
Verrill	34.531	-49.794	8/19/2005	H0506	VER2	*Hercules*	16.1	1343	1029	1512	2129	24
Yakutat	35.124	-48.109	8/12/2005	H0501	LYM1	*Hercules*	12.28	2443	1170	1380	1753	17
Yakutat	35.192	-47.672	8/13/2005	H0502	LYM2	*Hercules*	11.88	1317	1131	1943	2412	15
Yakutat	35.369	-48.163	8/14/2005	H0503	LYM3	*Hercules*	15.53	3180	1131	1425	1653	18
						Total	**417.3**	**38276**				**589**



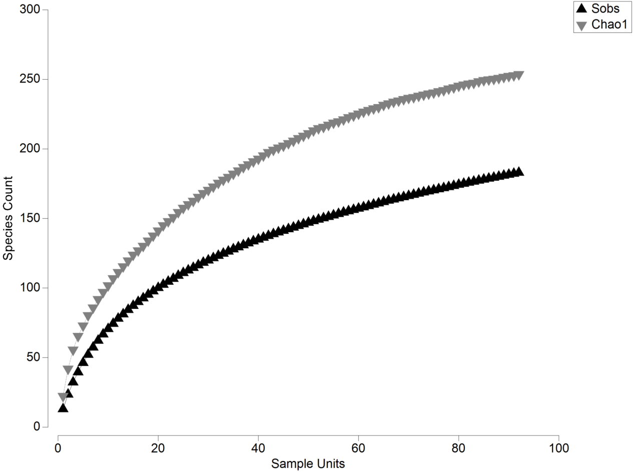
1. Bear
2. Physalia
3. Mytilus
4. Retriever
5. Picket
6. Balanus
7. Kelvin
8. Atlantis II
9. Gosnold
10. Manning complex
11. Rehoboth
12. Nashville
13. Corner
14. Caloosahatchee
15. Yakutat

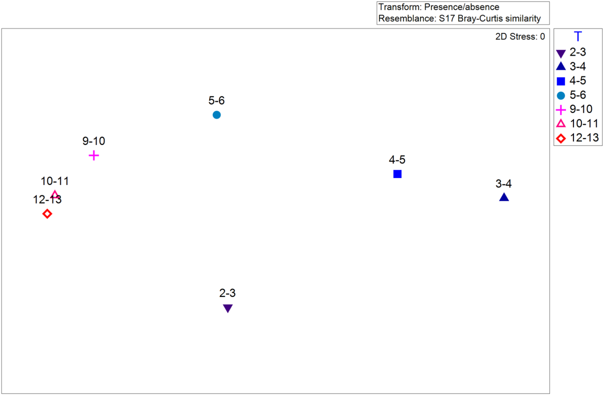




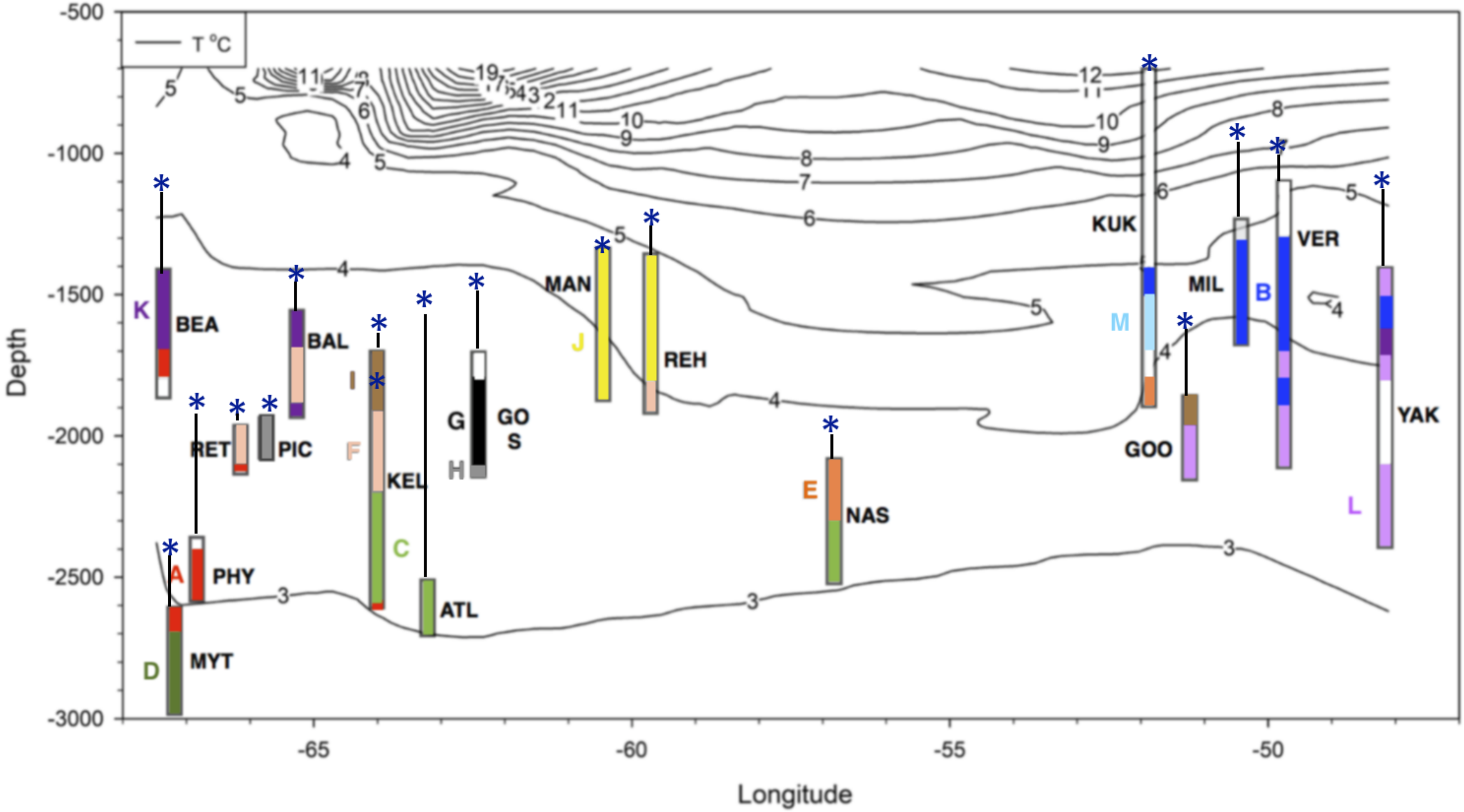


Number of Sample Units
Taxa
0
10
20
30
40
50
60
70
0
20
40
60
80
100
120
140
160
180

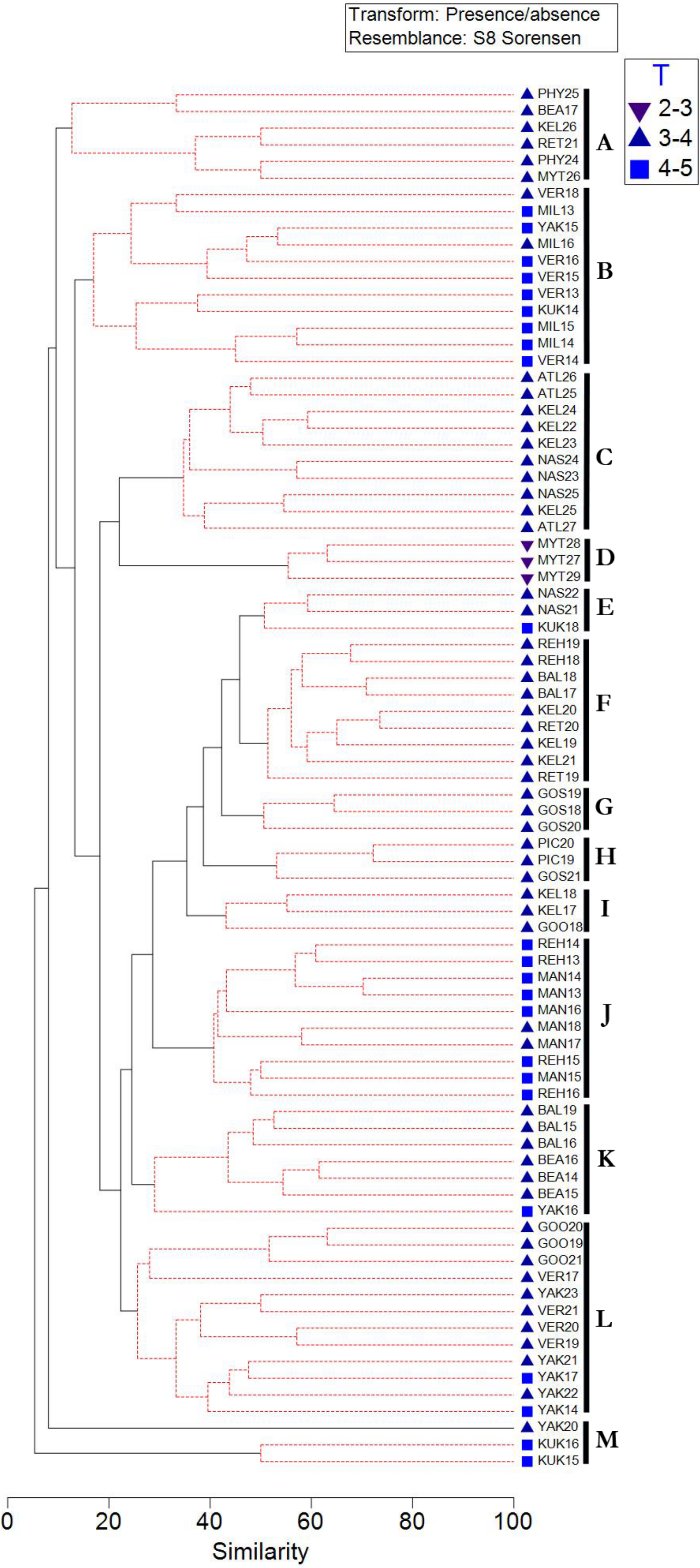

Sobs
Chao1
Species Count
Sample Units
0
50
100
150
200
250
300
0
20
40
60
80
100

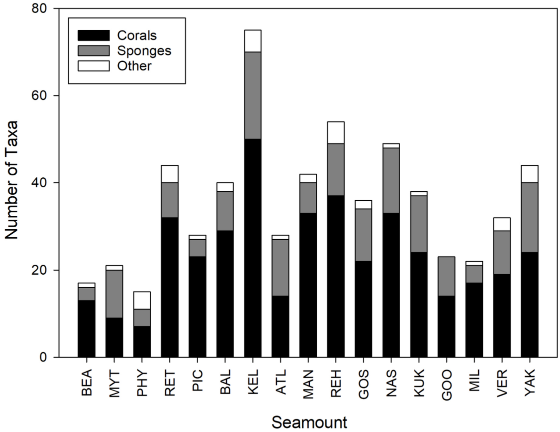


Transform: Presence/absence
Resemblance: S17 Bray-Curtis similarity
2D Stress: 0
5-6
9-10
4-5
10-11
3-4
12-13
2-3
T
2-3
3-4
4-5
5-6
9-10
10-11
12-13

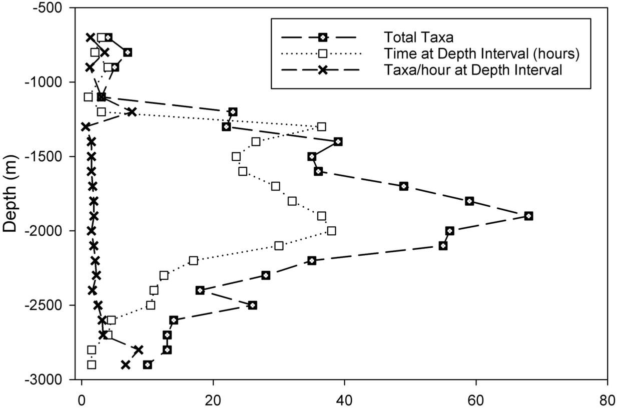


T °C
Depth
Longitude
-500
-1000
-1500
-2000
-2500
-3000
-65
-60
-55
-50
BEA
BAL
RET
PIC
PHY
MYT
KEL
ATL
GO
S
MAN
REH
NAS
KUK
MIL
VER
GOO
YAK
K
A
D
I
F
C
G
H
J
E
M
B
L


Transform: Presence/absence
Resemblance: S8 Sorensen
T
2-3
3-4
4-5
PHY25
BEA17
KEL26
RET21
PHY24
MYT26
VER18
MIL13
YAK15
MIL16
VER16
VER15
VER13
KUK14
MIL15
MIL14
VER14
ATL26
ATL25
KEL24
KEL22
KEL23
NAS24
NAS23
NAS25
KEL25
ATL27
MYT28
MYT27
MYT29
NAS22
NAS21
KUK18
REH19
REH18
BAL18
BAL17
KEL20
RET20
KEL19
KEL21
RET19
GOS19
GOS18
GOS20
PIC20
PIC19
GOS21
KEL18
KEL17
GOO18
REH14
REH13
MAN14
MAN13
MAN16
MAN18
MAN17
REH15
MAN15
REH16
BAL19
BAL15
BAL16
BEA16
BEA14
BEA15
YAK16
GOO20
GOO19
GOO21
VER17
YAK23
VER21
VER20
VER19
YAK21
YAK17
YAK22
YAK14
YAK20
KUK16
KUK15
A
B
C
D
E
F
G
H
I
J
K
L
M
0
20
40
60
80
100
Similarity



Corals
Sponges
Other
Number of Taxa
0
20
40
60
80
BEA
MYT
PHY
RET
PIC
BAL
KEL
ATL
MAN
REH
GOS
NAS
KUK
GOO
MIL
VER
YAK
Seamount



Total Taxa
Time at Depth Interval (hours)
Taxa/hour at Depth Interval
Depth (m)
-500
-1000
-1500
-2000
-2500
-3000
0
20
40
60
80

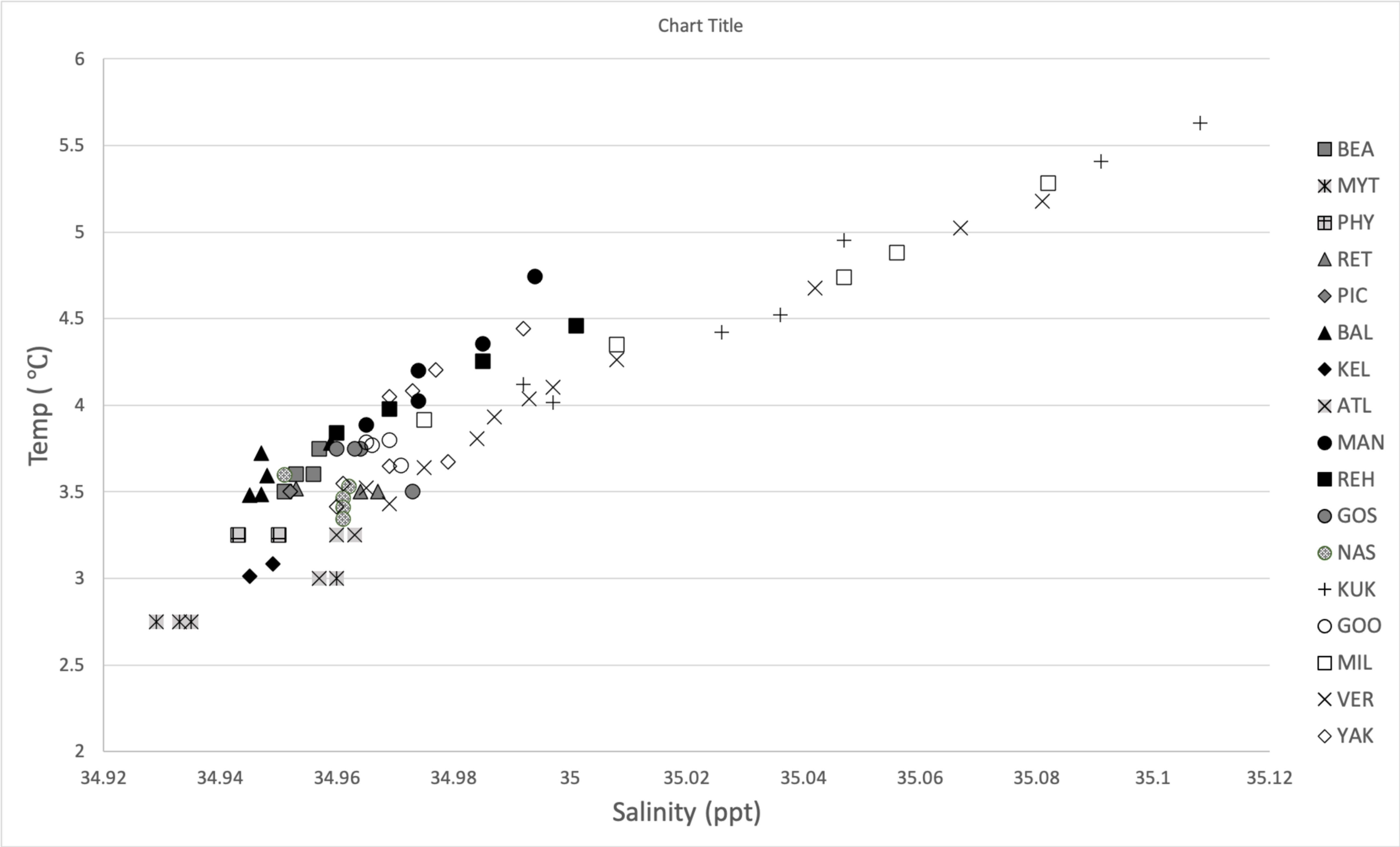


Chart Title
Temp (°C)
Salinity (ppt)
6
5.5
5
4.5
4
3.5
3
2.5
2
34.92
34.94
34.96
34.98
35
35.02
35.04
35.06
35.08
35.1
35.12
BEA
MYT
PHY
RET
PIC
BAL
KEL
ATL
MAN
REH
GOS
NAS
KUK
GOO
MIL
VER
YAK