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SALAS Y GÓMEZ BENTHIC HABITAT AND COMMUNITY ASSESSMENT OF SEAMOUNTS AND OCEANIC ISLANDS

A Thesis

by

KARA ECKLEY

Submitted in Partial Fulfillment of the

Requirements for the Degree of

MASTER OF SCIENCE

Major Subject: Ocean, Coastal, and Earth Studies

The University of Texas Rio Grande Valley

December 2022

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KARA ECKLEY

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December 2022

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ABSTRACT

Eckley, Kara, Salas y Gómez Ridge Benthic Habitat and Community Assessment of Seamounts and Oceanic Islands. Master of Science (MS), December, 2022, 119 pp., 18 tables, 20 figures, references, 49 titles.

Seamounts are essential benthic habitats that are ecologically important, providing habitat and functioning as stepping stones for dispersal and possible refugia, and economically valuable, supporting fisheries and potential mineral mining. The Salas y Gómez Ridge in the southeast Pacific Ocean longitudinally contains dozens of seamounts that extend ~2,900 km across the South Pacific Subtropical Gyre and experience a range of oxygen and nutrient conditions that could contribute to differences within and among seamount species assemblages. Four seamounts, several never having been surveyed, and two oceanic islands were surveyed by a towed camera system to describe the benthic habitats and megafauna, and to assess relationships between environmental data and communities along the ridge. Faunal communities differed among stations, with different dominant fauna at each. Changes with depth were unclear, though the best explanatory variable for community changes was depth; further studies are needed to understand observed patterns and aid conservation efforts.

DEDICATION

The support of my family, including my mother, Valerie Eckley, and my sister, Corin Eckley, and their eternal optimism and belief in my capabilities encouraged me to further my education in the pursuit and completion of this degree. Emily Stohler also provided support, as well as the occasional much needed distraction. Thank you all.

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CHAPTER I

INTRODUCTION

Seamounts

Seamounts are underwater geologic structures that individually rise 1000 m or more from the surrounding seafloor (Wessel, 2007), and seamount ranges can span vertically and horizontally across depths and conditions, including nutrient, dissolved oxygen concentrations and productivity. Thus, even a single seamount can support several diverse communities. Seamounts and smaller (< 1000 m) abyssal hills and knolls are estimated to comprise 21% of the ocean floor globally (Yesson et al., 2011). Estimates of the number of seamounts worldwide (Figure 1) vary widely and can range from tens of thousands to upwards of a million or more including hills and knolls (Kitchingman et al., 2012). Seamounts, much like oceanic islands, are typically volcanic in origin and are often located at mid-ocean ridges but can also be found at subduction zones and within oceanic plates, where linear seamount chains extend from mid-ocean ridges and hotspots (Wessel, 2007).

The study of seamounts is a relatively new field – with their discovery occurring in the mid- to late-1800s – but earlier peoples unknowingly relied on seamounts over which aggregations of seabirds were observed. These peoples knew seabirds indicated the presence of accumulations of fishes below the surface, so these locations were popular fishing grounds. We now know these aggregations often indicate the existence of shallow seamounts below the surface. Because of their often-isolated locations and the deeper depths, i.e., depths below scuba limits, at which they are found, seamounts have been studied less frequently than other marine habitats and most remain unmapped. Today, most seamount locations and depths are modelled based on satellite-based bathymetry; these modeled depth and locations are often inaccurate (Wessel, 2007) and require ground-truthing. Once found, seamounts are generally surveyed by advanced technology, including remotely operated vehicles (ROVs), autonomous underwater vehicles, and submersibles. These studies have provoked a number of hypotheses on seamount ecology, including that they have high endemism (i.e., species which are native to a geographically restricted region and not found elsewhere) and biomass, may be sites of high biodiversity, harbor undiscovered species, and are potentially stepping stones to dispersal of organisms (Rowden et al., 2010a).

For many of these hypotheses, supporting evidence scarceness is due to seamount habitats being largely understudied and the challenges involved with accessing and surveying seamounts. Nevertheless, seamounts are considered vulnerable marine ecosystems because many of the benthic organisms comprising their communities are sessile, slow growing, long lived, and fragile, so seamount ecosystems are sensitive to disturbances to the seabed – such as trawling – and may take decades to recover (Williams et al., 2010). Seamounts will be targeted by the increasing threat of mineral mining, which will also be damaging to the communities occupying the seabed. Because many seamounts have no protections, are already targeted for deep-sea fishing, and are facing increasing threats, it is important to survey unexplored seamounts to protect these areas and prevent the loss of endemic species and species not yet known to science. Thus, any results or discoveries from their assessment is highly informative.

It is not fully understood what drives patterns in community composition on seamounts. Many variables could be involved, from temperature and dissolved oxygen concentrations to distance from continental shelf, currents, and light availability. Comparisons to oceanic island communities can be informative as these features are similarly formed, often in proximity, and experience comparable conditions. Because oceanic islands extend beyond the surface of the ocean, their slopes can receive input of both organic and inorganic matter from the land above that can support a higher biomass and diversity than nearby seamount slopes (Worm et al., 2003). For example, a study in the southwest Pacific found biomass of epibenthic megafauna to be four times higher on oceanic island slopes than seamount slopes (Rowden, et al., 2010b). Nevertheless, seamount habitats can sustain an abundance of life and although biomass may be higher on oceanic islands, hypotheses on richness and diversity lack consistent evidence, and increased biomass may result from increased abundance of one or a few species. For example, most of the biomass increase found by Rowden et al. (2010b) was comprised by a single species of the coral *Solenosmilia variabilis*. Likewise, species richness is significantly higher on seamount slopes and plateaus near New Zealand than on nearby relatively flat slopes around the sampled seamounts (Tracey et al., 2004). However, many of these trends in richness, abundance, and diversity are not consistent, can vary by the scale of analysis (O'Hara, 2007), and it's possible that no differences are found between seamounts and comparable habitats (Howell et al., 2010).

Seamounts and the slopes of oceanic islands are useful in analyzing the effects of depth on communities as they have rapid elevation changes over short horizontal distances (10s to 100s of meters) from their summits to the surrounding seafloor. Depth is important as many species are restricted to a particular bathymetric range. Many studies have found assemblage changes at specific depth breaks that can differ among habitats and environmental conditions but generally follow a pattern of an increase in richness at mid-depths and a decrease in deeper waters. For example, a study of seamount and oceanic island slopes in the mid-Atlantic found several assemblage changes (Menezes et al., 2006) from a shallow assemblage that extended to approximately 200 m, followed by an upper slope assemblage at 200-600 m, a lower slope assemblage at 600-800 m, and a deep assemblage at 800-1200 m. These depth breaks reflect the boundaries of several water masses, which can vary in a number of environmental factors including dissolved oxygen and temperature (Menezes et al., 2006). A study of seamounts northwest of Spain found the composition of fish assemblages changed with distance from the continental slope as well as depth, which both explained much of the observed variation (González-Irusta et al., 2021). Likewise, McClain et al. (2010) observed a 50% assemblage turnover of benthic megafauna over a 1500 m change in depth on Davidson seamount in the northeast Pacific Ocean.

While these conditions and other environmental factors (substrate, productivity, etc.) can have wide-ranging effects on benthic habitats and the communities that they support, changes on a smaller scale also play an important role. Broad-scale analyses (across seamounts) may not always be effective for describing observed patterns of fauna and communities, and detailed assessment of a seamount at a fine-scale (within-seamount) may be necessary as variables such as the side of the seamount surveyed and substrate may be important factors as well (Auscavitch et al., 2020). Seamounts and oceanic islands can have widely different macrohabitats (meter-scale) and microhabitats (centimeter-scale) within and among a single seamount or island. For example, in the southeast Pacific, oceanic island macrohabitats included bedrock and cobbles, coarse sandy, or silty sediment whereas seamounts macrohabitats were largely coarse sand and rhodolith beds (Tapia-Guerra et al., 2021). The variety in substrates was also reflected in the fauna present, with mobile fauna and predators being most frequent on the island slopes and hemisessile and sessile fauna, particularly invertebrates, typically being predominant on the seamounts.

On a larger scale, environmental conditions (e.g., nutrients, temperatures, and oxygen) range horizontally across latitudes and longitudes and with depth. For example, oxygen can vary widely both horizontally and vertically across and within water masses as well as oxygen minimum zones (OMZs). Hypoxia in these regions may occur at slightly different concentrations of oxygen, but generally occurs below 1.4 – 2.75 ml/l of dissolved oxygen. Because of the often negative effects of low oxygen on fauna, OMZs may increase regional diversity and endemism, particularly in terms of the beta diversity within and across the boundaries of the OMZ (Gooday et al., 2010; Rogers, 2000). Although alpha diversity generally decreases in the vertical center of an OMZ and with increasing hypoxia because the few species present have adapted to the conditions, the transition between hypoxic to normoxic at the boundaries supports a higher number of species tolerant to the low-oxygen conditions. Although these boundaries will range in size and depths dependent on the individual characteristics of an OMZ, the effects of OMZs extend ~300 m around the boundaries of the OMZ, with lower diversity above, below, and within the vertical center of the OMZ (Gooday et al., 2010). Large OMZs are common in some ocean and coastal regions, can be spread and distributed via currents, and are expected to increase in size and number in the coming years and decades (Stramma et al., 2008).

Subtropical gyres can also affect horizontal patterns in marine environments because of patterns of productivity and lack thereof across these gyres. Low productivity and nutrients are commonly found in the gyres center, which can lead to low biomass. Due to the low productivity, these locations frequently have increased water clarity, which can allow light to extend beyond typical depths and increasing the extent of the mesophotic zone (Kletou and Hall-Spencer, 2012), which it typically found at 30-200 m and contains low levels of light. As light penetrates to increasing depths light-dependent organisms can follow to a depth they would not be found in other locations and conditions. This can include algae and light-dependent coral, among others, and the fauna that depend on them. As seamounts can extend across vertical distances of 1000's of m, from the aphotic zone to the mesophotic zone or higher, much like oceanic islands or continental slopes, this provides an interesting opportunity to observe habitats and communities across a range of depths and distinct geographical features. These habitats, with numerous similarities and differences, provide an interesting comparison of habitats and environmental conditions and how they interact and affect benthic communities. This research can help explain what distinguished seamounts from oceanic islands and other comparable environments and will be instrumental in confirming or disproving the many little-understood hypotheses on seamount communities.

Salas y Gómez Ridge

The highest abundance of seamounts can be found in the Pacific Ocean (Yesson et al., 2011), including those of the Salas y Gómez Ridge (Figure 2) on the Nazca Plate. The Salas y Gómez Ridge is remote, making the study of these habitats more challenging. Among the few studies in the region, are a dozen or so done in the mid to late 1900s and earlier that were largely focused on the islands at scuba diving depths (Easton et al., 2017; Fernandez et al., 2014) and a few studies below 200 m that were largely conducted by trawl (Parin, 1991). Studies focusing on the mesophotic zone (~50-200 m) came later, in the early 2000s, with advances made in technology, including technical diving, which allows for observation and sample collection at deeper sites (Easton et al., 2019). Additional studies of the seamounts and oceanic islands of the Salas y Gómez Ridge will provide important information to advise the protection and management of the region under the range of environmental parameters (e.g., oxygen and nutrients) it experiences.

The Salas y Gómez Ridge is unique in that it coincides with a hypoxic region of an OMZ (Stramma et al., 2008) along its eastern extent (~80°W; Figure 3) and the oligotrophic center of a subtropical gyre along the western extent (~105°W, Figure 4), both of which increase in intensity across the ridge in opposite directions. Oxygen concentrations along the Salas y Gómez ridge range from hypoxia at ~0.5 ml/l to nonmonic concentrations of ~5 ml/l.

The Salas y Gómez Ridge also coincides with the South Pacific Subtropical Gyre (SPSG), containing oligotrophic (0.06-0.10 mg/m^3 chlorophyll a) and ultraoligotrophic (<0.06 mg/m^3 chlorophyll a; Kletou and Hall-Spencer, 2012) waters. The SPSG rotates counterclockwise and borders the equator to the north, Australia and New Zealand to the east, the Antarctic Circumpolar Current to the south, and South America to the west. Along the west coast of South America, it coincides with the Humboldt Current, bringing cool sub-Antarctic water towards the equator (Montecino and Lange, 2009). The center of the SPSG contains some of the lowest productivity and clearest water in the world (Morel et al., 2010; von Dassow and Collado-Fabbri, 2014). Together, the SPSG and OMZ create a unique range of conditions along the Salas y Gómez Ridge, from hypoxic and eutrophic along the eastern extent of the ridge near Chile to nonmonic and oligotrophic on the western extent near the center of the SPSG.

These conditions of the Salas y Gómez Ridge experiencing oligotrophy and hypoxia may influence the diversity and abundance of fauna within and among seamounts (Almeida et al., 2017). In addition, numerous SPSG seamounts reach into the euphotic zone, allowing for mesophotic reefs, which are reefs below ~30 m that contain light dependent organisms. Because of the water clarity in the region, mesophotic reefs and algal growth can extend far beyond the depths to which they are typically limited and have been reported to nearly 300 m (Easton et al., 2019). These conditions can create unique environments that can support diverse fauna communities.

Fauna of the Nazca and Salas y Gómez Ridge are more similar to that of the Indo-West Pacific than the coast of South America (Parin, 1991). Thus, it is likely that these ridges were colonized primarily by species from the Indo-West Pacific as the seamounts were formed when the Pacific was narrower and as species moved along the ridge and settled into suitable habitats as they dispersed. Due to the isolation of the islands and seamounts and the unique conditions across the ridge, species have likely adapted to the unique conditions present throughout the ridge and they may be especially vulnerable to disturbances such as trawling, mining, and the impacts of climate change (Dewitte et al., 2021), particularly as much of the ridge is found in Areas Beyond National Jurisdiction (ABNJ; Wagner et al., 2021). It is important to study this area to confirm the suspected high endemism along the ridge (Easton et al., 2017), to identify locations of community shifts along the ridge (Parin, 1991) and with depth (Friedlander et al., 2021), to identify the faunal communities and species ranges to inform conservation efforts and to manage resources sustainably in the area.

This study aims to assess the benthic habitats and associated fauna of the Salas y Gómez Ridge from towed camera video surveys. Analyses of these data along with environmental data such as dissolved oxygen and depth will be used to determine the trends between environmental data and community composition on seamounts and oceanic islands along the Salas y Gómez

Ridge in the southeast Pacific. Because most of the prior studies were conducted by dredge, and the few video surveys were largely performed at depths above 300 m, this study will analyze the first video surveys of the Salas y Gómez Ridge from 200-1000 m to provide much needed information on these habitats to aid in their protection and that of the species residing in ABNJs, exclusive economic zones, and marine protected areas of the Salas y Gómez Ridge.

Objectives

Objectives for this research are:

1. To characterize and compare the benthic habitat and communities of four Salas y Gómez Ridge seamounts and two oceanic island slopes from ~200-1000 m.
2. To analyze the relationship between faunal community patterns, depth and water masses.
3. To analyze the relationship between faunal community patterns and environmental factors: substrate, temperature, salinity, dissolved oxygen, slope, aspect, and bathymetric position index.

Hypotheses

Hypotheses are:

1. Faunal abundance, species richness, diversity, and evenness are expected to differ between oceanic island slopes and seamounts.
2. Community composition is expected to differ with depth and water mass with communities being more similar among stations at similar depths than within a station across depths.
3. Community composition is expected to differ with and among substrate types, with

sessile fauna such as sponges and corals occurring on hard substrate and mobile fauna such as fishes and crustaceans on soft substrate.

CHAPTER II

METHODS

Study area

The Salas y Gómez Ridge stretches over 2900 km east to west off the coast of Chile (Figure 2), contains several islands including Easter Island, and consists of dozens of seamounts (Fernandez et al., 2014). The ridge was formed as the Nazca plate moved east over two hotspots – the Eastern Hotspot and the Salas y Gómez Hotspot – approximately 15-23 million years ago (Bello-González et al., 2018; Ray et al., 2012). As per these authors, the east-west portion of the ridge was formed by the Eastern Hotspot, and the northeast-southwest section by the Salas y Gómez Hotspot. The formations created by both hotspots decrease in age moving west, and the hotspots are thought to currently be near Easter Island and Salas y Gómez Island.

The ridge also overlaps with the Southeast Pacific OMZ (Figure 3) and the SPSG (Figure 4). Due to the OMZ, the eastern extent of the ridge experiences hypoxic conditions while the western extent normoxic conditions. The ultraoligotrophic center of the SPSG is located at the western side of the ridge, and nutrient concentrations and productivity then increase moving east.

Data Collection

Benthic surveys were conducted using a towed camera system at six stations – four seamounts (SM) and two oceanic islands (OI; Easter Island and San Ambrosio; Table 1, Figure 2) – along the Salas y Gómez Ridge during the EPIC (East Central Pacific International Campaign) Cruise (MR18-06-03) on the Japan Agency for Marine-Earth Science and Technology's (JAMSTEC) R/V *Mirai* in February 2019. Transect were named using EPIC cruise convention of SPG for South Pacific Gyre and number 1-8 for each station sampled on the cruise, with alternate stations having an additional letter code (A) at the end of the name (e.g., SPG7A). Stations SPG1, SPG2, and SPG8 were excluded from this study as they were neither seamount nor oceanic island stations. One upslope transect was conducted at ~1000 m to the summit or local high islands at ~200-500 m at each station, except at SPG7A, where two transects were conducted (Figure 5, Table 1). The towed camera system, SuperDeepTow6KC (hereafter DeepTow), was developed by JAMSTEC and equipped with numerous cameras ranging from standard definition to an 8K high-definition camera (Table 2), CTD and dissolved oxygen sensors (Table 3), and a laser line (Skate, SubC Imaging, Clarenville, Canada). The two downward-facing standard-definition video feeds along with one forward-facing and one downward-facing video feed were projected live to create a four-screen video with depth, temperature, salinity, and dissolved oxygen overlaid on the video at all stations except SPG3 and SPG4 because of a technical problem with CTD power supply. Each transect was annotated live using SquidVidPro with Squidle+ (https://squidle.org/). These annotations along with corresponding 8K images for each recorded annotation were later used to assist in faunal analysis.

Additional CTD casts were conducted to ~2000 m near each station except at SPG7A because of rough weather. Sensors measured and recorded conductivity, temperature, depth, and dissolved oxygen at intervals of 1 m. Water sampling was conducted using a 36-position carousel water sampler (CWS; Table 3) with 12 L sample bottles (Table 3). Water samples were taken between 2000 m and the surface at increasingly smaller intervals to the surface and were analyzed by W. Schneider's laboratory (Departamento de Oceanografía, Universidad de Concepción, Chile) for environmental variables such as oxygen concentrations and fluorescence. Bathymetric data were collected using a bathymetric multibeam system and a sub-bottom profiler (Table 3).

Data Analyses

Video Processing

Video feeds from the downward-facing 2K HD video camera were used for faunal community and benthic substrate analyses, with additional feeds used as references to aid identification. If the original videos were not available because of video file corruption, four-screen video files were used to extract the quadrant with same view and camera feed for analysis with Adobe Premiere Pro v 21-22.5 (Adobe, San Jose, USA). Premiere Pro was used to overlay timecodes (in Coordinated Universal Time; UTC) to the 2K HD downward-facing videos that were missing overlays due to errors during recording. GOM Player (GOM, Seoul, South Korea) was used to take still images with overlaid timecodes from videos taken by the 2K, high-definition, downward-facing camera at one-minute intervals. Images that were blurry or too dark were excluded from subsequent analyses; in general, these images were taken from >10-12 m above the seabed. For station SPG7A, where high-wave conditions caused the DeepTow to swing, obtaining usable clear images at subsequent one-minute intervals was difficult because of image quality rather than high altitude. Therefore, SPG7A images were retaken at 5 s intervals, and the clear image closest to the original one-minute interval time was used for analysis.

Still Image Analysis

Coral Point Count with Excel Extensions (CPCe; Kohler and Gill, 2006) was used to determine the percentage cover of substrate types (sand, hard substrate that combined rock and old reef structures for analyses, pebbles and cobbles, rubble, or shells and tests), fauna (corals, sponges, hydrozoans, other sessile fauna, and mobile fauna), and algae (crustose coralline, macroalgae, rhodolith, other) for each of the images (Table 4). Percentage cover was determined by overlaying 30 randomized points (Figure 6), which was selected based on a previous study of deep-sea, cold-water corals that analyzed percentage cover using 9, 16, 21, and 36 points (Guinan et al., 2009). Their survey area was smaller and recorded from a lower altitude (1.5–5.0 m) from which they determined that more than 21 points were impractical and obscured the image during analysis and there was >0.95 correlation in derived percentage cover from 9, 16, and 21 points (Guinan et al., 2009). The altitude for this study was 3-12 m and 30 points did not obscure the image, so it was determined that 30 points would be sufficient to estimate percentage cover. In addition to being used for percentage cover estimates of substrate and sessile fauna (Table 4), these images were also used for habitat characterization following Greene et al. (1999) as applied in recent description of the Nazca-Desventuradas Marine Park by Tapia-Guerra et al. (2021). Classifiers (subcategories in Table 5) included substrate type and morphology, and habitat modifiers such as the presence of sediment deposition and fauna, bioturbation, and physical erosional features and ripples.

Video Analysis

BIIGLE (Bio-Image Indexing and Graphical Labeling Environment; Zurowietz and Nattkemper, 2021) was selected for video annotation as it had the most desired features, including the ability to search, edit, and review previous annotations; to annotate videos and images; and to allow access for multiple users (Gomes-Pereira et al., 2016). Videos were cut with Adobe Premier Pro into 20 min segments for easier transfer to the BIIGLE servers. Videos were watched at full speed and megafauna (>1 cm) observable on the 2K HD downward-facing videos were marked as point annotations on BIIGLE (Figure 7). Point annotations recorded the label, unique number identifier, video time, and position within the frame of the annotated object (hereafter object of interest; OOI). These annotation data were exported to .csv files. Some annotations were tracked across the screen while visible within the frame, generally for fast-moving OOIs, to prevent double counting while moving through the frame. For tracked OOIs, position and time were recorded for the first and last frame containing the OOI. Each OOI was identified to morphospecies or the lowest possible taxon, also called an operational taxonomic unit (OTU). Each annotation label represented a unique OTU. Real-time annotations from Squidle, publications from the region (Dyer and Westneat, 2010; Easton et al., 2017; Mecho et al., 2019; Parin, 1991; Randall and Cea, 2011), the World Register of Marine Species (WoRMS, 2021, http://www.marinespecies.org), the University of Hawai'i Undersea Research Laboratory Deep-sea Animal Identification Guide (HURL, 2021, http://www.soest.hawaii.edu/HURL/HURLarchive/guide.php), and FishBase (Froese and Pauly, 2021, https://www.fishbase.se/search.php) were used to assist in identification. OTUs were assigned to taxa codes representing a higher-level classification such as class, phyla, or grouping of taxa by similarities such as taxa with alike functional roles, for subsequent analyses. Each of these groups were assigned a letter code for analysis: a represents arthropods, b for sharks, c for cnidarians excluding corals, d for cephalopods, e for eel-like fish, f for fish, g for non-cephalopod mollusks, h for sea cucumbers, p for sponges, r for true eels, s for brittle and sea stars, u for sea urchins, z for corals, and m for OTUs unable to be placed into another grouping.

Bathymetric Data Analysis

Onboard technicians corrected and edited bathymetric data with sound velocity profiles using HIPS version 10.2 (Teledyne CARIS, Fredericton, Canada) to account for conditions and movement of the boat. Data were analyzed and displayed using ArcMAP (ArcGIS Desktop 10.8.1, 2020, ESRI, West Redlands, USA) to produce figures and calculate seafloor surface descriptors as follows for subsequent statistical analyses. Bathymetry data were used to create 50 m grids that were used for analysis with Benthic Terrain Modeler (BTM; Walbridge et al., 2018) to calculate bathymetric position index (BPI), slope, and aspect for each station. BPI shows the relative change in elevation between a single grid cell and the cells in a specified radius around the cell. Values above 0 indicate a higher elevation and values below 0 indicate a decreased elevation, with 0 showing no relative elevation change. For fine-scale BPI, an inner radius of 1 cell and outer radius of 3 cells were used to analyze the range of 50-150 m around the specified cell. For broad-scale BPI, an inner radius of 5 cells and an outer radius of 10 cells were used to analyze a range of 250-500 m around the specified cell. These values were chosen based on the resolution of the bathymetric data and depiction of both small- and large-scale geologic features ranging from 10’s to 100’s of m and were displayed using color ramps using 2.5 standard deviations. Slope and aspect values were calculated for each 50 m cell with default BTM settings. Slope refers to the degree value of the slope at each cell, from 0° to 90°, where 0°

represents a flat surface and 90° represents a right-angle perpendicular to the 0° flat surface. Aspect uses a degree value from 0-360°**,** with 0° and 360° representing north and 180° representing south, to display the direction in which a slope is facing.

Data Compilation

Jupyter Notebook was used with Python 3 to select CTD environmental data at the nearest point to each CPCe image timestamp to combine the data sets into a single file for each dive for further analysis. Latitude and longitude data were recorded at intervals of approximately 6 s and the CTD data every s. Similarly, data from BTM analysis of aspect, slope, and both fine-scale and broad-scale BPI were combined for further statistical analysis by their timestamps. These values were then averaged by 50 m depth categories, which allowed the use of multiple replicates for statistical analysis. 50 m depth categories were assigned a majority substrate category; if no substrate was >70%, the depth category was described as mixed substrate. Percentage coverage by fauna was excluded as this data was used in analyses to assess faunal communities. This same method of extracting environmental data was also used for each BIIGLE annotation timestamp of each (Appendix A). Unlike compilation of the CPCe data, which included values of BTM analyses for each timecode, compilation of the BIIGLE data excluded data from BTM as annotations occurred much more frequently than every 1 min, which was the interval used for CPCe analysis. Annotations that were not assigned an OTU were excluded from statistical analysis, as well as ones with environmental data outliers such as erroneous depth measurements far beyond the depth range of the surveys.

Data Assessments

Data exploration and visualization, including normality quantile plots and pie graphs of the proportions of taxa codes or substrates by station, was conducted with JMP Pro 16.1.0 (2021, SAS Institute, Cary, NC, USA). To assess sampling effort, species accumulation curves were created in Microsoft Excel (Version 2202, 2022, Microsoft Corporation, Redmond, WA, USA) using the number of species observed by the number of organisms observed for each station, as well as average values across all stations. The curves indicated that sampling effort was insufficient as they did not near an asymptote.

Hypothesis 1: Seamounts vs. Oceanic Islands. To test for differences between seamounts and oceanic islands (hypothesis 1) by abundance, species richness (S), Shannon's diversity (H'), and Pielou's evenness (J'), these values and indices were calculated in Microsoft Excel for each station. These station values were averaged to determine the mean abundance, richness, diversity, and evenness by subsystem (seamount or oceanic island). Differences between seamount stations and oceanic island stations were tested using an unpaired two-sample t-test assuming unequal variance to assess differences between oceanic islands and seamounts for abundance, richness, diversity, and evenness.

Hypothesis 2: Community Patterns with Depth. To test for differences in community composition by depth (hypothesis 2), three methods of grouping annotations and percentage cover by depth. Depth breaks selected for analysis were 0-300 m, 300-600 m, 600-800 m, and 800-1200 m because they are breaks at which community composition changes have been observed in similar studies (e.g., Menezes et al., 2006). Distance from seamount summit or from surface for oceanic islands (summit/surface to 150 m, 150-500 m, >500 m) were selected because species turnover has been observed with increasing depth from summits **(Bergstad et al., 2008)**, particularly when they extend into the mesophotic zone **(Ramos et al., 2016)**. In addition, data were analyzed by the depth range of the water masses at each station because they may be drivers of change in communities, particularly when these water masses differ in environmental conditions such as dissolved oxygen **(Auscavitch et al., 2020)**. Using depth and oxygen profiles, five water masses were identified (Table 6 and Figure 8): the Equatorial Subsurface Water (O, southeastern Pacific OMZ), the Antarctic Intermediate Water (A), the Eastern South Pacific Intermediate Water (E), Coastal/Transition Water (C), and Pacific Deep Water (D). All five water masses were observed along the eastern portion of the ridge, with three of the water masses existing at all stations while the equatorial subsurface water and the coastal transition zone were only present at the easternmost stations.

Multivariate analyses were conducted using PRIMER-E version 7.0.21 with PERMANOVA+ (2021, PRIMER-E, Auckland, New Zealand) to assess the validity of hypotheses 2 – differences in community composition with depth – and 3 – differences in community composition by environmental variables. Multivariate analyses used two data sets: habitat data, which consisted for percentage cover of substrates from CPCe analysis and the associated environmental data, and abundance by OTU groups calculated from BIIGLE annotations. Both data sets were assigned eight factors: station, subsystem, 50 m depth categories, 200 m depth bins, majority substrate (sand, rock, or mixed), depth break, summit distance, and water mass. The 50 m depth category was to create replicate samples within a transect as there was only one transect per station, and thus was not used as an explanatory variable in analysis. The 200 m depth bin was used as a factor in preliminary analyses for

Hypothesis 1 but excluded from subsequent analyses as I had no *a priori* assumptions that communities would change at such a regular interval. Both data sets, the habitat data set and the abundance data set, were standardized, and OTU group abundance underwent two transformations, the first was a Log(X+1) transformation (hereafter abundance data) the second a presence/absence transformation (hereafter presence/absence data). Bray-Curtis similarity matrices of these two data sets and the percentage coverage of substrates with environmental data (hereafter CPCe data) were used for further analyses.

Hypothesis 3: Community Patterns with Environmental Factors. Draftsman plots in PRIMER-E were used to assess collinearity of environmental data. Variables with over 0.95 correlation were excluded from further analysis; temperature, which co-varied by dissolved oxygen concentration, and sand substrate, which co-varied with hard substrate, were excluded. Non-metric multidimensional scaling (nMDS) plots were used to compare community assemblages by the three depth groupings (expected ecological depth breaks, distance from summit, and water mass) and station. The nMDS analyses were run with the following settings: a metric proportion of 0.05, two minimum dimensions, three maximum dimensions, 50 restarts, 0.01 minimum stress, and default settings of Kruskal fit scheme and Shepard diagrams. For any resulting collapsed nMDS plots, the nMDS analysis was run a second time with the same previous settings, but the option for "fix collapse" was selected. Two-way permutational analysis of variance (PERMANOVA) was run on presence/absence data by OTU groups to test for differences in the communities by depth and station. PERMANOVA analyses included three designs: station (random factor) by depth break (fixed factor), station (random factor) by distance from summit (fixed factor), and station (random factor) by water mass (fixed factor). All

PERMANOVA analyses used Type III sum of squares and permutation of residuals under a reduced model using 999 permutations and the fixed effects sum to zero feature.

For designs with significant p-values (<0.05) for either factor or interactions between factors, pairwise testing was applied to assess differences within factors, followed by PERMDISP to assess whether differences in samples were a result of dispersion effects or location effects. PERMDISP settings used 999 permutations, with p-values from the permutations and distances calculated to the centroid. For each PERMDISP a combined factor was created using the two factors from the PERMANOVA design, and results included pairwise tests for all combinations of the combined factor.

BEST (Bio-Env + stepwise) analyses were conducted on abundance data (standardized and log(X+1) transformed data from BIIGLE annotations) as OTU groupings along with the standardized CPCe data using Spearman rank and Euclidean distance resemblance matrices to assess changes in community composition with environmental data (hypothesis 3). The analyses were run both with and without station as a factor. Settings selected were a maximum of five variables and provide the top ten resulting models. Two-way crossed SIMPER (similarity percentages) analyses on Bray-Curtis similarity matrices with a cut-off of ≥70% contribution were run to assess the contribution of environmental variables and taxa to the observed patterns. The SIMPER analyses were run on the same factors as the PERMANOVA analyses (station by water mass, station by distance to summit, and by depth groups). The option to list pair-wise groups was selected to be able to directly compare groups.

CHAPTER III

RESULTS

Benthic Terrain

Stations were surveyed across different depths, with the survey at SPG7A reaching the shallowest depth of all stations at 136 m and the one at SPG4 reaching the deepest at 1044 m. SPG3 and SPG7 were both oceanic islands of which SPG3 was surveyed into the mesophotic zone that extends to > 300 m in this region. Several seamounts, SPG4 (189 m), SPG7A (136 m), and SPG6 (252 m) were also surveyed into the mesophotic zone (Table 1). Surveys of each station spanned several hundred meters in depth over 1.4-3.8 km in transect length. SPG5 (deepest summit) and SPG7A transects both reached relatively flat sandy plateaus on the seamount summits at 537 m and 136 m, respectively (Figure 5, Table 1). BTM analyses revealed SPG5 transect shows the greatest range in slope, from steep cliffside to flat plateau. SPG7A transect also crossed a steep cliffside to flat plateau, though slopes were less intense and a larger distance across a flat area was surveyed than at other stations. SPG6 and SPG7 consisted of comparatively moderate slopes through nearly the entirely of the transect, and both SPG3 and SPG4 transects crossed moderately sloped and the edge of flat regions (Figure 9). bBPI (Figure 10) and fBPI (Figure 11) likewise indicate terrain differences among stations: SPG5 and SPG7A show areas of low bBPI and fBPI on the plateaus and high on the slopes, SPG6 and SPG7 had consistent variations throughout the transects, and SPG3 and SPG4 have a combination of these patterns. The transects also differed in aspect (Figure 12); survey transects on SPG3, SPG4, and SPG7 faced west with little variation within SPG3 or SPG4. The SPG7 transect ranged from southwest to northwest (Figure 12). Aspect of the SPG5 transect was north and northeast with very little variation within the station (Figure 12). The surveyed area of SPG6 faced east to southeast, with a small southern-facing region on the deeper end of the transect (Figure 12). The two transects on SPG7A with one transect facing south to west and the other from southeast on the shallow end to north at the shallow end of the transect on the plateau (Figure 12).

Habitat

Sand and hard substrate were the most frequently observed substrates, making up > 97% of cover, with both mobile and sessile fauna making up much smaller percentages (< 1%) in the CPCe habitat analyses (Figure 13). SPG3, SPG4, SPG5, and SPG7 consisted of at least 80% sand, with SPG7 having the highest sand cover (>95%). Hard substrate, which included both rock and old reef structures, coverage was 2-25% at each station. Only SPG6 had 1% or greater coverage of another CPCe category, sponges, which was the predominant fauna in abundance (Figure 14).

The SPG3 transect showed a nearly flat sandy area on the shallow upper slopes of the island, which was dominated by sea urchins (Figure 15A). As the survey went deeper, rocky substrate increased along with slope (Figure 15B), before reaching over 90% sand observed (Figure 15C) at the deepest portion of the transect. On SPG4, the summit of the seamount was predominantly sand, with a flat plateau where fish were the most prevalent OTU group (Figure 15D). Deeper, the transect consisted largely of rock with some sand at deeper depths (Figure

15F), but a large portion of the points were unidentifiable because the extreme slopes caused much of the image to capture cliffs with the bottom not visible (Figure 15D-E). The SPG5 transect showed sand at both the beginning and the end of the transect, with rock becoming more frequent in the middle of the transect, where steep rocky slopes were present (Figure 16A-C). There was also a smaller area just above the rocky slopes where biogenic substrate was found, and the most common OTU on SPG5 were mollusks (Figure 14). Similarly, SPG6 displayed a pattern of sandy substrate at the deeper and shallower ends of the transect, with steeper rocky slopes in between (Figure 16D-F). However, on the deeper rocky slopes there were hundreds of sponges covering much of the exposed bedrock (Figure 16F) and within and just below mesophotic depths old reef was a major contributor to hard substrate availability (Figure 16E). SPG7 was largely sand throughout, with rubble present at the shallow end of the SPG7 transect (Figure 17A-B). The deeper portions of the transect showed larger grain sizes (Figure 17 B-C) and coral was the most common OTU group on SPG7 (Figure 14). In addition, there were erosional features along the transect at shallower depths. The SPG7A transect had largely mixed substrate, with large percentages of both sand and rock throughout the depths surveyed with many rhodoliths observed at shallower depth (Figure 17D-F). The most dominant OTU group were non-coral cnidarians (Figure 14), which largely consisted of anemones and sea pens.

Faunal Communities

The average species accumulation curve for the combined stations (Figure 18) shows a leveling off as the curve approaches its asymptote representing the theoretical total species richness. However, when considered by station plateaus were not achieved for any station. It is likely that rare species were missed, as only six stations were surveyed, and a total of seven transect surveys were conducted.

Across the six stations, 16,965 OOIs were recorded across the seven transects spanning a range of environmental conditions (Table 7). SPG7A, a seamount station, was surveyed twice due to difficult weather conditions, which impacted video quality and led to portions of video being unable to be fully analyzed. These OOIs were assigned to 174 OTUs, which could be pooled into 13 OTU groups. Stations differed widely in the number of observed OOI from 217 on SPG4 to over 10,000 on SPG7A (Table 8. OTU richness, along with diversity and evenness, showed less variation, ranging from 27-56 OTUs observed within a station, with SPG3 containing the most and SPG4 the least (Table 8). Stations each had different predominant OTU groups determined by the percentage of fauna by groups within each station (Figure 14-17); each station showed a different OTU group as a majority of >50% of OOI within the station in which the OTU group dominated (Figure 14). These OTU groups were sea urchins (SPG3), fishes (SPG4), mollusks (SPG5), sponges (SPG6), corals (SPG7), and another cnidarian category consisting of anemones and sea pens (SPG7A; Figure 14). Most OTUs were only present at one or two stations, but a few were observed at up to four stations. When an OTU was observed at multiple stations it general was present at some of the eastern stations (SPG3, SPG4, SPG5, SPG6) or the western stations (SPG6, SPG7, SPG7A), and occasionally could be found in the middle together (SPG5, SPG6) or at eastern and western station from SPG3/4 to SPG7/7A (Table 9).

Hypothesis 1: Seamounts vs. Oceanic Islands

No significant differences were observed between subsystems (seamount, SM, and oceanic islands, OI) in overall abundance [SM: 3483 ± 2341.43SE, OI: 1516.5 ± 742.5, $t_{(4)} = -0.801$, $p = 0.468$], species richness (SM: 38 ± 4.78, OI: 49.5 ± 6.5; $t_{(2)} = 1.43$, $p = 0.29$), diversity (SM: 1.63 ± 0.34, OI: 1.58 ± 0.01; $t_{(3)} = -0.14$, $p = 0.90$), or evenness (SM: 0.46 ± 0.11, OI: 0.41 ± 0.016; $t_{(3)} = -0.51$, $p = 0.65$). A preliminary PERMANOVA analysis was run on station (random factor) within subsystem (fixed factor) by 200 m depth bins (random factor). This analysis only showed significant differences for station within subsystem and an interaction between 200 m depth bins and station within subsystem (Table 10). Subsystem was excluded from further analyses as there were only two oceanic island stations which were very different from one another, likely due to their distance of nearly 3000 km. These results could also have been impacted by the overall low sample size of the study.

Hypothesis 2: Community Patterns with Depth

The "fix collapse" option was selected for the following PERMANOVA analyses, as variation was obscured in the initial analyses, but well observed with this option (Figures 19-20). PERMANOVA analyses found similar patterns for each of the two-way analyses of station vs. depth grouping (station by water mass, station by distance-from-summit, station by depth breaks). All PERMANOVAs found significant differences in faunal communities among stations ($p = 0.001$) but not among depth group, with a significant interaction between station and each of the depth groupings ($p < 0.005$; Table 10).

Subsequent pairwise analyses for station and water mass showed that significant location (station)effects within water masses existed within the Equatorial Subsurface Water (ESSW), within Antarctic Intermediate Water (AAIW), and within Eastern South Pacific Intermediate Water (ESPIW). These differences were largely seen between eastern (SPG3, SPG4, and SPG5) and western (SPG6, SPG7, and SPG7A, Table 11) stations. The exceptions of this pattern were significant differences between SPG6 and SPG7A for AAIW and for ESPIW and SPG6 and SPG7 and SPG7 and SPG7A for AAIW (Table 11). PERMDISP found several significant dispersion effects for station by water mass, all of which included SPG3 or SPG7A (Table 11). SPG7A has larger dispersion (spread of points) whereas SPG3 has smaller dispersion than other stations. The nMDS graph plotting stations show location effects for SPG7, and SPG5 that have minimal overlap in faunal communities based on Bray-Curtis similarity (Figure 19). SPG7A overlaps with nearly all the other stations, and SPG6 shows considerable overlap as well. Within stations, pairwise test results only showed significant differences within SPG6 between AAIW and ESPIW, and PERMDISP showed no dispersion effects (Table 11).

Pairwise PERMANOVA analyses for station and summit distance showed few significant location differences within distance-from-summit groups. In the first 150 m (group 1) from the summit (surface level for OI; SPG3 and SPG7) the only significant difference was between SPG6 and SPG7A (Table 12). Within the group over 500 m (group 3) below the surface all significant location effects included SPG3, SPG6, or SPG7; only in combination with SPG6 or SPG7 were there dispersion effects as determined by PERMDISP. Within the middle group, from 150-500 m below the summit (group 2), nearly all showed significant location effects between eastern and western stations, as found for water masses, and between stations in the middle of the ridge such as SPG4 and SPG5 (Tables 11& 12). Several of these pairs showed significant dispersion effects as well as location effects, namely pairs including SPG3, SPG4, or SPG7A. The only significant difference within stations by distance from summit was within SPG6 between the groups 1 and 2; no dispersion effects were found (Table 12).

Pairwise and PERMDISP analyses following the two-way PERMANOVA of station by depth breaks showed no significant location effects within the shallow (S; 0-300 m) or deep (D; >1200 m) groups (Table 13). Within the mid-slope group (M; 600-800 m), significant location effects were observed between SPG3 and SPG6 and between SPG3 and SPG7, with a dispersion effect observed for SPG3 and SPG7 (Table 13). There were more differences between stations within the upper-slope group (U; 300-600 m), most of which included SPG3, SPG5, SPG6, or SPG7A; several of which displayed dispersion effects as well as location effects. nMDS plot shows mixing by M and U, but both S and D have lower dispersion with little overlap in faunal communities based on Bray-Curtis similarity of presence-absence data (Figure 20). Within stations pairwise tests found no significant depth effects within SPG4, SPG5, or SPG7A (Table 13). Within SPG3, S and U as well as U and M had significant location effects but no dispersion effects; likewise, no dispersion effects occurred within SPG6, but location effects between U and M as well as U and D were observed; SPG7 had location effects between U and D (Table 13).

SIMPER analyses found different OTU groups contributed the most to similarity within stations and dissimilarity among stations for analyses of station by water mass, stations by distance-from-summit, and station by depth breaks. For the station by water mass analysis, percentage contribution to similarity within stations ranged from 45-71%, with the highest value at SPG3, and the lowest at SPG7A (Table 14). At stations SPG3, SPG6, and SPG7 all had corals (OTU group z) as the OTU groups contributing the largest percentage to their similarity, from 30-75%. Fishes (f) and arthropods (a) were also important contributors to within station similarity, and at SPG4 fishes contributed the most to the average similarity of 41%. Among station dissimilarity was highest between SPG5 and SPG7A, and SPG5 and SPG6 with an average dissimilarity value of 100 (Table 14). Mollusks (g) were the OTU group responsible for the highest contribution to these differences, from 25-31% of the dissimilarity. The lowest dissimilarity was between the two oceanic islands: SPG3 and SPG7 (43% dissimilar). Within water masses, similarity ranged from 43-59, and again coral, fishes, and arthropods contributed much of this similarity, ranging from ~20-65% (Table 14). Among water masses, dissimilarity ranged from 55-89, and the OTU group contributing the most dissimilarity to all comparisons except ESSW and ESPIW and ESSW and ESPTW (Eastern South Pacific Transition Water) were the corals (Table 14).

Within station comparisons for the SIMPER analysis of station by distance-from-summit all ranged in similarity from 43-60% (Table 15). Again, corals and arthropods were responsible for much of the similarity, except at SPG4 where similarity was nearly 70% due to the contribution of fishes and at SPG5 with mollusks contributing 65% to within-station similarity. Among station comparisons by distance-from-summit ranging widely, from 54-100%; the 100% dissimilarity was between SPG5 and SPG7A, and comparisons including SPG6 or SPG7A had dissimilarities of at least 70%; fishes, corals, and mollusks were responsible for much of this dissimilarity. Similarity within distance-from-summit groups were not as high, 47-59%, with fish contributing ~20-30% similarity for groups 1 and 2 (0-150 and 150-500 m below the summit; Table 15). Among distance-from-summit groups, similarity was highest between groups 1 and 3 (0-150 m and >500 m) at 82.5%, and lowest between groups 2 and 3 (150-500 m and >500 m from the summit) at 64%. Corals again contributed one of the highest dissimilarities, ranging

~18-30% in contribution; only one OTU group – fishes – contributed higher dissimilarity, 20%, between the two shallower groups (0-150 m and 150-500 m).

SIMPER results for station by depth breaks within stations showed an average similarity from 45-68% (Table 16). SPG5 and SPG7 were lowest, from 45-50%, and SPG3 the highest, at 68% similarity. Fishes, corals, and arthropods contributed much of this similarity, 15-66%, within the stations they appeared in. Mollusks contributed 36% within SPG5 being the dominant OTU and was not found in similar numbers in any other station. Among station dissimilarity was 53-100%, with 100% occurring between SPG5 and SPG7A and between SPG5 and SPG6 (Table 16). Average dissimilarity was high in comparisons involving SPG5 due to the contribution of mollusks, whose high abundances were unique within SPG5. Within depth break groups, average similarity was 47-65%. For the shallow group (0-300 m), non-coral cnidarians had the largest contribution (34%), for the upper-slope group (300-600 m) the largest contribution was fishes (39%), and both the mid slope (600-800 m) and deep slope (800-1200 m) groups had their largest contributions (51-70%) from corals. Among depth break groups, average dissimilarity was ~60-90%, with the exception of the mid and deep slope groups, which only had a 46% dissimilarity (Table 16). Many of the same OTU groups that appeared in previous groups contributed to the dissimilarities, including corals (18-30%), fishes (10-21%), and non-coral cnidarians (11-25%).

Hypothesis 3: Community Patterns with Environmental Factors

BEST analysis with station as a factor revealed that depth was the variable with the highest single correlation (0.48, Table 17) with the correlation not being improved by adding variables to explain within station community patterns, and even decreasing after the addition of 4 or more variables. However, the best variables excluding depth in the following two and three variable models were longitude and latitude. An additional BEST analysis was conducted after removing station as a factor, and the results found dissolved oxygen was the best single explanatory variable, but the correlation was lower (0.23; Table 18). However, the correlation increased with additional variables in the models, which did not include dissolved oxygen and instead included several other variables, including latitude and hard substrate. Variables with ≥0.4 correlation were displayed against depth groups (Figure 20) and included latitude, longitude, depth, and dissolved oxygen concentration.

CHAPTER IV

DISCUSSION

General Habitat and Fauna

This study is the first visual study by video transect below 300 m along the Salas y Gómez Ridge and thus these findings provide an overview of habitats and communities previously unexplored within the studied depths. A 2021 study investigated oceanic islands and seamounts of the eastern extent of this same region from 50-370 m and was the first description of habitats and communities in the area (Tapia-Guerra et al., 2021). Another prior study at stations at the eastern and western extent of the Salas y Gómez Ridge, conducted stationary video surveys with an autonomous baited camera at depths ranging from 150-1850 m (Friedlander et al., 2021). Similar challenges to sampling effort and OTU assignment were faced in these studies. For instance, based on the calculated species accumulation curve (Figure 18) it is likely that species were missed. These missed species may include smaller organisms as the classification used in this study for megafauna was >1 cm, though it is unlikely all fauna of this size were observed, as well as rare species that could easily be missed as they may have been infrequently observed. Tapia-Guerra et al. (2021) encountered the same issue because the surveys included a single transect per seamount and oceanic island, so transects cover only a small portion of the seamount and are unable to capture the full range of its habitats. This limitation is not unexpected because few stations were sampled and each except SPG7A were only surveyed once.

Based on the small number of stations and transects surveyed, the stations appear very different in the species present within this study and compared with prior visual assessments. The Tapia-Guerra et al. (2021) study identified 118 OTUs, ~33% less than the 174 in this study. The present study covered ~3 times the depth range and thus observed greater richness as species turnover increase with depth (e.g., Long & Baco, 2014). The Tapia-Guerra study had more stations, but due to the narrower depth range surveyed, they found lower species richness within a station, ranging 4-45, while this study found 27-56. Stations with abundance counts over 1000 were largely due to one to a few OTUs with many individuals, so increased abundance did not necessarily lead to increased richness, diversity, or evenness. For example, 3006 OOIs were observed at SPG6, and 2651, almost 90%, were all the same sponge OTU. Interestingly, each of the six stations were dominated by a different OTU group, these included: sponges (SPG6), sea urchins (SPG3), fishes (SPG4), corals (SPG7), non-coral cnidarians (SPG7A), and mollusks (SPG5; Figure 14). Transects in this study also differed by using other environmental variables, e.g., slope, aspect, depth, which can contribute to community patterns (Auscavitch et al., 2020), along with substrate. The sponges and corals were most often found attached to hard substrate, which is a necessity for these groups to attach to the seafloor. The dominant OTU groups on hard substrate were sponges and corals, both sessile invertebrate OTU groups, and on hard substrate mobile groups were dominant, including fishes and sea urchins, which is consistent with earlier studies in the region (Tapia-Guerra et al., 2021).

Similar patterns in substrate were observed at most stations, with sandy sediment, often of mixed grain size, predominant at the deepest portions of transects and on relatively flat portions of the transect (usually at the summit). Rocky habitat was prevalent where slopes were highest; several stations containing near-vertical rocky slopes. Summits tended to be sandy flat plateaus with sandy areas and low slopes (<10°). Flat-top seamounts (i.e., guyots) are typically formed from former oceanic islands which have sunk below the surface once more. (Wessel, 2007). During this process, reefs form and can be broken down forming the flat-top plateaus, and deposit sediment and biogenic material on the slopes below. This biogenic material was often a result of the most prevalent OTU group at a station, such as coral rubble in an area dominated by coral. Deeper sandy areas likely are from accumulation of the sand raining down from the shallower summits. Evidence of this sediment deposition includes coral rubble on seamounts and seamounts with sand over rocky areas and informs about the communities of the depths above providing the sediment.

Hypothesis 1: Seamounts vs. Oceanic Islands

While differences in diversity and richness metrics between seamounts and comparable non-seamount habitats such as oceanic islands, banks, or continental slopes have been found in other studies in both in the Atlantic and the Pacific (Hall-Spencer et al., 2007; Samadi et al., 2006), none were found between the seamounts and oceanic islands in this study. Similarly, a recent study along the Salas y Gómez Ridge found no differences in richness, diversity, or evenness (Tapia-Guerra et al., 2021). The lack of difference found in this study and by Tapia-Guerra et al. (2021) may be because sample sizes were limiting, with only four seamounts and two islands surveyed in this study and five oceanic island and seven seamount stations studied by them. Species accumulation curves in both studies indicated that sufficient sampling was not achieved in either study (e.g., Figure 18). Additionally, the lack of difference in diversity and richness metrics in this study could be because the two islands were located at opposite ends of the Salas y Gómez Ridge, separated by nearly 3000 km, and thus are too distant and with too dissimilar environmental conditions to be comparable. For example, SPG3 is on the east end of the ridge and is in a hypoxic region whereas SPG7 is on the west side and does not experience hypoxia but is located in the oligotrophic center of the SPSG. The differences between these oceanic islands are likewise supported by results from SIMPER analyses of station crossed with each of the three depth groupings that found SPG3 and SPG7 had an average dissimilarity of ~40-55%. These dissimilarity values are among the lower dissimilarity values observed, with other comparisons having typical values of 50-80. In a study in the northeast Pacific, depth-aligned assemblages showed dissimilarities of 80-85% (Menezes et al., 2009).

Another factor contributing to this lack of difference could be that transect locations differed greatly by station. For example, SPG5 was surveyed on the south side of the seamount, but due to variable slope the transect is largely north-northwest-facing, and SPG3 was on the west side of the seamount and is west-facing. Different sides of seamounts can experience widely different environmental conditions and therefore have different communities (Baco, 2019). Due to the small sample size, there are many possible differences in slope, aspect, depth, and currents which have been found to affect changes in seamount and comparable habitats (Auscavitch et al., 2020) and may be affecting patterns on the ridge. Therefore, to determine whether communities differ among seamounts and oceanic islands in the region, more data is needed to realistically consider many of these additional factors, including additional transect replicates as well as additional environmental variables like side of the seamount and rugosity (Baco, 2019).

Numerous studies have explored whether seamounts have higher rates of endemism than comparable non-seamount habitats. In this study, endemism is not specifically addressed, but high levels of endemism have been recorded in the region (Friedlander et al., 2021). Of note, differences in endemism and species richness were not observed between the seamount and non-seamount habitats in the southwest Pacific Ocean between continental slopes and oceanic ridges (O'Hara, 2007). O'Hara (2007) suggested that investigating such differences on such a broad scale might not be able to provide useful results. Similarly, a study in the Northeast Atlantic, while not investigating oceanic islands, found no difference in diversity between seamount sites and a nearby bank (Howell et al., 2010). Although this study comparing bank and seamount habitats also found low endemism, which provides evidence against hypotheses of seamounts as sites of high endemism, the Salas y Gómez region does contain high endemism – potentially even the highest levels of marine endemism anywhere – regardless of the disputed inherent endemism of seamounts alone (Wagner et al., 2021). Species accumulation curves indicate that sampling effort was insufficient, indicating that likely many OTUs were not recorded, particularly rare OTUs. Many OTUs were only observed in the east, west, or center of the ridge, which indicates many OTUs may have restricted ranges, contributing to regional endemism.

Hypothesis 2: Community Patterns with Depth

Although faunal community differences with depth are commonly reported on seamounts (Menezes et al., 2006; Tracey et al., 2004), few significant differences were found in the present study despite exploring these discrepancies for several variable depth groups. Like the seamount vs. oceanic island comparisons, the lack of significant findings could be because of insufficient sampling effort, transect locations were not comparable, and stations were too distant. For example, studies with a limited number of surveys and therefore a limited range of depth and the sides of the seamount surveyed are likely not collecting enough accurate data to fully understand patterns in abundance and diversity (Tapia-Guerra et al., 2021). The surveyed side of a seamount can also affect results regarding invertebrate faunal assemblages as found in a study of a seamount near Hawaii in the Pacific Ocean (Baco, 2019).The difference in stations being a factor is supported by significant effects of station for all depth by station analyses as well as interactions between station and each of the depth groups using PERMANOVA. In addition, inappropriate *a priori* depth groups were selected or differences were obscured by smaller-scale differences in habitat (Baco, 2019).

However, early data exploration included a PERMANOVA design – station by depth breaks – using Bray-Curtis similarity matrix from log(X+1) transformed, which yielded significant p-values for station, depth breaks, and an interaction for the two factors (not shown). This may also suggest that the selected *a priori* groups – water mass, distance from summit, and depth breaks – were not appropriate selections for analysis. Bergstad et al. (2008) found fishes abundance to decrease with depth from summit of a mid-ocean ridge, and while depth was an important explanatory variable for changes in community composition, this was attributed to individual species ranges rather than particular depths associated with assemblage turnover. Because depth can have a strong effect on marine communities and changes in depth are often associated with assemblage changes (Long & Baco, 2014), high beta diversity across vertical depth ranges is often observed, although many other factors can play a role. For example, a study of a seamount in the northeast Pacific found a 50% change in community composition in only 1500 m (McClain et al., 2010). Further analysis using depth break groups may be able to answer currently unanswered questions about assemblage changes with greater sampling effort or by reevaluating communities by substrate, fauna mobility, and feeding method, as mobile fauna and predators have been found to be more common on island slopes and sessile filter feeders and hemisessile deposit feeders have been found to be more common on seamounts in this region (Tapia-Guerra et al., 2021).

Hypothesis 3: Community Patterns with Environmental Factors

Alongside depth, a variety of environmental factors have been found to contribute to seamount community patterns. A study in the Mediterranean found community changes to occur with depth as well as a longitudinal and oligotrophic gradient (Almeida et al., 2017). A previous study has also described a potential longitudinal barrier at ~80°W affecting the communities along the Salas y Gómez Ridge (Parin, 1991). The barrier and the resulting change in communities may be a result of species originating in the Indo-West Pacific and communities persisting since the seamounts were formed at a time when they were close to Indo-West, a result of dispersion patterns, or the effects of physical barriers like the Humboldt Current and Atacama Trench with few species shared between the western and eastern extents. A recent study of echinoderms along the ridge supports Parin's findings and suggests an additional longitudinal break with assemblage turnover along the ridge (Mecho et al., 2021). These breaks, occurring at approximately 101 and 86°W, contribute to the isolation of communities in the region and thus has led to high endemism of echinoderms along the ridge. The limiting conditions of the SPSG, the OMZ, and the physical barriers off the coast of Chile likely contribute to these geographic breaks and the differences in seamount communities among stations in this study. In this study, both latitude and longitude were included in the models identified by the BEST analysis to explain community changes along the Salas y Gómez Ridge. Longitude was expected to influence results as the Salas y Gómez Ridge stretches across nearly 3000 km of longitude and environmental parameters, including oxygen and nutrients, differ along this range. Dissolved oxygen was only correlated with community composition when station was not included as a factor but was found to be significant from the PERMANOVA analyses by all depth groups. It is also possible that the effects of dissolved oxygen were not observed due to other factors. For instance, previous studies have found that oxygen differed by water masses (Menezes et al., 2006). Water mass, or other factors which were not assessed in this study, particularly more appropriate *a priori* groups, may better explain a relationship between oxygen and the observed community changes.

Additional factors found to be significant in other studies have included seamount age and bBPI (Friedlander et al., 2021), along with depth correlate with changes in invertebrate assemblage structure. For example, a ROV-based study conducted near Hawaii from 320-530 m depth being the most highly correlated variable with terrain variables slope, rugosity, and relief contributing to the best overall model (Long and Baco, 2014). Likewise, once depth was removed, substrate and BPI were among the variables in the best model selected for the present study. This finding aligns with O'Hara's (2007) suggestion that broad categorization may not be informative for communities, and that other macroscale factors, such as small-scale slope, relief, and substrate may be more informative.

Substrates likely affect community composition to some degree and can vary between seamounts and oceanic islands with corresponding communities. Tapia-Guerra et al. (2021) found that both seamounts and oceanic islands consisted of coarse sand and rocky habitat, along with silty sediment the oceanic island slopes, but were dominated by different faunal community compositions. Mobile fauna tended to dominate sandy and silty areas on oceanic islands and their nearby seamounts, while communities on seamounts more distant from the oceanic islands consisted largely of sessile and hemisessile fauna with suspension feeders on hard substrate and deposit feeders on soft sediment and biogenic substrate components. Similarly, the present study found that sandy substrate tended to be dominated by mobile invertebrates (sea urchins, crustaceans, brittle and sea stars) and rocky substrate by sessile invertebrates (corals, sponges). The substrate data from CPCe was biased towards sandy substrate likely because the seamount summits were once shallow enough to have reefs that have eroded and have provided sediment downslope, covering the hard and potentially obscuring other patterns by environmental data.

Conclusions and Relevance

The six stations surveyed, two islands and four seamounts, ranged widely in abundance, richness, and diversity, though similar substrates comprised many of the stations. Sand dominated the stations, with at least ~60% of substrate at each station being sand, and with hard substrate the two categories make up >95% of substrates at each station, with small percentages of biogenic material or other. Despite this pattern, each of the six stations were dominated by a different OTU group, three of which were sessile invertebrates, two mobile invertebrates, and one mobile vertebrates. Though differences were expected among subsystems based on prior studies, no significant differences were seen between seamounts and oceanics islands likely because of the large distances between our stations and within seamount variability. Depth and dissolved oxygen were the best explanatory variables correlated with communities, though the relatively low correlations suggest variables not assessed in the study likely play an important role as well, such as the sides of a seamount and its exposure to physiochemical factors or nutrient concentrations. Many of these environmental variables vary along a horizontal gradient, such as dissolved oxygen concentrations and productivity, which vary within the southeast OMZ and the SPSG, respectively, and can affect the ranges of fauna in the environment.

Future studies might find more significant differences with an increased number of stations, particularly focusing on evening the numbers of seamounts and oceanic islands studied, and increasing the number of transects per station, ideally at least 3-4 transects so that differences in communities by environmental factors and sides of the stations may be discernable. Additional factors such as seamount age or nitrate would also be useful to incorporate. It could be beneficial to use an ROV rather than a towed camera system as it would provide more mobility and allow for the transects and stations to be better explored and for higher quality video for analysis to be obtained. In doing so, more OTUs that were not observed here, whether due to video quality, small size of fauna, or rare OTUs, would be more likely to be observed and thus may improve the species accumulation curves and sampling effort.

The findings in this study highlight the diversity of this region and that the surveys did not capture the full diversity based on insufficient sampling, so the Salas y Gómez Ridge needs further studies. With so few seamounts in the area having been surveyed, each study contributes data and results that can continue to be built upon to create a more cohesive understanding of the benthic habitats of the region. This understanding will be crucial to the protection of the area, much of which exists in ABNJ and is largely without protections. With several anthropogenic effects impacting the ocean on a global scale including climate change, ocean acidification, and expanding OMZs as well as more direct actions including commercial deep-sea fishing and mineral mining expected to begin in the upcoming years, it will be important to understand and monitor these communities to provide protection.

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APPENDIX A

APPENDIX A

TABLES AND FIGURES

Table 1: Transect Data Summary
Transect data by survey station along the Salas y Gómez Ridge. SPG7A was surveyed twice due to inclement weather. Time is shown in Coordinated Universal Time (UTC).

Survey Station	Habitat Type	Date (2019)	Time (UTC)	Starting Coordinates (°)	Ending Coordinates (°)	Transect Length (km)	Depth Range (m)
SPG3	Oceanic Island: San Ambrosio	3 Feb	20:53:16 – 22:31:26	-26.475, -79.795	-26.475, -79.808	2.0	212 – 827
SPG4	Seamount	6 Feb	13:48:53 – 16:05:18	-25.407, -89.744	-25.404, -81.770	3.0	189 – 1044
SPG5	Seamount	9 Feb	14:43:26 – 16:23:38	-25.601, -89.128	-25.594, -89.126	1.4	537 – 975
SPG6	Seamount	13 Feb	20:10:16 – 21:43:34	-26.187, -102.995	-26.181, -102.976	2.5	252 – 876
SPG7	Oceanic Island: Easter Island	16 Feb	20:03:49 – 22:35:25	-27.067, -109.169	-27.065, -109.202	3.8	395 – 1055
SPG7A1	Seamount	17 Feb	15:45:50 – 19:33:20	-26.909, -110.294	-26.922, -110.239	3.6	136 – 902
SPG7A2	Seamount	17 Feb	21:29:40 – 23:00:53	-26.964, -110.229	-26.965, -110.239	1.8	552 – 611

Table 2: Camera Details
Information of the cameras used to survey along the transects. SD is "Standard Definition," HD is "High Definition," and "-" indicates not available.

Manufacturer	Model	Video Definition	View Direction	Quantity
AstroDesign, Inc. (Tokyo, Japan)	AB-4805	8K	45° forward and down	1
Sony (Minato City, Japan)	FBC-EVI7100	2K	Forward	2
	FDR-AX1000	4K		2
	FCB-H11	HD	45° forward and down	1
Kongsberg	OE14-377	2K	1 down, 1 forward	2
Canon (Ōta, Japan)	VB-R13	2K	Down	1
Pacific Corp. (Tokyo, Japan)	PA-310	SD	Down	2
GoPro (San Mateo, USA)	Hero4+	-	Forward	1
	Hero5	-	Forward and down	2

Table 3: Sensor Details
Sensors used in data collection along the Salas y Gómez Ridge. NR stands for "Not Recorded," DT for "DeepTow," and R for "CTD Rosette."

Manufacturer	Model	Sampling Method	Calibration Date (2018)	Accuracy	Sample Frequency	Parameters
RBR (Ottawa, Canada)	XR-420	DT x2	NR	NR	1 s	Conductivity, Temperature, Depth
OxyGuard (Farum, Denmark)	Ocean Probe DO5	DT	NR	NR	1 s	Dissolved Oxygen
Imagenex (Port Coquitlam, Canada)	Model 864-000-201-006	DT	NR	NR	1 s	Altimetry
Sea-Bird Electronics (Bellevue, USA)	SBE911plusCTD	R	26 Feb	0.001%FS	1 m	Pressure
	SBE 3-4F	R	22 Feb	0.001degC	1 m	Oceanographic Temperature
	SBE 4C	R	15 Feb	0.0003S/m	1 m	Conductivity
	SBE43	R	3 Feb	2%	1 m	Dissolved Oxygen
	36-position Carousel Water Sampler SBE32	R				
JFE Advantech Co. (Nishinomiya, Japan)	RINKO III Dissolved Oxygen Sensor	R	5 Oct	0.01-0.04%	1 m	Dissolved Oxygen
L-3 ELAC Nautik (Kiel, Germany)	SEABREAM 3012		NR	<1%	NR	Bathymetric Multibeam System
SyQwest (Cranston, USA)	Bathy2010		NR	± 10 cm – 100 m	NR	Sub-bottom Profiler

Table 4: Coral Point Count Categories
Substrate and additional categories used in Coral Point Count with Excel Extensions (CPCe) for habitat analysis. Categories are listed above the table and subcategories below the line.

Substrate	Algae	Fauna	Other Categories
Sand (S)	Crustose Coralline Algae (CCA)	Coral (CR)	Timecode (T)
Old Reef (RF)	Macroalgae (MA)	Sponge (SP)	Not Identifiable (NI)
Pebbles and Cobbles (P/C)	Rhodoliths (RH)	Hydrozoan (HZ)	
Rock (R)	Other Algae (AO)	Other Sessile Fauna (SF)	
Rubble (RB)		Mobile Fauna (MF)	
Shells and Tests (S/T)			

Table 5: Benthic Habitat Classifiers
Descriptive classifiers for benthic habitats. Classification categories are column labels with subcategories listed below (Greene, 1999).

Substrate	Morphology	Estimated Deposition (cm)	Physical	Bioturbation	Fauna
Coarse Sand	Regular	<1	Erosional Features	Absent	Absent
Old Reef	Irregular	1-5	2D Ripples	Present	Fauna
Pebbles and Cobbles	Irregular with Exposed Volcanic Bedrock	>5	3D Ripples		
Rock					
Rubble					
Sand					
Mixed Sediment					

Table 6: Water Masses Depths
Water mass depth range for each station. ESPIW stands for Eastern South Pacific Intermediate Water, ESSW for Equatorial Subsurface Water, AAIW for Antarctic Intermediate Water, CTW for Coastal Transition Water, and PDW for Pacific Deep Water.

	SPG3	SPG4	SPG5	SPG6	SPG7	SPG7A
ESPIW	0-100 m	0-200 m	0-200 m	0-400 m	0-400 m	0-400 m
ESSW	100-450 m	200-550 m	200-550 m	400-550 m		
AAIW	450-750 m	550-750 m	550-800 m	550-800	400-950 m	400-950 m
CTW	750-1300 m	750-1200 m				
PDW	1300+ m	1200+ m	800+ m	800+ m	950+ m	950+ m

Table 7: OTU CTD Ranges
OTU's (operational taxonomic units) listed with ranges and average of depth (m), temperature (°C), salinity (PSU), and dissolved oxygen (DO; µmol/kg).

OTU	# of OOIs	Depth Average	Depth Range	PSU Average	PSU Range	°C Average	°C Range	DO Average	DO Range
a01	1	961.5	961.5-961.5	34.4	34.4-34.4	4.2	4.2-4.2	3.3	3.3-3.3
a02	5	961.1	928.8-971.6	34.5	34.4-34.5	4.1	4.1-4.2	3.3	3.3-3.3
a05	2	759.6	744.6-774.7	34.4	34.4-34.4	4.9	4.8-4.9	3.3	3.3-3.3
a06 - Palinuridae	378	346.5	235-684.3	34.5	34.3-34.6	8.7	5.2-10.5	3.7	3.3-3.8
a07	4	441.6	398-534.9	34.4	34.3-34.4	7.0	6.2-7.5	3.5	3.4-3.5
a08	3	371.4	276.1-431.5	34.5	34.4-34.6	8.4	7.3-10	3.6	3.5-3.8
a09	5	361.6	259.6-480.4	34.4	34.2-34.5	9.2	7.6-10.4	3.7	3.6-3.8
a10 - *Paromola*	5	237.2	214.3-258.5	34.5	34.4-34.6	10.7	10.4-11.3	3.8	3.8-3.9
a11 - *Paromola*	2	236.7	233.3-240.2	34.5	34.5-34.5	10.5	10.5-10.5	3.8	3.8-3.8
a12	4	965.1	946.5-972.6	34.5	34.5-34.5	4.1	4.1-4.2	3.3	3.3-3.3
a14	2	367.2	361.1-373.3	34.6	34.6-34.6	9.5	9.3-9.7	3.7	3.7-3.8
a16	9	934.0	862.4-948.8	34.5	34.4-34.5	4.2	4.2-4.5	3.3	3.3-3.3
a17	1	939.6	939.6-939.6	34.5	34.5-34.5	4.2	4.2-4.2	3.3	3.3-3.3
a19	3	825.1	794-879.4	34.3	34.3-34.4	4.9	4.5-5.1	3.3	3.3-3.3
a20 - Paguridae	14	515.3	433.8-608.1	34.3	34.3-34.3	6.9	6.1-8.1	3.5	3.4-3.6
a22	2	877.0	874.9-879.1	34.3	34.3-34.3	4.7	4.6-4.7	3.3	3.3-3.3
b01	2	635.4	576.5-694.4	34.4	34.3-34.4	5.5	5.2-5.8	3.4	3.3-3.4
b03 - *Squalus* sp. cf. *mitsukurii*	2	481.6	424-539.2	34.4	34.3-34.5	7.2	6.3-8.1	3.5	3.4-3.6
b06 - *Etmopterus*	2	778.5	498.3-1058.6	34.4	34.4-34.4	5.6	4-7.1	3.4	3.3-3.5
b1	2	601.6	405-798.3	34.5	34.4-34.5	6.6	4.7-8.6	3.5	3.3-3.6
c01 - Pelagic jelly	1	804.0	804-804	34.4	34.4-34.4	4.8	4.8-4.8	3.3	3.3-3.3
c02 - Pennatulacea	12	430.9	329.1-728.9	34.4	34.3-34.5	7.7	5.5-8.4	3.6	3.4-3.6

Table 7, cont.

OTU	# of OOIs	Depth Average	Depth Range	PSU Average	PSU Range	°C Average	°C Range	DO Average	DO Range
c03 - Actiniaria	1	218.3	218.3-218.3	34.5	34.5-34.5	10.7	10.7-10.7	3.8	3.8-3.8
c04 - Actiniaria	2	210.2	209.7-210.7	34.4	34.4-34.4	10.8	10.8-10.9	3.8	3.8-3.8
c05 - Actiniaria	793	160.9	156.6-261.8	35.6	34.4-35.7	19.8	13.3-19.9	4.9	4.1-4.9
c06 - Pennatulacea	4587	303.9	277-491.9	34.7	34.3-34.8	12.7	7-14.1	4.0	3.5-4.2
c07 - Pelagic jelly	1	863.4	863.4-863.4	34.3	34.3-34.3	4.8	4.8-4.8	3.3	3.3-3.3
c09 - Actiniaria	54	142.3	141.2-143	35.7	35.6-35.7	20.1	20-20.1	4.9	4.9-4.9
c10 - Actiniaria	43	162.4	158.6-263.7	35.6	34.7-35.6	19.8	14.3-19.9	4.8	4.2-4.9
c11	23	509.3	488.4-900.3	34.4	34.3-34.4	6.7	4.4-6.8	3.5	3.3-3.5
c12 - Actiniaria	3	889.0	880-907	34.3	34.3-34.3	4.7	4.6-4.7	3.3	3.3-3.3
d01	1	1056.4	1056.4-1056.4	34.4	34.4-34.4	4.0	4-4	3.3	3.3-3.3
d02	1	491.3	491.3-491.3	34.3	34.3-34.3	6.8	6.8-6.8	3.5	3.5-3.5
e01 - Halosauridae	131	897.4	569.7-1044.7	34.4	34.3-34.5	4.4	4-6.3	3.3	3.3-3.4
e02 - Macrouridae	71	645.7	454.3-923.3	34.4	34.3-34.5	5.7	4.3-7.8	3.4	3.3-3.6
e03 - Macrouridae	5	740.0	709.6-759.4	34.4	34.4-34.4	4.9	4.9-5	3.3	3.3-3.3
e04 - Macrouridae (*Hymenocephalus antraeus*)	4	727.9	671.3-793	34.4	34.3-34.4	5.1	4.8-5.2	3.3	3.3-3.3
e05 - Macrouridae (Trachonurus sentipellis)	1	784.2	784.2-784.2	34.4	34.4-34.4	4.8	4.8-4.8	3.3	3.3-3.3
e08	2	361.4	290.8-432.1	34.5	34.5-34.6	8.9	8-9.8	3.7	3.6-3.8
e11 - Halosauridae	2	945.1	922.4-967.9	34.5	34.4-34.5	4.2	4.1-4.3	3.3	3.3-3.3
e12	1	967.4	967.4-967.4	34.5	34.5-34.5	4.1	4.1-4.1	3.3	3.3-3.3
e16	7	761.9	549.2-944.8	34.4	34.3-34.4	5.2	4.3-6.3	3.3	3.3-3.4
e19 - Macrouridae	7	886.6	549.2-1058	34.4	34.3-34.4	4.6	4-6.3	3.3	3.3-3.4
e21	1	798.6	798.6-798.6	34.4	34.4-34.4	4.7	4.7-4.7	3.3	3.3-3.3
e23	2	557.2	544.6-569.7	34.4	34.4-34.4	6.3	6.3-6.3	3.4	3.4-3.4
e24 - Macrouridae	1	290.9	290.9-290.9	34.6	34.6-34.6	12.9	12.9-12.9	4.1	4.1-4.1

Table 7, cont.

OTU	# of OOIs	Depth Average	Depth Range	PSU Average	PSU Range	°C Average	°C Range	DO Average	DO Range
e26	1	798.1	798.1-798.1	34.3	34.3-34.3	5.1	5.1-5.1	3.3	3.3-3.3
e27	1	558.1	558.1-558.1	34.3	34.3-34.3	5.9	5.9-5.9	3.4	3.4-3.4
f02 - *Rexea*	15	571.2	344-827.4	34.4	34.3-34.5	6.2	4.7-8.3	3.4	3.3-3.6
f06	2	699.3	694.4-704.3	34.4	34.4-34.4	5.1	5.1-5.2	3.3	3.3-3.3
f08 - Macrouridae	83	491.2	417.3-606.2	34.4	34.3-34.5	7.2	5.7-8.3	3.5	3.4-3.6
f09 - *Antigonia* sp. cf. *capros*	1	661.2	661.2-661.2	34.4	34.4-34.4	5.2	5.2-5.2	3.3	3.3-3.3
f10	3	481.6	345.8-563.2	34.4	34.3-34.5	6.8	5.9-8.3	3.5	3.4-3.6
f14	11	492.8	456.9-547.6	34.4	34.3-34.5	7.1	6.2-7.8	3.5	3.4-3.6
f16 - Scorpaenidae	2	412.0	370.1-453.9	34.4	34.3-34.4	8.4	6.9-9.9	3.6	3.5-3.7
f17 - *Beryx* sp. cf. *splendens*	13	333.1	265.9-481.8	34.6	34.4-34.7	10.7	7-14.2	3.8	3.5-4.2
f20	5	334.1	258.9-524.4	34.6	34.3-34.7	10.7	6.7-14.4	3.9	3.5-4.2
f21 - Scorpaeniformes	19	357.3	215.7-502.2	34.5	34.3-34.6	9.0	7.1-10.8	3.7	3.5-3.8
f22	5	306.3	301.4-312.4	34.5	34.5-34.5	9.4	8.8-9.5	3.7	3.7-3.7
f23 - Pleuornectiformes	3	267.2	233.1-285.1	34.8	34.6-35.1	12.9	11.1-16.4	4.1	3.9-4.5
f24	11	275.4	210.4-449.5	34.5	34.4-34.6	10.5	7.9-13.6	3.8	3.6-4.1
f25	2	448.6	446.8-450.5	34.5	34.5-34.5	7.9	7.9-7.9	3.6	3.6-3.6
f29	3	471.9	469.5-473.5	34.5	34.5-34.5	7.8	7.8-7.8	3.6	3.6-3.6
f32	6	392.6	331.3-421.7	34.5	34.5-34.6	8.9	8.1-10.4	3.7	3.6-3.8
f34 - Bothidae (*Arnoglossus*)	3	281.1	276-291.4	34.6	34.6-34.6	11.1	11-11.1	3.9	3.9-3.9
f37 - Ateleopodidae	2	1007.2	970.8-1043.7	34.4	34.4-34.5	4.1	4.1-4.1	3.3	3.3-3.3
f38 – Ipnopidae or Bathygadus	1	970.8	970.8-970.8	34.5	34.5-34.5	4.1	4.1-4.1	3.3	3.3-3.3
f45	2	559.1	559.1-559.1	34.3	34.3-34.3	6.3	6.3-6.3	3.4	3.4-3.4

Table 7, cont.

OTU	# of OOIs	Depth Average	Depth Range	PSU Average	PSU Range	°C Average	°C Range	DO Average	DO Range
f49	14	318.5	295.9-405.7	34.5	34.3-34.6	12.3	8.7-13	4.0	3.6-4.1
f50 - Gobioidei	3	377.9	336.8-398.4	34.4	34.3-34.5	9.7	8.7-11.8	3.7	3.6-3.9
f51	12	358.3	273.2-374.1	34.4	34.3-34.6	10.3	9.6-13.2	3.8	3.7-4.1
f52 - Ateleopodidae	14	275.6	256.3-373.4	34.7	34.3-34.8	13.7	9.7-14.8	4.1	3.7-4.3
f53	2	365.6	361.7-369.4	34.3	34.3-34.3	9.9	9.9-10	3.8	3.8-3.8
f54	6	292.5	270.2-363.9	34.6	34.3-34.8	12.8	9.9-13.8	4.1	3.7-4.2
f55	4	328.7	304.5-345.5	34.5	34.4-34.5	11.7	10.6-12.6	3.9	3.8-4
f56	4	358.4	281.7-405.5	34.4	34.3-34.6	10.5	8.7-13.1	3.8	3.6-4.1
f57	1	404.2	404.2-404.2	34.3	34.3-34.3	8.7	8.7-8.7	3.6	3.6-3.6
f60	2	322.3	318.1-326.6	34.5	34.5-34.5	11.9	11.8-12	4.0	3.9-4
f61	3	274.7	247.7-324.4	34.7	34.5-34.9	13.9	11.8-15	4.2	3.9-4.3
f62	1	323.8	323.8-323.8	34.5	34.5-34.5	11.8	11.8-11.8	3.9	3.9-3.9
f63	22	276.2	266.4-321.6	34.6	34.5-34.7	13.3	11.9-14.2	4.1	4-4.2
f66	3	307.5	271.8-325.4	34.5	34.5-34.6	12.3	11.8-13.2	4.0	3.9-4.1
f67 - *Prognathodes* sp. cf. *basabei*	7	260.5	161.6-294.2	34.8	34.6-35.6	14.3	12.8-19.9	4.2	4-4.9
f68 – *Cookeolus japonicus*	1	270.8	270.8-270.8	34.6	34.6-34.6	13.2	13.2-13.2	4.1	4.1-4.1
f70	2	272.3	265.9-278.6	34.8	34.7-34.8	14.2	14.1-14.2	4.2	4.2-4.2
f71 - *Seriola lalandi*	18	172.0	156-261.9	35.5	34.7-35.6	19.3	14.2-19.9	4.8	4.2-4.9
f72 - *Etelis carbunculus*	4	236.8	209.9-271	35.0	34.6-35.2	15.8	13.2-17.5	4.4	4.1-4.6
f74	2	595.5	591.4-599.7	34.3	34.3-34.3	6.3	6.3-6.3	3.4	3.4-3.4
f75	1	587.5	587.5-587.5	34.3	34.3-34.3	6.4	6.4-6.4	3.4	3.4-3.4
f76 - *Synodontidae* sp. cf. *isolatus*	2	423.9	423.9-423.9	34.3	34.3-34.3	8.4	8.4-8.4	3.6	3.6-3.6
f78 - (*caprodon*)	6	209.9	209.9-209.9	35.2	35.2-35.2	17.5	17.5-17.5	4.6	4.6-4.6

Table 7, cont.

OTU	# of OOIs	Depth Average	Depth Range	PSU Average	PSU Range	°C Average	°C Range	DO Average	DO Range
f79 – (*Caranx lugubris*)	1	257.5	257.5-257.5	34.8	34.8-34.8	14.4	14.4-14.4	4.2	4.2-4.2
f81	5	253.1	249.9-256.4	34.9	34.9-34.9	14.8	14.7-14.8	4.3	4.3-4.3
f82	1	247.9	247.9-247.9	34.9	34.9-34.9	14.9	14.9-14.9	4.3	4.3-4.3
f83	3	142.8	142.3-143	35.7	35.6-35.7	20.0	20-20.1	4.9	4.9-4.9
f84	3	159.7	158.3-160.6	35.7	35.6-35.7	19.9	19.9-19.9	4.9	4.9-4.9
f85 - Lophiiformes	2	308.8	295.9-321.6	34.5	34.5-34.6	12.4	11.9-12.8	4.0	4-4
f87	1	258.2	258.2-258.2	34.7	34.7-34.7	14.4	14.4-14.4	4.2	4.2-4.2
f88 - Lophiiformes	1	295.5	295.5-295.5	34.6	34.6-34.6	12.8	12.8-12.8	4.0	4-4
f89	4	485.4	429.2-600.5	34.3	34.3-34.3	7.4	6.2-8.3	3.5	3.4-3.6
f92 - Lophiiformes (Chaunacidae)	1	504.9	504.9-504.9	34.3	34.3-34.3	7.0	7-7	3.5	3.5-3.5
g01	187	858.9	262-947.4	34.4	34.3-34.7	4.6	4.2-14.2	3.3	3.3-4.2
g02	3	730.0	483-926.8	34.4	34.3-34.4	5.4	4.3-7.2	3.4	3.3-3.5
g03	1	548.3	548.3-548.3	34.4	34.4-34.4	6.3	6.3-6.3	3.4	3.4-3.4
g05	5	552.2	547-554.5	34.4	34.4-34.4	6.3	6.3-6.3	3.4	3.4-3.4
g1a	109	811.1	210.7-929.4	34.4	34.4-35.2	5.0	4.2-17.6	3.3	3.3-4.6
h01	1	1054.3	1054.3-1054.3	34.4	34.4-34.4	4.0	4-4	3.3	3.3-3.3
h02	10	486.9	255.1-571	34.5	34.3-34.9	8.1	6.3-14.8	3.6	3.4-4.3
m01	8	819.3	765.1-973.8	34.4	34.4-34.5	4.7	4.1-4.9	3.3	3.3-3.3
m05	3	740.1	739.5-740.4	34.3	34.3-34.3	5.4	5.4-5.4	3.4	3.3-3.4
m16	1	946.8	946.8-946.8	34.5	34.5-34.5	4.2	4.2-4.2	3.3	3.3-3.3
m18	3	886.4	854.1-903.1	34.4	34.4-34.4	4.4	4.4-4.5	3.3	3.3-3.3
m27	1	472.7	472.7-472.7	34.3	34.3-34.3	7.5	7.5-7.5	3.5	3.5-3.5
m32	3	730.8	722.3-739.8	34.3	34.3-34.3	5.5	5.4-5.6	3.4	3.4-3.4

Table 7, cont.

OTU	# of OOIs	Depth Average	Depth Range	PSU Average	PSU Range	°C Average	°C Range	DO Average	DO Range
m34	1	491.9	491.9-491.9	34.3	34.3-34.3	7.0	7-7	3.5	3.5-3.5
p01	16	755.0	478.9-967.5	34.4	34.3-34.5	5.2	4.1-7.3	3.3	3.3-3.5
p02	2653	528.3	420.6-631.4	34.3	34.3-34.4	6.6	5.9-7.6	3.5	3.4-3.5
p03 - Hexactinellida	33	1021.2	845.1-1060.6	34.4	34.3-34.4	4.1	4-5	3.3	3.3-3.3
p06 - Hexactinellida	2	859.8	700.2-1019.5	34.3	34.3-34.4	4.8	4.1-5.6	3.3	3.3-3.4
p07	1	713.4	713.4-713.4	34.3	34.3-34.3	5.5	5.5-5.5	3.4	3.4-3.4
r0	2	360.5	320.5-400.6	34.4	34.4-34.5	9.8	7.6-11.9	3.7	3.5-4
r01	1	680.5	680.5-680.5	34.4	34.4-34.4	5.2	5.2-5.2	3.3	3.3-3.3
r02	1	505.1	505.1-505.1	34.3	34.3-34.3	6.3	6.3-6.3	3.4	3.4-3.4
r03	13	828.4	572.2-941	34.4	34.3-34.5	4.7	4.2-5.9	3.3	3.3-3.4
r04	1	499.4	499.4-499.4	34.4	34.4-34.4	7.1	7.1-7.1	3.5	3.5-3.5
r06	1	552.0	552-552	34.4	34.4-34.4	6.3	6.3-6.3	3.4	3.4-3.4
s01	3	808.0	778.3-850.2	34.3	34.3-34.4	5.0	4.8-5.2	3.3	3.3-3.3
s02	1	780.9	780.9-780.9	34.4	34.4-34.4	4.8	4.8-4.8	3.3	3.3-3.3
s03	57	219.7	156.7-550.6	35.3	34.3-35.6	17.4	6.1-19.9	4.6	3.4-4.9
s03a	4	579.0	579-579	34.3	34.3-34.3	6.3	6.3-6.3	3.4	3.4-3.4
s04	1	158.4	158.4-158.4	35.6	35.6-35.6	19.9	19.9-19.9	4.9	4.9-4.9
s06	1	421.3	421.3-421.3	34.5	34.5-34.5	8.1	8.1-8.1	3.6	3.6-3.6
s07	5	557.8	546.1-575.1	34.3	34.3-34.4	6.3	6.3-6.4	3.4	3.4-3.4
s11	4	331.5	257.2-545.2	34.6	34.3-34.8	12.4	6.4-14.4	4.0	3.4-4.2
s12	383	241.9	169.8-272.5	35.0	34.8-35.6	15.8	14.1-19.6	4.4	4.2-4.8
s13 - Astropectinidae	14	193.9	160.7-216	35.4	35.2-35.6	18.7	17.4-19.9	4.7	4.6-4.9
s14	2	198.2	196.5-199.9	35.4	35.4-35.4	18.7	18.5-18.9	4.7	4.7-4.7
s15 - Goniasteridae	141	159.6	151.6-181.3	35.6	35.5-35.7	19.8	19.1-20	4.9	4.8-4.9

Table 7, cont.

OTU	# of OOIs	Depth Average	Depth Range	PSU Average	PSU Range	°C Average	°C Range	DO Average	DO Range
s16 - Goniasteridae	11	167.7	156.9-173.6	35.6	35.6-35.7	19.7	19.5-19.9	4.8	4.8-4.9
s17 - Oreasteridae	5	161.2	159.9-161.8	35.6	35.6-35.6	19.9	19.9-19.9	4.9	4.9-4.9
s18 – (*Pentaceraster*)	14	160.8	159.2-162.2	35.6	35.6-35.7	19.9	19.8-19.9	4.9	4.9-4.9
u01	5	811.1	805.2-828.9	34.4	34.4-34.4	4.8	4.7-4.8	3.3	3.3-3.3
u02 - *Stereoidaris nasnaensis*	1428	219.8	187.4-296.4	34.5	34.3-35.5	11.3	10.4-19	3.9	3.8-4.7
u03 - Diadematidae	2	545.6	545.2-545.9	34.4	34.4-34.4	6.3	6.3-6.3	3.4	3.4-3.4
u04 - Diadematidae	212	221.2	151.6-263.1	35.1	34.7-35.6	16.6	14.3-19.9	4.5	4.2-4.9
u09 - Cidaridae (*Prionocidaris*)	11	237.0	178.6-259	35.0	34.9-35.5	15.9	14.6-19.2	4.4	4.3-4.8
u11 - Clypeaster (*reticulatus* or *isolatus*)	6	157.9	156.4-159.5	35.6	35.6-35.6	19.9	19.9-19.9	4.9	4.9-4.9
u12 - Clypeaster	25	243.7	161.6-264.2	34.9	34.4-35.7	15.1	10.8-19.9	4.3	3.8-4.9
z01	8	617.5	377.3-729.7	34.4	34.3-34.4	5.7	4.9-7.8	3.4	3.3-3.6
z02 - *Bathypathes*	3	652.6	623.8-707.4	34.4	34.4-34.4	5.5	5-5.7	3.4	3.3-3.4
z03	7	629.4	559-699.2	34.4	34.3-34.4	5.6	5.2-6.2	3.4	3.3-3.4
z04	1	403.6	403.6-403.6	34.4	34.4-34.4	7.5	7.5-7.5	3.5	3.5-3.5
z05	1	400.7	400.7-400.7	34.4	34.4-34.4	7.6	7.6-7.6	3.5	3.5-3.5
z09	1	337.0	337-337	34.5	34.5-34.5	8.3	8.3-8.3	3.6	3.6-3.6
z11	11	596.6	479.9-890.3	34.3	34.3-34.4	6.3	4.4-7.3	3.4	3.3-3.5
z12 - *Stichopathes*	2899	352.1	142.5-975.4	34.8	34.3-35.7	13.2	4.1-20	4.1	3.3-4.9
z13	2	866.5	862.2-870.8	34.4	34.4-34.4	4.5	4.5-4.5	3.3	3.3-3.3
z14	1	876.3	876.3-876.3	34.4	34.4-34.4	4.5	4.5-4.5	3.3	3.3-3.3
z15	13	616.5	514.9-850.2	34.3	34.3-34.4	6.1	4.6-6.7	3.4	3.3-3.5
z18	21	570.1	514-773.1	34.3	34.3-34.3	6.3	5.2-6.7	3.4	3.3-3.5

Table 7, cont.

OTU	# of OOIs	Depth Average	Depth Range	PSU Average	PSU Range	°C Average	°C Range	DO Average	DO Range
z19	2	543.9	543.9-543.9	34.3	34.3-34.3	6.4	6.4-6.4	3.4	3.4-3.4
z20	3	717.5	706.1-740.1	34.3	34.3-34.3	5.5	5.4-5.6	3.4	3.4-3.4
z21	1	700.0	700-700	34.3	34.3-34.3	5.6	5.6-5.6	3.4	3.4-3.4
z22	3	603.0	600.7-606.7	34.3	34.3-34.3	6.1	6-6.2	3.4	3.4-3.4
z23	19	479.5	421.1-538.5	34.3	34.3-34.3	7.4	6.5-8.6	3.5	3.4-3.6
z23a	10	429.3	422-434.4	34.3	34.3-34.3	8.2	8.1-8.5	3.6	3.6-3.6
z24	5	571.2	491.9-699.7	34.3	34.3-34.3	6.4	5.6-7	3.4	3.4-3.5
z25	3	453.3	433.9-492.2	34.3	34.3-34.3	7.7	7-8.1	3.6	3.5-3.6
z26	3	471.5	428.7-541.4	34.3	34.3-34.3	7.6	6.4-8.4	3.5	3.4-3.6
z27	3	631.8	580.1-670.7	34.4	34.3-34.4	5.5	5.1-5.8	3.4	3.3-3.4
z28	382	530.0	342.9-705.2	34.4	34.3-34.5	6.3	5.1-8.3	3.4	3.3-3.6
z29	28	563.5	557.9-609.1	34.3	34.3-34.3	6.2	6-6.3	3.4	3.4-3.4
z30	1584	903.0	861.4-911.4	34.3	34.3-34.3	4.6	4.6-4.8	3.3	3.3-3.3
z31	1	911.0	911-911	34.3	34.4-34.4	4.6	4.6-4.6	3.3	3.3-3.3
Total:	16,965								

Table 8: Station Diversity
Operational taxonomic units (OTUs) abundances, OTUs species richness, Shannon diversity (H'), and Pielou's evenness (J') by station and subsystem (oceanic island = OI or seamount = SM).

Station	Subsystem	Abundance	OTU Richness	H'	Evenness J'
SPG3	OI	2359	56	1.6	0.4
SPG4	SM	217	27	2.3	0.7
SPG5	SM	459	34	1.9	0.5
SPG6	SM	3009	49	0.7	0.2
SPG7	OI	774	43	1.6	0.4
SPG7A	SM	10247	42	1.6	0.4
Mean	OI	1516.5	49.5	1.6	0.4
Mean	SM	3483	38	1.6	0.5

Table 9: OTU Presence by Species
Species listed with total counts (N) = number of stations a species was present, and which stations each species was present represented as an X.

OTU	N Total	SPG3	SPG4	SPG5	SPG6	SPG7	SPG7A
a01	1					X	
a02	1			X			
a05	1	X					
a06 - Palinuridae	2	X	X				
a07	1	X					
a08	2	X	X				
a09	2	X	X				
a10 - *Paromola*	2	X	X				
a11 - *Paromola*	1	X					
a12	1			X			
a14	1		X				
a16	1			X			
a17	1			X			
a19	2				X	X	
a20 - Paguridae	1					X	
a22	1					X	
b01	1	X					
b03 - *Squalus* sp. cf. *mitsukurii*	2		X	X			
b06 - *Etmopterus*	2		X			X	
b1	2		X	X			
c01 - Pelagic jelly	1	X					
c02 - Pennatulacea	2	X				X	
c03 - Actiniaria	1	X					
c04 - Actiniaria	1	X					
c05 - Actiniaria	2		X				X
c06 - Pennatulacea	2					X	X
c07 - Pelagic jelly	1						X
c09 - Actiniaria	1						X
c10 - Actiniaria	2				X		X
c11	2	X		X			
c12 - Actiniaria	1						X
d01	1					X	
d02	1				X		
e01 - Halosauridae	4	X		X	X	X	
e02 - Macrouridae	3	X	X	X			
e03 - Macrouridae	1	X					
e04 - Macrouridae (*Hymenocephalus antraeus*)	2	X				X	

Table 9, cont.

OTU	N Total	SPG3	SPG4	SPG5	SPG6	SPG7	SPG7A
e05 - Macrouridae (Trachonurus sentipellis)	1	X					
e08	2	X	X				
e11 - Halosauridae	1			X			
e12	1			X			
e16	4	X		X	X	X	
e19 - Macrouridae	2			X		X	
e21	1			X			
e23	1			X			
e24 - Macrouridae	1				X		
e26	1					X	
e27	1	X					
f02 - *Rexea*	2	X	X				
f06	1	X					
f08 - Macrouridae	2	X	X				
f09 - *Antigonia* sp. cf. *capros*	1	X					
f10	1	X					
f14	3	X	X	X			
f16 - Scorpaenidae	2	X			X		
f17 - *Beryx* sp. cf. *splendens*	3	X	X		X		
f20	3	X			X	X	
f21 - Scorpaeniformes	2	X	X				
f22	1	X					
f23 - Pleuornectiformes	2		X				X
f24	3	X	X		X		
f25	1		X				
f29	1		X				
f32	1		X				
f34 - Bothidae (*Arnoglossus*)	1		X				
f37 - Ateleopodidae	2			X		X	
f38 – Ipnopidae or Bathygadus	1			X			
f45	1				X		
f49	1				X		
f50 - Gobioidei	1				X		
f51	1				X		
f52 - Ateleopodidae	1				X		
f53	1				X		
f54	2				X		X
f55	1				X		
f56	1				X		
f57	1				X		

Table 9, cont.

OTU	N Total	SPG3	SPG4	SPG5	SPG6	SPG7	SPG7A
f60	1				X		
f61	2				X		X
f62	1				X		
f63	1				X		
f66	1				X		
f67 - *Prognathodes* sp. cf. *basabei*	2				X		X
f68 – *Cookeolus japonicus*	1				X		
f70	2				X		X
f71 - *Seriola lalandi*	2				X		X
f72 - *Etelis carbunculus*	2				X		X
f74	1					X	
f75	1					X	
f76 - *Synodontidae* sp. cf. *isolatus*	1					X	
f78 - (*caprodon*)	1						X
f79 – (*Caranx lugubris*)	1				X		
f81	1						X
f82	1						X
f83	1						X
f84	1						X
f85 - Lophiiformes	1				X		
f87	1				X		
f88 - Lophiiformes	1				X		
f89	1					X	
f92 - Lophiiformes (Chaunacidae)	1					X	
g01	2			X	X		
g02	3	X		X		X	
g03	1			X			
g05	1			X			
g1a	3		X	X			X
h01	1					X	
h02	3			X		X	X
m01	2	X		X			
m05	1					X	
m16	1			X			
m18	1			X			
m27	1				X		
m32	1					X	
m34	1					X	
p01	3	X		X		X	
p02	3	X			X		X

Table 9, cont.

OTU	N Total	SPG3	SPG4	SPG5	SPG6	SPG7	SPG7A
p03 - Hexactinellida	1					X	
p06 - Hexactinellida	1					X	
p07	1						X
r0	2	X			X		
r01	1	X					
r02	1	X					
r03	2	X		X			
r04	1		X				
r06	1			X			
s01	2	X				X	
s02	1	X					
s03	4	X	X		X		X
s03a	1						X
s04	1						X
s06	1		X				
s07	2			X			X
s11	2				X		X
s12	1						X
s13 - Astropectinidae	1						X
s14	1						X
s15 - Goniasteridae	1						X
s16 - Goniasteridae	1						X
s17 - Oreasteridae	1						X
s18 – (*Pentaceraster*)	1						X
u01	1	X					
u02 - *Stereoidaris nasnaensis*	4	X	X		X		X
u03 - Diadematidae	1			X			
u04 - Diadematidae	2				X		X
u09 - Cidaridae (*Prionocidaris*)	1						X
u11 - Clypeaster (*reticulatus* or *isolatus*)	1						X
u12 - Clypeaster	2	X					X
z01	1	X					
z02 - *Bathypathes*	1	X					
z03	2	X				X	
z04	1	X					
z05	1	X					
z09	1	X					
z11	2			X		X	
z12 - *Stichopathes*	4	X			X	X	X
z13	1			X			

Table 9, cont.

OTU	N Total	SPG3	SPG4	SPG5	SPG6	SPG7	SPG7A
z14	1				X		
z15	1				X		
z18	2				X	X	
z19	1				X		
z20	1					X	
z21	1					X	
z22	1					X	
z23	1					X	
z23a	1					X	
z24	1					X	
z25	1					X	
z26	2				X	X	
z27	1	X					
z28	2	X				X	
z29	1				X		
z30	1						X
z31	1						X

Table 10: PERMANOVA and PERMDISP Results
2-way PERMANOVA using station as a random factor and each of the three depth groups as a fixed factor. Analyses with significant p-values were then tested pair-wise and followed up with PERMDISP. Si = station, De = depth break, Su = summit distance, Wa = water mass, Db = 200 m Depth Bin, Sb = Subsystem. ** Term has one or more empty cells. Bolded values represent significant values ($p < 0.05$).

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Station by Depth Breaks						
Si	5	46216	9243.2	7.8012	**0.001**	997
De	3	15686	5228.7	1.8074	0.082	999
SixDe**	11	36134	3284.9	2.7724	**0.001**	998
Res	45	53318	1184.8			
Total	64	1.84E+05				
Station by Summit Distance						
Si	5	53354	10671	7.4194	**0.001**	998
Su	2	7547.1	3773.6	1.0681	0.428	998
SixSu**	7	27031	3861.5	2.6849	**0.002**	998
Res	50	71912	1438.2			
Total	64	1.84E+05				
Station by Water Mass						
Si	5	43406	8681.2	6.4229	**0.001**	998
Wa	4	14386	3596.6	0.90855	0.538	998
SixWa**	7	30553	4364.7	3.2293	**0.001**	998
Res	48	64877	1351.6			
Total	64	1.84E+05				
Station Within Subsystem by Depth Bins						
Db	5	25474	5094.9	1.1901	0.333	999
Su	1	12210	12210	1.136	0.338	998
Si(Sb)	4	41303	10326	2.521	**0.013**	997
DbxSb**	3	7966.9	2655.6	0.57046	0.847	999
Si(Sb)xDb**	9	39098	4344.2	5.5792	**0.001**	999
Res	42	32703	778.64			
Total	64	1.83E+05				

Table 11: PERMANOVA and PERMDISP pairwise results by Water Mass
Calculated using Type III Sum of Squares and permutation of residuals under a reduced model. ESPIW = Eastern South Pacific Intermediate Water, ESSW = Equatorial Subsurface Water (also the Eastern South Pacific Oxygen Minimum Zone), AAIW = Antarctic Intermediate Water, ESPTW = Eastern South Pacific Transition Water, and PDW = Pacific Deep Water. Bolded values represent significant values ($p < 0.05$).

	PERMANOVA			PERMDISP	
Groups	t	P(perm)	Groups	t	P(perm)
Water Mass: ESSW					
SPG3, SPG4	1.8712	**0.029**	227	2.6003	**0.04**
SPG3, SPG5	3.5214	0.155	5	3.2906	0.163
SPG3, SPG6	2.1086	0.058	41	3.2772	**0.022**
SPG4, SPG5	1.8462	0.152	6	4.3157	0.134
SPG4, SPG6	2.1471	**0.028**	47	2.1342	0.174
SPG5, SPG6	1.2773	0.501	2	2.4138	0.516
Water Mass: A					
SPG3, SPG5	13.554	**0.039**	8	1.5465	0.371
SPG3, SPG6	5.7042	**0.001**	40	4.7667	**0.002**
SPG3, SPG7	1.2561	0.234	705	4.1227	**0.001**
SPG3, SPG7A	2.8189	**0.008**	31	9.3868	**0.005**
SPG5, SPG6	5.375	**0.046**	8	2.283	0.327
SPG5, SPG7	3.0333	**0.01**	67	2.1545	0.103
SPG5, SPG7A	1.6994	0.15	6	4.8104	0.124
SPG6, SPG7	1.7984	**0.041**	570	1.654	0.187
SPG6, SPG7A	2.1537	**0.015**	41	4.9839	**0.011**
SPG7, SPG7A	2.3405	**0.003**	546	2.3879	**0.041**
Water Mass: E					
SPG4, SPG6	3.8324	0.226	3	2	0.498
SPG4, SPG7A	0.58333	0.698	4	1.553	0.286
SPG6, SPG7A	3.6715	**0.009**	34	1.3999	0.116
Water Mass: D					
SPG5, SPG6	3.9135	0.062	8	1.9773	0.398
SPG5, SPG7	0.92118	0.474	35	1.5782	0.328
SPG5, SPG7A	2.6252	0.211	4	1.3264	0.414
SPG6, SPG7	1.5892	0.22	5	3.3147	0.465
SPG6, SPG7A	Denominator is 0			No test	
SPG7, SPG7A	1.0744	0.503	2	2.1396	0.501
SPG3					
O, A	1.7468	0.074	64	6.3879	**0.003**
O, C	1.5615	0.228	16	2.8948	0.192
A, C	1.4485	0.26	8	19.919	**0.022**
SPG4					

Table 11, cont.

	PERMANOVA			PERMDISP	
Groups	t	P(perm)	Groups	t	P(perm)
O, E	2.5725	0.135	6	4.3157	0.144
SPG5					
O, A	1.9907	0.681	2	No test	
O, D	1.4015	0.215	4	1.3264	0.401
A, D	1.9504	0.147	11	1.3994	0.52
SPG6					
O, A	1.7502	0.086	19	3.1582	**0.01**
O, E	1.7995	0.417	3	3.0696	0.101
O, D	1.5492	0.195	7	3.7395	0.498
A, E	5.4464	**0.017**	19	1.001	0.426
A, D	0.93145	0.745	4	3.543	**0.035**
E, D	6.8848	0.115	5	3.0984	0.608
SPG7					
A, D	0.85296	0.54	279	1.1334	0.385
SPG7A					
A, E	1.3368	0.178	59	2.3055	**0.047**
A, D	0.91652	1	2	3.7113	0.207
E, D	0.30041	1	4	1.553	0.292

Table 12: PERMANOVA and PERMDISP pairwise results by Distance from Summit Calculated using Type III Sum of Squares and permutation of residuals under a reduced model. Group 1 = summit/surface to 150 m, 2 = 150-500 m, 3 = 500+ m; NaN = not a number. Bolded values represent significant values ($p < 0.05$).

	PERMANOVA			PERMDISP	
Groups	t	P(perm)	Unique perms	t	P(perm)
1					
SPG4, SPG5	1.7088	0.346	2	No test	
SPG4, SPG6	1.0595	0.507	7	7.3587	0.098
SPG4, SPG7A	1.6008	0.149	8	2.8156	0.139
SPG5, SPG6	6.4376	0.099	5	1.6045	0.596
SPG5, SPG7A	5.5426	0.077	8	0.56929	0.878
SPG6, SPG7A	5.4294	**0.031**	18	0.044362	1
2					
SPG3, SPG4	2.2064	0.011	228	2.7525	**0.026**
SPG3, SPG5	4.2396	**0.005**	154	1.392	0.167
SPG3, SPG6	2.849	**0.008**	454	1.3198	0.359
SPG3, SPG7	1.1084	0.309	17	2.9476	**0.029**
SPG3, SPG7A	2.918	**0.006**	83	9.2915	**0.008**
SPG4, SPG5	2.2983	**0.009**	91	0.5075	0.681
SPG4, SPG6	3.0212	**0.004**	277	0.29505	0.817
SPG4, SPG7	1.9816	**0.046**	16	4.7154	0.05
SPG4, SPG7A	2.1958	**0.017**	48	5.2452	**0.009**
SPG5, SPG6	2.9113	**0.004**	179	0.47999	0.743
SPG5, SPG7	3.1225	0.063	15	2.4547	0.127
SPG5, SPG7A	2.4281	**0.032**	11	3.7257	**0.028**
SPG6, SPG7	1.3211	0.23	23	1.4507	0.276
SPG6, SPG7A	2.4125	**0.003**	66	1.1167	0.389
SPG7, SPG7A	1.541	0.201	8	7.61E+07	0.058
3					
SPG3, SPG5	1.9775	0.252	5	1.069	0.139
SPG3, SPG6	5.1792	**0.008**	20	1.9123	0.129
SPG3, SPG7	1.567	0.114	931	2.907	**0.027**
SPG3, SPG7A	2.5779	**0.009**	31	2.5501	0.164
SPG5, SPG6	Denominator is 0			NaN	**0.001**
SPG5, SPG7	1.0541	0.37	11	2.2168	0.076
SPG5, SPG7A	1.3229	0.511	2	2	0.503
SPG6, SPG7	1.8767	**0.034**	163	3.8859	**0.002**
SPG6, SPG7A	1.291	0.088	3	4	0.087
SPG7, SPG7A	1.6717	0.053	271	0.5139	0.717

SPG3

Table 12, cont.

	PERMANOVA			PERMDISP	
Groups	t	P(perm)	Unique perms	t	P(perm)
2, 3	1.6367	0.126	215	0.47294	0.707
SPG4					
1, 2	1.3434	0.233	16	3.5543	0.084
SPG5					
1, 2	1.4194	0.112	15	2.2784	0.26
1, 3	5.8914	0.325	3	No test	
2, 3	1.1035	0.829	4	2.0608	0.422
SPG6					
1, 2	2.6597	**0.028**	35	1.2159	0.326
1, 3	8.8882	0.107	3	4	0.106
2, 3	1.5325	0.198	19	2.1467	0.068
SPG7					
2, 3	0.91996	0.499	79	2.7029	**0.028**
SPG7A					
1, 2	1.3904	0.269	13	4.2233	**0.03**
1, 3	1.328	0.187	11	2.2056	0.183
2, 3	1.0911	0.308	8	0.59761	0.674

Table 13: PERMANOVA and PERMDISP pairwise results by Depth Breaks
Calculated using Type III Sum of Squares and permutation of residuals under a reduced model. S = shallow, U = upper-slope, M = mid-slope, D = deep. Bolded values represent significant values ($p < 0.05$).

	PERMANOVA			PERMDISP	
Groups	t	P(perm)	Unique perms	t	P(perm)
S					
SPG3, SPG4	Negative			No test	
SPG3, SPG6	1.4272	0.324	2	No test	
SPG3, SPG7A	3.6088	0.066	11	0.14618	1
SPG4, SPG6	Negative			No test	
SPG4, SPG7A	1.6008	0.143	8	2.8156	0.132
SPG6, SPG7A	2.8395	0.208	4	0.76033	0.792
U					
SPG3, SPG4	2.6541	**0.004**	177	6.7151	**0.004**
SPG3, SPG5	9.0559	**0.031**	17	4.0242	0.069
SPG3, SPG6	2.3588	**0.004**	82	3.3571	**0.02**
SPG3, SPG7	1.2546	0.225	53	2.1951	0.05
SPG3, SPG7A	3.2526	**0.01**	61	58.825	**0.005**
SPG4, SPG5	2.3716	**0.049**	16	4.4201	**0.044**
SPG4, SPG6	1.9591	**0.041**	148	0.95274	0.362
SPG4, SPG7	1.8036	0.056	91	0.98341	0.46
SPG4, SPG7A	2.1958	**0.02**	48	5.2452	**0.008**
SPG5, SPG6	2.4417	**0.04**	12	2.0851	0.151
SPG5, SPG7	4.067	0.059	11	1.523	0.488
SPG5, SPG7A	1.9831	0.203	4	7.34E+07	0.069
SPG6, SPG7	1.2109	0.245	57	1.3623	0.21
SPG6, SPG7A	2.1977	**0.003**	34	0.86233	0.58
SPG7, SPG7A	2.2199	**0.034**	18	3.6326	**0.033**
M					
SPG3, SPG5	3.6073	0.2	3	1.3416	0.417
SPG3, SPG6	5.9649	**0.032**	7	4.05E-08	0.907
SPG3, SPG7	2.0956	**0.023**	15	3.8594	**0.023**
SPG3, SPG7A	5.3104	0.199	3	1.3416	0.4
SPG5, SPG6	5.3104	0.195	3	1.3416	0.375
SPG5, SPG7	2.0307	0.199	5	4.6545	0.199
SPG5, SPG7A	No test			No test	
SPG6, SPG7	1.2225	0.342	6	3.8594	**0.02**
SPG6, SPG7A	5.3104	0.197	3	1.3416	0.409
SPG7, SPG7A	2.2104	0.204	4	4.6545	0.205
D					
SPG3, SPG5	2.0875	0.201	5	1.3264	0.389

Table 13, cont.

Groups	PERMANOVA t	P(perm)	Unique perms	PERMDISP t	P(perm)
SPG3, SPG6	Denominator is 0			No test	
SPG3, SPG7	1.8159	0.145	7	1.0674	0.133
SPG3, SPG7A	Denominator is 0			No test	
SPG5, SPG6	3.9135	0.072	8	1.9773	0.426
SPG5, SPG7	1.8671	0.063	208	0.16905	0.879
SPG5, SPG7A	3.9135	0.074	8	1.9773	0.396
SPG6, SPG7	2.2943	0.082	22	1.5468	0.109
SPG6, SPG7A	Denominator is 0			No test	
SPG7, SPG7A	2.5046	0.06	22	1.5468	0.118
SPG3					
S, U	3.2364	**0.033**	9	1.5132	0.254
S, M	2.6438	0.064	7	4.67E-08	1
S, D	1	1	1	No test	
U, M	2.5028	**0.018**	31	0.4357	0.832
U, D	4.0156	0.142	4	7.8718	0.138
M, D	2.8284	0.195	3	1.3416	0.371
SPG4					
S, U	1.3434	0.239	16	3.5543	0.087
SPG5					
U, M	1.9907	0.636	2	No test	
U, D	2.05	0.131	11	1.3994	0.463
M, D	1.2626	0.398	4	1.3264	0.423
SPG6					
S, U	0.9486	0.431	5	1.7466	0.148
S, M	5.3104	0.206	3	1.3416	0.403
S, D	Denominator is 0			No test	
U, M	2.623	**0.012**	34	2.449	0.067
U, D	1.9972	**0.03**	12	2.5311	0.087
M, D	0.66667	1	2	2	0.406
SPG7					
U, M	1.6785	0.113	21	1.132	0.315
U, D	2.4406	**0.022**	210	0.23067	0.879
M, D	1.3751	0.204	194		
SPG7A					
S, U	1.3904	0.271	13	4.2233	**0.027**
S, M	3.8482	0.22	4	0.76033	0.785
S, D	1.9107	0.329	5	1.1334	0.731
U, M	1.3416	0.216	2	5.74E+07	0.216

Table 13, cont.

Groups	PERMANOVA			PERMDISP	
	t	P(perm)	Unique perms	t	P(perm)
U, D	1.2766	0.213	4	8.56E+07	0.19
M, D	Denominator is 0			No test	

Table 14: SIMPER Results by Water Mass

SIMPER results with factors of station by water mass, consisting of within- and among-station comparisons and within- and among-water mass comparisons. ESPIW stands for Eastern South Pacific Intermediate Water, ESSW for Equatorial Subsurface Water, AAIW for Antarctic Intermediate Water, ESPTW for Eastern South Pacific Transition Water, and PDW for Pacific Deep Water. The letters in the operational taxonomic unit (OTU) column represent groups of morphospecies by taxa or similar functional roles: a = arthropods, b = sharks, c = non-coral cnidarians, d = cephalopods, e = eel-like fish, f = fish, g = mollusks, h = sea cucumbers, m = other OTUs, p = sponges, r = eels, s = sea and brittle stars, u = sea urchin, z = coral; N/A = not available.

	OTU	Average Abundance (Group 1)	Average Abundance (Group 2)	Average Dissimilarity (Similarity)	Dissimilarity (Similarity)/ SD	Percentage Contribution	Cumulative Percentage
Within-station comparisons							
SPG3: 70.69	z	2.29	N/A	(21.7)	(1.28)	30.7	30.7
	a	2.36	N/A	(20.13)	(1.15)	28.47	59.18
	f	1.6	N/A	(14.54)	(2.82)	20.56	79.74
SPG4: 61.25	f	3.53	N/A	(41.91)	(5.78)	68.42	68.42
	a	1.89	N/A	(11.94)	(0.78)	19.5	87.92
SPG5: 48.34	g	3.33	N/A	(20.04)	(0.99)	41.46	41.46
	e	2.48	N/A	(11.93)	(1)	24.69	66.15
	a	1.04	N/A	(7.94)	(0.76)	16.43	82.58
SPG6: 58.17	z	2.14	N/A	(36.44)	(0.93)	62.65	62.65
	f	1.34	N/A	(12.38)	(0.43)	21.29	83.93
SPG7: 48.54	z	3.21	N/A	(36.03)	(1.49)	74.23	74.23
SPG7A: 45	c	2.06	N/A	(29.81)	(0.86)	66.26	66.26
	s	1.55	N/A	(6.94)	(0.31)	15.43	81.68
Among-station comparisons							
SPG3 & SPG4: 62.18	f	1.6	3.53	14.87	2.79	23.91	23.91
	a	2.36	1.89	12.95	1.38	20.83	44.75
	u	0.72	0.65	8.58	0.7	13.81	58.55
	g	0	1	6.81	0.68	10.95	69.5
	z	2.29	0	5.77	0.96	9.28	78.78
SPG3 & SPG5: 85.67	g	0	3.33	20.23	5.06	23.62	23.62
	z	2.29	0	15.98	1.93	18.65	42.27
	a	2.36	1.04	11.66	1.66	13.61	55.88
	h	0	0.96	10.57	1.22	12.34	68.22

Table 14, cont.

	OTU	Average Abundance (Group 1)	Average Abundance (Group 2)	Average Dissimilarity (Similarity)	Dissimilarity (Similarity)/ SD	Percentage Contribution	Cumulative Percentage
	f	1.6	0	9.26	3.76	10.81	79.03
SPG4 & SPG5: 79.64	f	3.53	0	20.79	6.46	26.11	26.11
	h	0	0.96	19.2	10.86	24.11	50.22
	e	0.84	2.48	12.97	1.9	16.28	66.5
	g	1	3.33	11.08	1.51	13.91	80.41
SPG3 & SPG6: 69.28	a	2.36	0	16.04	1.53	23.15	23.15
	p	0	1.41	14.74	0.94	21.28	44.43
	f	1.6	1.34	13.1	2.42	18.92	63.34
	e	1.97	0	11.22	1.26	16.19	79.53
SPG4 & SPG6: 80.20	f	3.53	1.34	22.32	1.66	27.84	27.84
	p	0	1.41	18.21	1.11	22.71	50.55
	a	1.89	0	12.59	1.12	15.7	66.25
	g	1	0	7.15	0.61	8.92	75.16
SPG5 & SPG6: 100	g	3.33	0	25.28	2.12	25.28	25.28
	z	0	2.14	24.59	1.79	24.59	49.87
	e	2.48	0	16.79	2.21	16.79	66.67
	p	0.87	1.41	11.92	0.89	11.92	78.58
SPG3 & SPG7: 42.82	e	1.97	0.72	12.46	1.96	29.09	29.09
	f	1.6	1.05	8.47	1.63	19.79	48.88
	a	2.36	1.19	7.06	1.88	16.48	65.36
	c	0.48	0.83	6.34	0.81	14.81	80.18
SPG5 & SPG7: 87.15	g	3.33	0	22.54	2.26	25.86	25.86
	z	0	3.21	16.72	1.35	19.19	45.05
	e	2.48	0.72	11.12	1.9	12.76	57.8
	a	1.04	1.19	7.72	1.06	8.86	66.66
	p	0.87	1.14	7.25	0.8	8.31	74.98
SPG6 & SPG7: 53.97	p	1.41	1.14	14.91	1.05	27.62	27.62
	z	2.14	3.21	12.54	0.92	23.24	50.86
	f	1.34	1.05	8.35	0.64	15.47	66.33
	a	0	1.19	8.01	0.88	14.84	81.17
SPG3 & SPG7A: 86.69	z	2.29	1.87	23.41	1.74	27	27

Table 14, cont.

	OTU	Average Abundance (Group 1)	Average Abundance (Group 2)	Average Dissimilarity (Similarity)	Dissimilarity (Similarity)/ SD	Percentage Contribution	Cumulative Percentage
	e	1.97	0	18.78	2.45	21.66	48.66
	s	0	1.55	14.86	0.98	17.14	65.8
	f	1.6	0	13.73	3.78	15.84	81.64
SPG4 & SPG7A: 61.97	u	0.65	0.5	27.06	2.09	43.67	43.67
	c	0.32	2.06	15.86	3.34	25.6	69.26
	z	0	1.87	11.55	1.15	18.64	87.91
SPG5 & SPG7A: 100	g	3.33	0	30.88	1.95	30.88	30.88
	e	2.48	0	17.5	2.32	17.5	48.38
	z	0	1.87	16.19	0.93	16.19	64.57
	s	0	1.55	11.24	0.66	11.24	75.8
SPG6 & SPG7A: 84.87	z	2.14	1.87	24.89	0.92	29.33	29.33
	f	1.34	0	15.41	0.84	18.15	47.48
	s	0	1.55	15.29	0.77	18.01	65.5
	c	0	2.06	14.37	0.77	16.93	82.43
SPG7 & SPG7A: 84.83	z	3.21	1.87	28.86	1.26	34.02	34.02
	s	0	1.55	17.61	0.89	20.75	54.78
	f	1.05	0	10.33	0.55	12.17	66.95
	a	1.19	0	9.14	0.9	10.78	77.73
Within-water mass comparisons							
ESSW: 55.53	f	2.48	N/A	(27.72)	(1.6)	49.92	49.92
	a	2.1	N/A	(18.09)	(0.87)	32.58	82.5
AAIW: 54.52	z	3.13	N/A	(36.04)	(1.47)	66.12	66.12
	a	0.83	N/A	(5.03)	(0.7)	9.22	75.34
ESPTW: 56.64	e	4.5	N/A	(56.64)	(SD=0!)	100	100
ESPIW: 58.64	c	2.43	N/A	(34.78)	(0.99)	59.32	59.32
	f	1.26	N/A	(11.7)	(0.41)	19.95	79.26
PDW: 43.39	z	1.78	N/A	(10)	(0.32)	23.05	23.05
	g	1.15	N/A	(9.71)	(0.59)	22.38	45.43
	e	1.45	N/A	(8.46)	(0.74)	19.5	64.93
	p	1.44	N/A	(7.12)	(0.5)	16.42	81.35
Among-water mass comparisons							

Table 14, cont.

	OTU	Average Abundance (Group 1)	Average Abundance (Group 2)	Average Dissimilarity (Similarity)	Dissimilarity (Similarity)/ SD	Percentage Contribution	Cumulative Percentage
ESSW & AAIW: 60.74	z	0.42	3.13	20.62	1.46	33.94	33.94
	e	0.67	0.9	8.78	1.15	14.45	48.39
	a	2.1	0.83	8.08	1.18	13.29	61.68
	p	0.61	0.6	7.82	0.45	12.88	74.56
ESSW & ESPTW: 74.32	e	0.67	4.5	27.74	6.07	37.32	37.32
	a	2.1	0.96	18.07	2.52	24.32	61.64
	u	0.46	1.24	10.87	0.94	14.62	76.27
AAIW & ESPTW: 55.16	z	3.13	0	21.95	6.38	39.79	39.79
	e	0.9	4.5	9.91	1.84	17.96	57.75
	f	0.85	0.58	7.54	1.74	13.67	71.42
ESSW & ESPIW: 82.98	f	2.48	1.26	27.12	1.7	32.68	32.68
	u	0.46	1.43	18.03	1.16	21.72	54.4
	p	0.61	0	17.42	0.78	20.99	75.39
AAIW & ESPIW: 89.37	z	3.13	1.13	23.91	1.39	26.76	26.76
	c	0.55	2.43	23.52	0.84	26.32	53.08
	f	0.85	1.26	15.17	0.74	16.97	70.05
ESSW & PDW: 78.69	z	0.42	1.78	26.87	1.12	34.14	34.14
	p	0.61	1.44	21.67	0.95	27.54	61.69
	f	2.48	0.27	10	0.47	12.71	74.39
AAIW & PDW: 59.74	z	3.13	1.78	16.03	0.86	26.84	26.84
	p	0.6	1.44	14	0.99	23.43	50.27
	a	0.83	1.12	7.64	0.83	12.79	63.06
	e	0.9	1.45	7.41	0.92	12.4	75.46
ESPIW & PDW: 86.13	z	1.13	1.78	35.76	2.01	41.52	41.52
	f	1.26	0.27	21.27	0.9	24.7	66.22
	c	2.43	0.01	16.05	0.77	18.63	84.85

Table 15: SIMPER Results by Summit Distance

SIMPER results by summit distance, consisting of within- and among-station comparisons and within- and among-water mass comparisons. Group 1 extends to 150 m below the seamount summit or surface for oceanic islands, group 2 from 150-500 m, and group 3 >500 m. The letters in the operational taxonomic unit (OTU) column represent groups of morphospecies by taxa or similar functional roles: a = arthropods, b = sharks, c = non-coral cnidarians, d = cephalopods, e = eel-like fish, f = fish, g = mollusks, h = sea cucumbers, m = other OTUs, p = sponges, r = eels, s = sea and brittle stars, u = sea urchin, z = coral; N/A = not available.

	Taxa	Average Abundance (Group 1)	Average Abundance (Group 2)	Average Dissimilarity (Similarity)	Dissimilarity (Similarity)/ SD	Percentage Contribution	Cumulative Percentage
Within-station comparisons							
SPG3: 59.90	a	2.36	N/A	(17.54)	(1.06)	29.28	29.28
	e	1.97	N/A	(16.47)	(1.03)	27.5	56.78
	z	2.29	N/A	(12.18)	(0.77)	20.34	77.12
SPG4: 53.39	f	3.53	N/A	(35.58)	(2.74)	66.63	66.63
	a	1.89	N/A	(7.73)	(0.58)	14.47	81.11
SPG5: 58.73	g	3.33	N/A	(37.93)	(2.35)	64.58	64.58
	e	2.48	N/A	(11.9)	(1.03)	20.26	84.84
SPG6: 48.82	z	2.14	N/A	(23.38)	(0.67)	47.88	47.88
	p	1.41	N/A	(17.5)	(0.52)	35.85	83.73
SPG7: 42.75	z	3.21	N/A	(29.93)	(1.04)	70.02	70.02
SPG7A: 43.45	c	2.06	N/A	(15.94)	(0.53)	36.68	36.68
	z	1.87	N/A	(15.37)	(0.62)	35.37	72.05
Among-station comparisons							
SPG3 & SPG4: 64.94	f	1.6	3.53	13.58	2.88	20.91	20.91
	a	2.36	1.89	12.28	1.29	18.91	39.82
	z	2.29	0	7.96	1.05	12.26	52.08
	g	0	1	7.91	0.78	12.18	64.26
	u	0.72	0.65	6.94	0.62	10.69	74.95
SPG3 & SPG5: 79.80	g	0	3.33	18.02	1.49	22.58	22.58
	a	2.36	1.04	13.55	1.36	16.98	39.56
	z	2.29	0	9.67	1.11	12.11	51.68
	f	1.6	0	8.62	2.67	10.8	62.48
	e	1.97	2.48	7.61	1.35	9.54	72.02

Table 15, cont.

	Taxa	Average Abundance (Group 1)	Average Abundance (Group 2)	Average Dissimilarity (Similarity)	Dissimilarity (Similarity)/ SD	Percentage Contribution	Cumulative Percentage
SPG4 & SPG5: 76.21	f	3.53	0	19.96	2.69	26.2	26.2
	g	1	3.33	15.54	1.72	20.39	46.58
	a	1.89	1.04	9.29	1.18	12.19	58.77
	e	0.84	2.48	8.69	1.35	11.4	70.17
SPG3 & SPG6: 77.49	a	2.36	0	19.37	1.62	25	25
	z	2.29	2.14	13.66	1.03	17.63	42.62
	p	0	1.41	12.15	0.77	15.67	58.3
	f	1.6	1.34	11.91	2.05	15.37	73.67
SPG4 & SPG6: 86.61	f	3.53	1.34	22.69	2.12	26.2	26.2
	p	0	1.41	14.33	0.95	16.54	42.74
	a	1.89	0	12.48	1.16	14.41	57.15
	z	0	2.14	11.4	0.89	13.16	70.32
SPG5 & SPG6: 94.12	g	3.33	0	25.55	2.09	27.15	27.15
	e	2.48	0	14.34	1.68	15.23	42.38
	p	0.87	1.41	13.59	0.91	14.43	56.81
	z	0	2.14	13.42	0.91	14.26	71.08
SPG3 & SPG7: 56.39	e	1.97	0.72	14.3	1.4	25.35	25.35
	z	2.29	3.21	11.28	0.95	20	45.35
	a	2.36	1.19	8.92	1.71	15.83	61.17
	f	1.6	1.05	8.32	1.28	14.76	75.93
SPG4 & SPG7: 79.39	c	0.32	0.83	20.93	6.15	26.36	26.36
	z	0	3.21	13.69	12.88	17.25	43.61
	f	3.53	1.05	13.57	4.02	17.09	60.7
	a	1.89	1.19	8.51	2	10.71	71.42
SPG5 & SPG7: 81.30	z	0	3.21	17.13	1.79	21.08	21.08
	e	2.48	0.72	16.08	1.62	19.78	40.85
	a	1.04	1.19	9.86	1.54	12.13	52.98
	c	0	0.83	9.53	0.85	11.72	64.7
	g	3.33	0	8.29	0.74	10.2	74.9
SPG6 & SPG7: 53.69	z	2.14	3.21	11.74	0.77	21.87	21.87

Table 15, cont.

	Taxa	Average Abundance (Group 1)	Average Abundance (Group 2)	Average Dissimilarity (Similarity)	Dissimilarity (Similarity)/ SD	Percentage Contribution	Cumulative Percentage
	p	1.41	1.14	11.07	0.86	20.61	42.48
	c	0	0.83	8.88	0.69	16.54	59.02
	f	1.34	1.05	8.81	0.69	16.4	75.42
SPG3 & SPG7A: 85.39	a	2.36	0	18.86	1.55	22.08	22.08
	e	1.97	0	14.07	0.87	16.48	38.56
	z	2.29	1.87	14.03	0.96	16.42	54.99
	f	1.6	0	11.79	2.4	13.81	68.8
	c	0.48	2.06	10.52	0.77	12.32	81.11
SPG4 & SPG7A: 91.21	f	3.53	0	24.01	2.24	26.33	26.33
	c	0.32	2.06	16.21	1.09	17.77	44.1
	s	0.51	1.55	14.6	1.23	16	60.1
	a	1.89	0	11.95	1.11	13.1	73.2
SPG5 & SPG7A: 100	g	3.33	0	23.4	1.75	23.4	23.4
	e	2.48	0	15.81	1.63	15.81	39.21
	c	0	2.06	15.08	0.95	15.08	54.29
	s	0	1.55	12.81	0.82	12.81	67.1
	a	1.04	0	6.47	0.74	6.47	73.57
SPG6 & SPG7A: 86.92	z	2.14	1.87	22.44	0.86	25.82	25.82
	c	0	2.06	19.34	0.91	22.25	48.07
	s	0	1.55	16.35	0.79	18.81	66.88
	p	1.41	0	14.42	0.69	16.59	83.47
SPG7 & SPG7A: 66.02	z	3.21	1.87	21.77	0.86	32.98	32.98
	p	1.14	0	10.11	0.66	15.31	48.29
	f	1.05	0	9.98	0.54	15.12	63.41
	a	1.19	0	9.82	0.81	14.88	78.28
Within-summit group comparisons							
Summit group 2: 47.16	f	1.33	N/A	(10.53)	(0.71)	22.32	22.32
	a	1.37	N/A	(8.85)	(0.54)	18.77	41.09
	p	0.9	N/A	(8.12)	(0.34)	17.23	58.32
	z	1.04	N/A	(7.5)	(0.46)	15.91	74.23
Summit group 3: 49.03	z	3.18	N/A	(29.32)	(0.96)	59.8	59.8

Table 15, cont.

	Taxa	Average Abundance (Group 1)	Average Abundance (Group 2)	Average Dissimilarity (Similarity)	Dissimilarity (Similarity)/ SD	Percentage Contribution	Cumulative Percentage
	e	1.46	N/A	(7.85)	(0.6)	16	75.8
Summit group 1: 58.84	f	1.55	N/A	(19.14)	(0.55)	32.53	32.53
	c	1.37	N/A	(12.49)	(0.58)	21.23	53.75
	z	1.03	N/A	(12.43)	(0.95)	21.12	74.88
Among-summit group comparisons							
Summit groups 2 & 3: 63.61	z	1.04	3.18	16.61	1.05	26.11	26.11
	c	0.8	0.21	10.74	0.61	16.89	43
	e	0.52	1.46	8.49	0.87	13.34	56.34
	a	1.37	1.02	7.39	1.01	11.62	67.97
	p	0.9	0.59	7.15	0.5	11.24	79.21
Summit groups 2 & 1: 70.76	f	1.33	1.55	15.45	0.81	21.84	21.84
	z	1.04	1.03	13.02	0.87	18.4	40.24
	p	0.9	0	9.66	0.56	13.66	53.89
	u	0.25	1.3	9.32	0.74	13.17	67.07
	c	0.8	1.37	6.15	0.52	8.69	75.75
Summit groups 3 & 1: 82.50	z	3.18	1.03	27.88	1.53	33.79	33.79
	f	0.9	1.55	16.65	0.75	20.18	53.96
	c	0.21	1.37	14.54	0.7	17.62	71.58

Table 16: SIMPER results by Depth Break

SIMPER results by depth break, consisting of within- and among-station comparisons and within- and among-water mass comparisons. S = 0-300 m, U = 300-600 m, M = 600-800 m, D = 800-1200 m. The letters in the operational taxonomic unit (OTU) column represent groups of morphospecies by taxa or similar functional roles: a = arthropods, b = sharks, c = non-coral cnidarians, d = cephalopods, e = eel-like fish, f = fish, g = mollusks, h = sea cucumbers, m = other OTUs, p = sponges, r = eels, s = sea and brittle stars, u = sea urchin, z = coral; N/A = not available.

	Taxa	Average Abundance (Group 1)	Average Abundance (Group 2)	Average Dissimilarity (Similarity)	Dissimilarity (Similarity)/ SD	Percentage Contribution	Cumulative Percentage
Within-station comparisons							
SPG3: 67.53	a	2.36	N/A	(21.3)	(1.64)	31.54	31.54
	z	2.29	N/A	(18.57)	(1.35)	27.5	59.03
	f	1.6	N/A	(14.22)	(2.11)	21.06	80.1
SPG4: 53.39	f	3.53	N/A	(35.58)	(2.74)	66.63	66.63
	a	1.89	N/A	(7.73)	(0.58)	14.47	81.11
SPG5: 49.84	g	3.33	N/A	(17.89)	(0.99)	35.9	35.9
	e	2.48	N/A	(13.03)	(1.01)	26.15	62.04
	a	1.04	N/A	(7.94)	(0.76)	15.93	77.98
SPG6: 50.03	z	2.14	N/A	(24.44)	(0.63)	48.85	48.85
	f	1.34	N/A	(14.18)	(0.41)	28.34	77.19
SPG7: 44.76	z	3.21	N/A	(27.84)	(1)	62.2	62.2
	p	1.14	N/A	(6.14)	(0.53)	13.71	75.91
SPG7A: 50.13	c	2.06	N/A	(18.39)	(0.58)	36.68	36.68
	z	1.87	N/A	(17.73)	(0.68)	35.37	72.05
Among-station comparisons							
SPG3 & SPG5: 60.42	z	2.29	0	13.38	1.65	22.15	22.15
	f	1.6	3.53	11.85	2.81	19.62	41.77
	a	2.36	1.89	11.34	1.32	18.77	60.53
	g	0	1	6.56	0.71	10.86	71.39
SPG3 & SPG5: 85.81	g	0	3.33	18.91	2.68	22.03	22.03
	a	2.36	1.04	13.15	1.87	15.32	37.35
	z	2.29	0	11.74	1.3	13.69	51.04
	e	1.97	2.48	11.42	1.73	13.31	64.35
	h	0	0.96	9.71	1.15	11.31	75.67

Table 16, cont.

	Taxa	Average Abundance (Group 1)	Average Abundance (Group 2)	Average Dissimilarity (Similarity)	Dissimilarity (Similarity)/ SD	Percentage Contribution	Cumulative Percentage
SPG4 & SPG5: 75.80	f	3.53	0	19.33	7.41	25.5	25.5
	h	0	0.96	16.11	5.27	21.26	46.76
	g	1	3.33	10.96	1.43	14.46	61.22
	e	0.84	2.48	9.93	1.63	13.1	74.32
SPG3 & SPG6: 76.78	a	2.36	0	18.13	1.67	23.61	23.61
	z	2.29	2.14	16.29	1.38	21.21	44.83
	f	1.6	1.34	13.73	2.43	17.88	62.7
	e	1.97	0	12.42	1.03	16.18	78.88
SPG4 & SPG6: 69.87	f	3.53	1.34	15	1.29	21.47	21.47
	p	0	1.41	14.1	0.91	20.19	41.65
	a	1.89	0	12.67	1.17	18.14	59.79
	g	1	0	9.34	0.75	13.36	73.15
SPG5 & SPG6: 100	g	3.33	0	24.31	2.2	24.31	24.31
	e	2.48	0	17.76	2.44	17.76	42.06
	z	0	2.14	17.68	1.05	17.68	59.74
	p	0.87	1.41	11.38	0.87	11.38	71.12
SPG3 & SPG7: 53.14	e	1.97	0.72	11.36	1.09	21.38	21.38
	z	2.29	3.21	11.16	1	21	42.38
	a	2.36	1.19	9.83	1.14	18.5	60.88
	c	0.48	0.83	8.02	0.98	15.09	75.97
SPG4 & SPG7: 65.48	z	0	3.21	12.43	1.5	18.98	18.98
	c	0.32	0.83	10.46	0.95	15.98	34.96
	f	3.53	1.05	10.05	2.04	15.35	50.31
	a	1.89	1.19	9.6	1.27	14.66	64.97
	g	1	0	7.99	0.76	12.2	77.17
SPG5 & SPG7: 84.50	g	3.33	0	19	1.66	22.49	22.49
	z	0	3.21	17.62	1.38	20.85	43.34
	e	2.48	0.72	12.27	1.63	14.52	57.86
	a	1.04	1.19	9.17	1.37	10.86	68.71
	p	0.87	1.14	8.01	0.89	9.48	78.19
SPG6 & SPG7: 56.58	p	1.41	1.14	14.46	0.94	25.55	25.55

Table 16, cont.

	Taxa	Average Abundance (Group 1)	Average Abundance (Group 2)	Average Dissimilarity (Similarity)	Dissimilarity (Similarity)/ SD	Percentage Contribution	Cumulative Percentage
	z	2.14	3.21	11.78	0.99	20.81	46.36
	f	1.34	1.05	9.77	0.79	17.27	63.63
	a	0	1.19	9.01	0.95	15.92	79.56
SPG3 & SPG7A: 93.03	z	2.29	1.87	21.02	2.12	22.6	22.6
	a	2.36	0	19.36	1.62	20.81	43.4
	c	0.48	2.06	14.65	1.1	15.75	59.15
	s	0	1.55	12.46	0.84	13.4	72.55
SPG4 & SPG7A: 91.21	f	3.53	0	24.01	2.24	26.33	26.33
	c	0.32	2.06	16.21	1.09	17.77	44.1
	s	0.51	1.55	14.6	1.23	16	60.1
	a	1.89	0	11.95	1.11	13.1	73.2
SPG5 & SPG7A: 100	g	3.33	0	24.13	1.62	24.13	24.13
	e	2.48	0	18.52	2.18	18.52	42.65
	z	0	1.87	14.98	0.88	14.98	57.63
	h	0.96	0	10.12	0.89	10.12	67.75
	c	0	2.06	7.86	0.64	7.86	75.61
SPG6 & SPG7A: 87.57	f	1.34	0	19.14	0.83	21.85	21.85
	c	0	2.06	18.5	0.83	21.12	42.98
	s	0	1.55	17.16	0.76	19.59	62.57
	p	1.41	0	17.07	0.73	19.49	82.06
SPG7 & SPG7A: 74.29	z	3.21	1.87	20.6	0.97	27.73	27.73
	f	1.05	0	12.23	0.76	16.46	44.19
	c	0.83	2.06	10.88	0.69	14.65	58.84
	a	1.19	0	9.33	0.88	12.55	71.39
Within-depth break comparisons							
S: 50.17	c	1.7	N/A	(17.17)	(0.72)	34.23	34.23
	z	1.26	N/A	(17.09)	(1.39)	34.06	68.29
	u	2.36	N/A	(8.45)	(0.73)	16.85	85.14
U: 51.25	f	2.03	N/A	(19.91)	(0.81)	38.85	38.85
	a	1.32	N/A	(9.45)	(0.67)	18.43	57.28
	z	1.14	N/A	(7.78)	(0.63)	15.18	72.46
M: 65.42	z	3.21	N/A	(45.63)	(1.46)	69.75	69.75
	e	1.38	N/A	(10.93)	(0.66)	16.71	86.46

Table 16, cont.

	Taxa	Average Abundance (Group 1)	Average Abundance (Group 2)	Average Dissimilarity (Similarity)	Dissimilarity (Similarity)/ SD	Percentage Contribution	Cumulative Percentage
D: 47.28	z	2.4	N/A	(24.26)	(0.68)	51.31	51.31
	p	1.21	N/A	(8.31)	(0.7)	17.57	68.87
	e	1.39	N/A	(5.95)	(0.65)	12.59	81.46
Among-depth break comparisons							
S & U: 65.74	u	2.36	0	16.69	1.36	25.39	25.39
	z	1.26	1.14	12.44	1.2	18.92	44.31
	c	1.7	0.84	8.91	0.72	13.56	57.87
	s	0.87	0.48	7.1	0.63	10.79	68.67
	f	1.11	2.03	6.79	0.73	10.33	79
S & M: 88.24	z	1.26	3.21	23.49	1.9	26.62	26.62
	u	2.36	0	22.23	1.96	25.2	51.82
	e	0.07	1.38	10.32	0.85	11.69	63.51
	c	1.7	0.22	9.95	0.46	11.27	74.78
U & M: 62.44	z	1.14	3.21	18.93	1.05	30.32	30.32
	f	2.03	0.64	12.98	0.72	20.78	51.1
	p	0.58	0.47	8.51	0.51	13.63	64.74
	c	0.84	0.22	6.95	0.39	11.13	75.87
S & D: 64.30	c	1.7	0.12	16.11	1.07	25.06	25.06
	z	1.26	2.4	15.25	1.1	23.72	48.78
	u	2.36	0.16	12.96	1.09	20.15	68.93
	s	0.87	0	8.39	0.8	13.05	81.98
U & D: 76.80	z	1.14	2.4	23.29	1.18	30.32	30.32
	f	2.03	0.26	12.06	0.7	15.7	46.02
	p	0.58	1.21	10.61	0.7	13.81	59.83
	c	0.84	0.12	8.85	0.64	11.52	71.35
M & D: 46.05	z	3.21	2.4	12.73	0.59	27.64	27.64
	p	0.47	1.21	9.67	0.79	21	48.64
	a	0.87	0.82	7.44	0.9	16.16	64.8
	e	1.38	1.39	6.09	0.87	13.22	78.02

Table 17: BEST Results by Station

BEST (Bio-Env + stepwise) analysis results by station factor. BEST analysis was conducted on standardized and log(X+1) transformed abundance data and environmental data from Coral Point Count analysis. Table consists of the models with the highest correlation value using 1 to 5 environmental variables to explain observed faunal community patterns.

Number of Variables	Correlation	Variable Selections
1	0.48	Depth
2	0.48	Longitude, Depth
3	0.48	Latitude, Longitude, Depth
4	0.47	Latitude, Longitude, Depth, Rubble
5	0.46	Latitude, Longitude, Depth, bBPI, Rubble

Table 18: BEST Results
BEST (Bio-Env + stepwise) analysis results. BEST analysis was conducted on standardized and log(X+1) transformed abundance data and environmental data from Coral Point Count analysis. Table consists of the models with the highest correlation value using 1 to 5 environmental variables to explain observed faunal community patterns.

Number of Variables	Correlation	Variable Selections
1	0.23	Dissolved Oxygen
2	0.32	Latitude, Hard Substrate
3	0.37	Latitude, Depth, Hard Substrate
4	0.37	Latitude, Depth, fBPI, Hard Substrate
5	0.40	Latitude, Depth, fBPI, bBPI, Hard Substrate

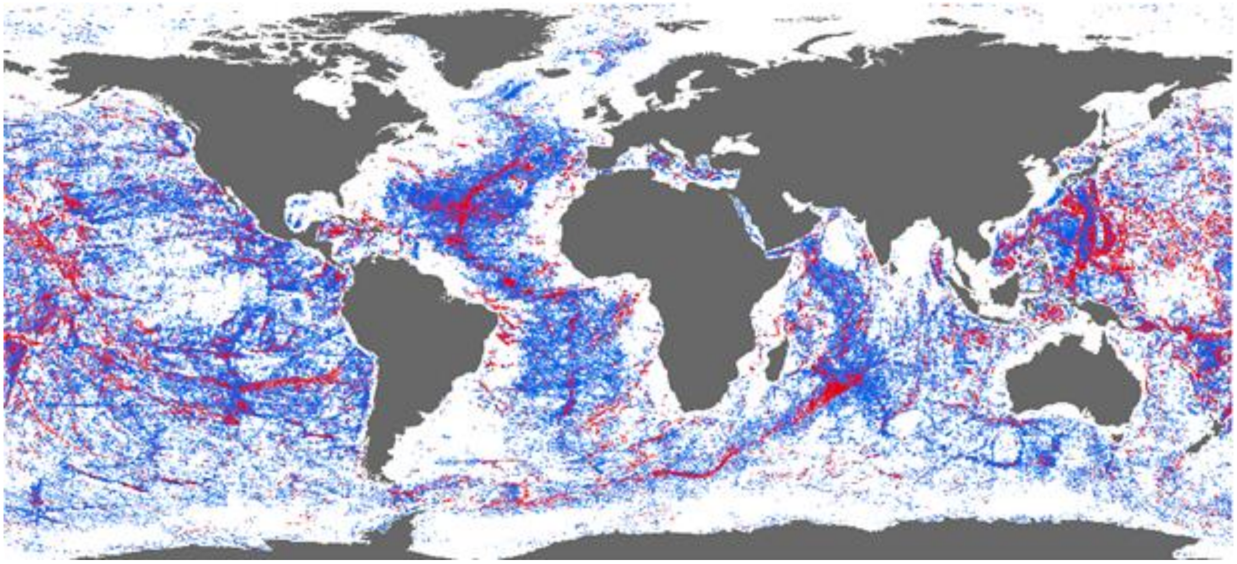

Figure 1: Global Seamount Distribution
Distribution of seamounts and knolls worldwide; seamounts (≥ 1000 m) shown in red, knolls (< 1000 m) in blue. Data from Yesson et. al. (2011).

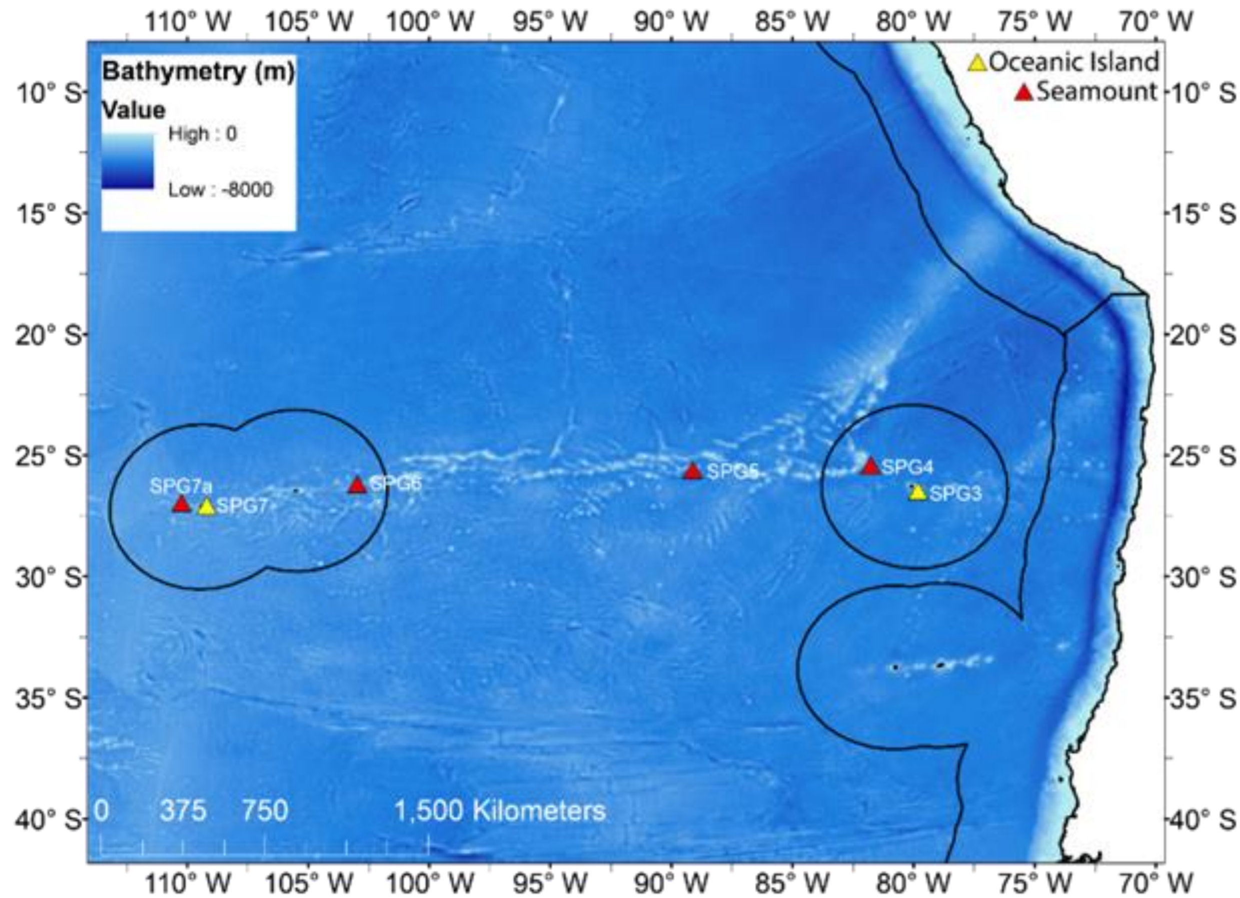

Figure 2: Salas y Gómez Ridge Stations
The Salas y Gómez Ridge off the west coast of South America. Triangles indicate the sampled stations of the seamounts (red) and oceanic islands (yellow), and the black lines represent the exclusive economic zones of Chile and Peru.

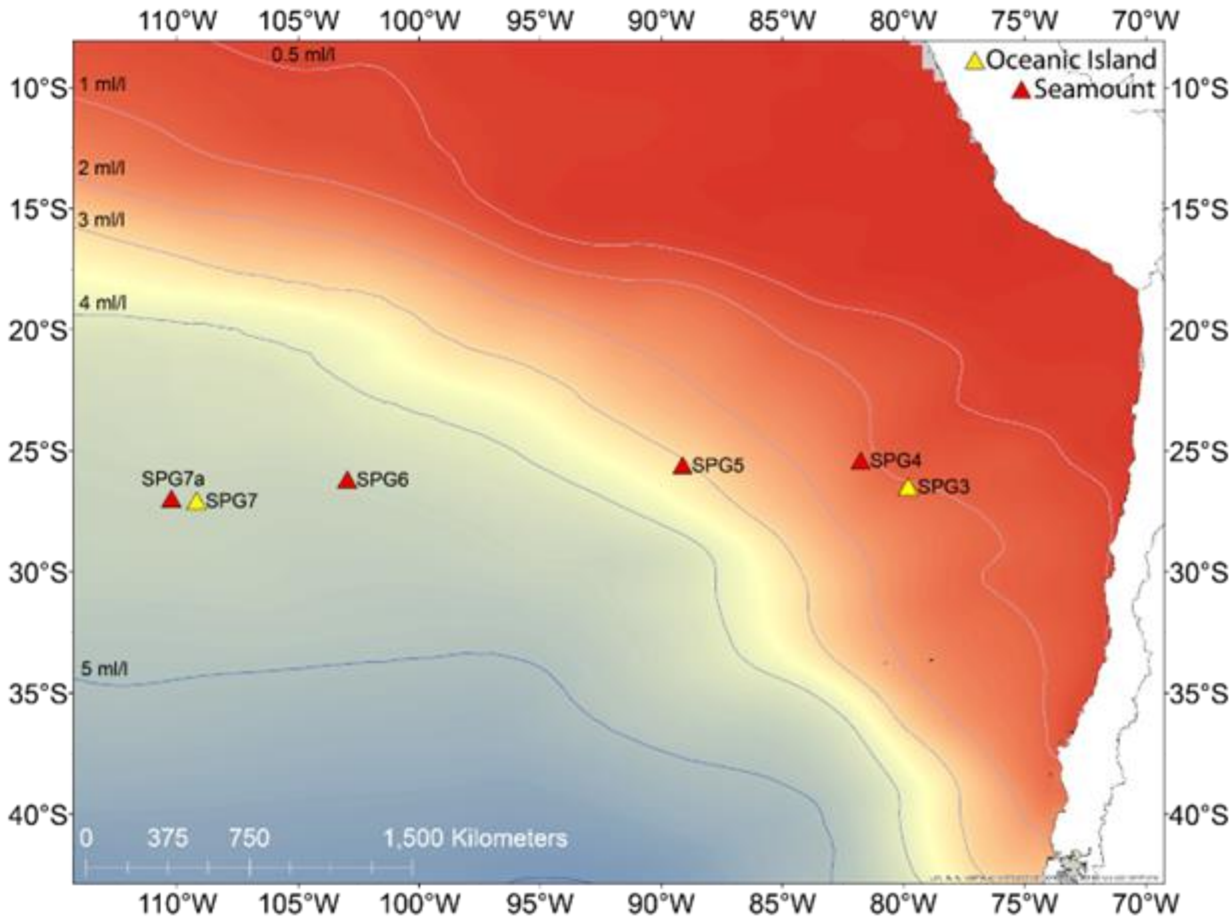

Figure 3: Salas y Gómez Ridge Oxygen Minimum Zone
The Eastern South Pacific oxygen-minimum zone along the Salas y Gómez Ridge at 300 m. Triangles indicate the sampled stations of the seamounts (red) and oceanic islands (yellow), and dissolved oxygen in ml/l is indicated by contour lines and color gradient.

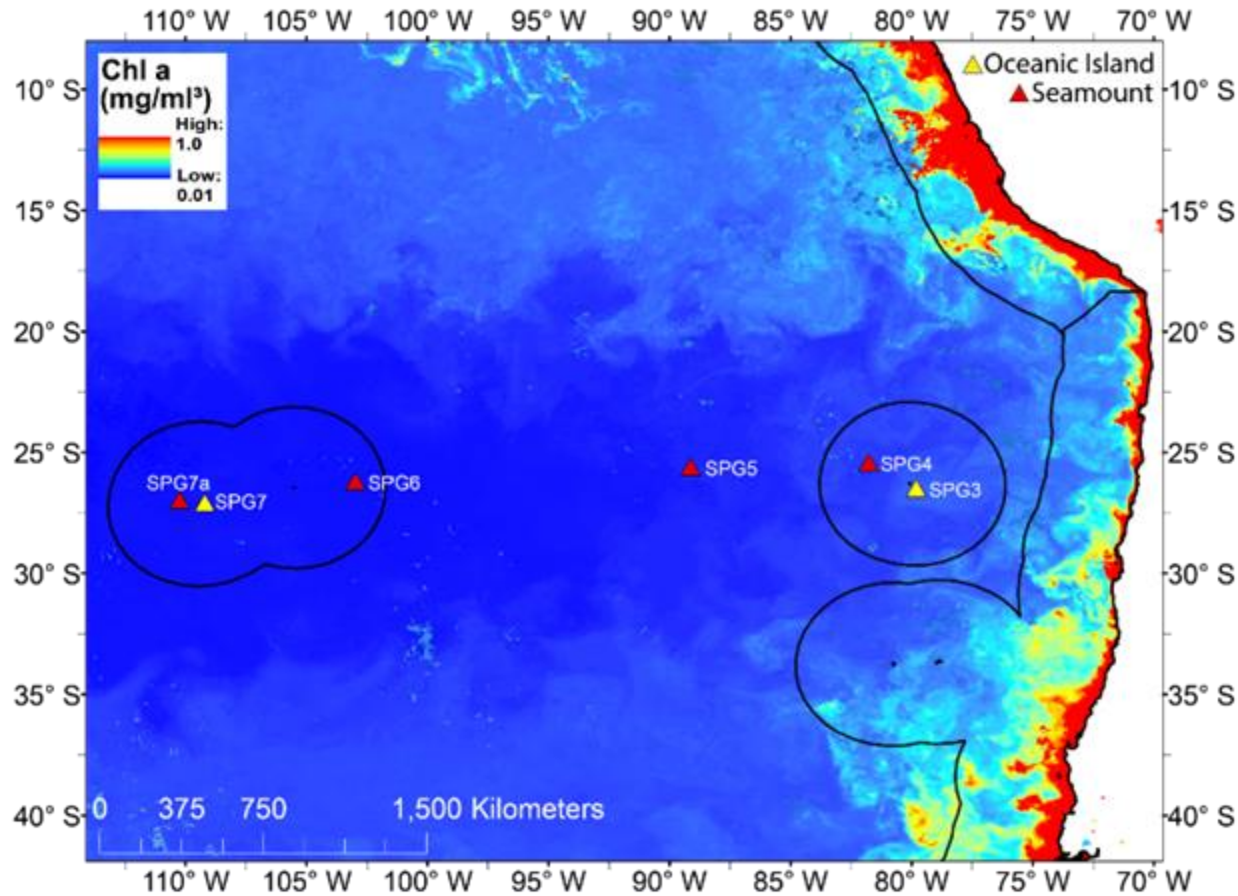

Figure 4: Chlorophyll a Concentrations
Chlorophyll a range along the eastern extent of the South Pacific Subtropical Gyre. Triangles indicate the sampled stations of the seamounts (red) and oceanic islands (yellow), and the black lines represent the exclusive economic zones of Chile and Peru.

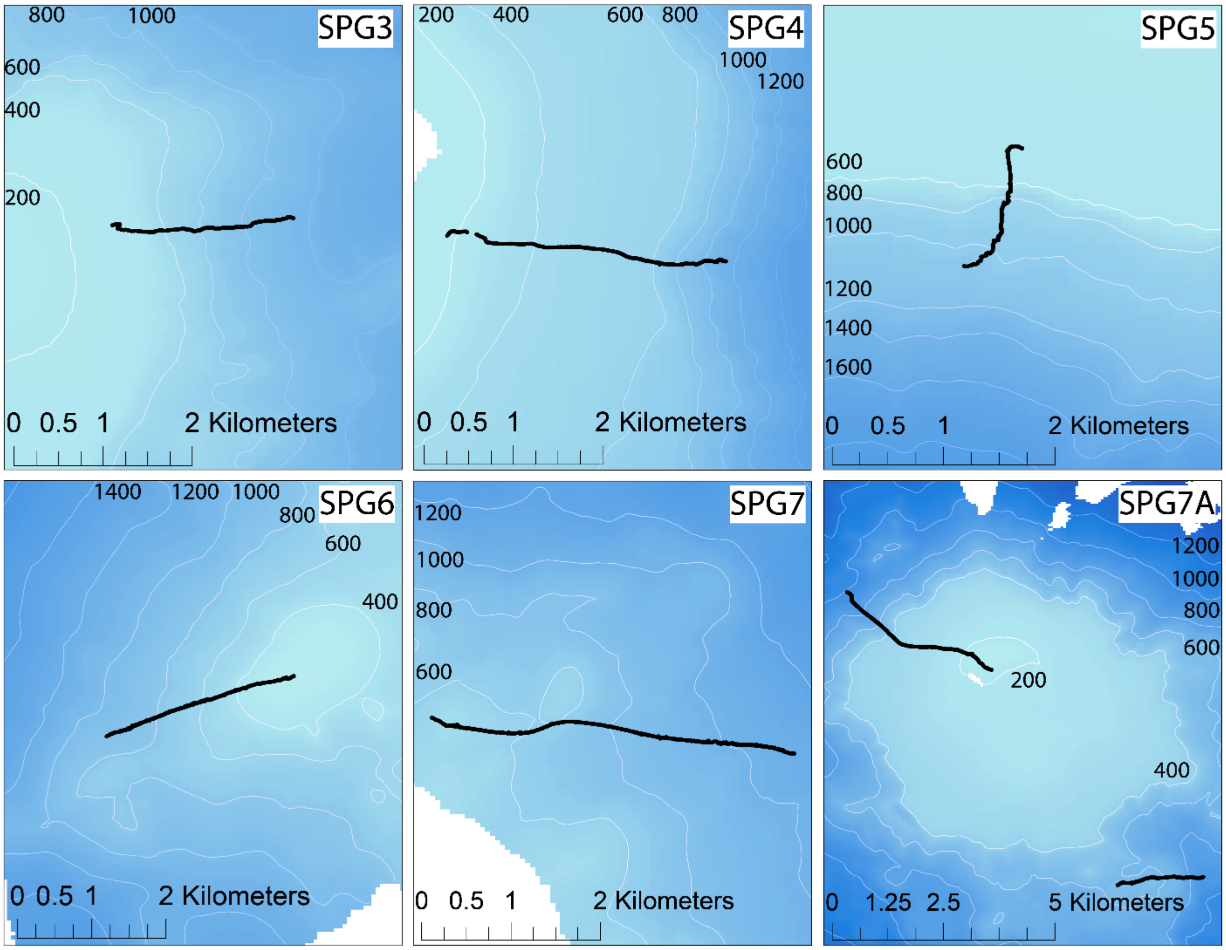

Figure 5: Transect Bathymetry
Survey transects at each of the six survey locations shown as black lines. All transects were surveyed from deep to shallow depths. Contour lines show depth in m at 200 m intervals. Geographic coordinates can be found in Table 1 and Figure 2.

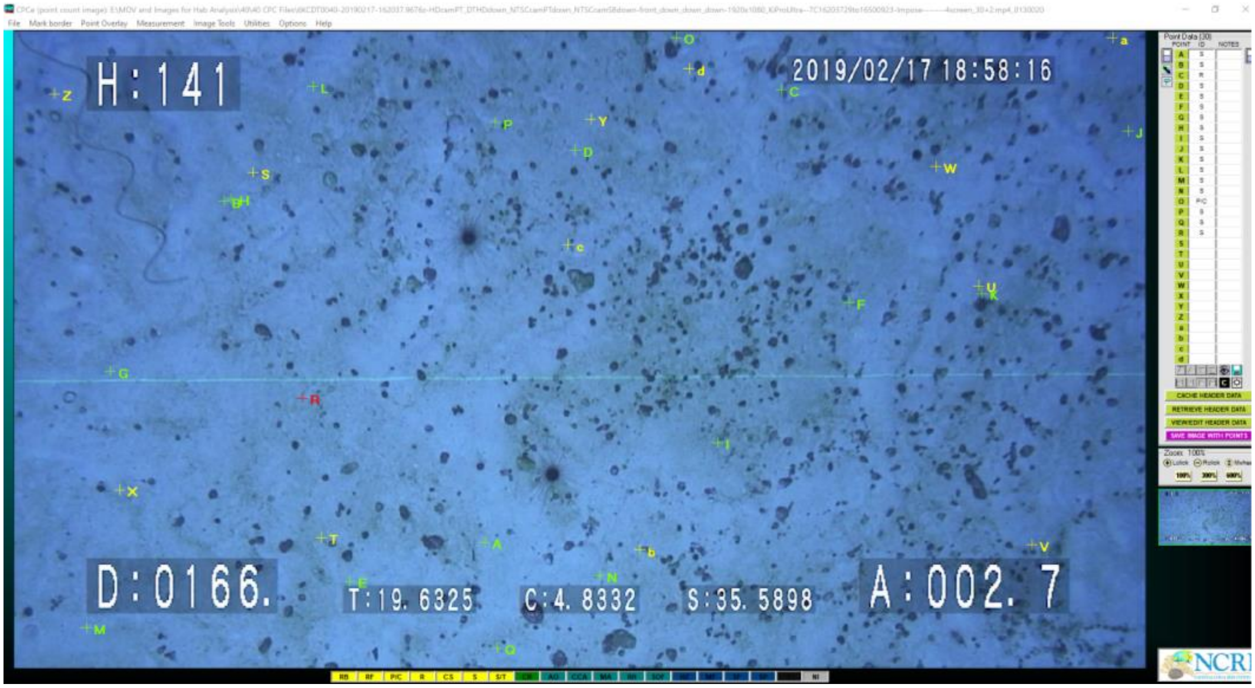

Figure 6: Coral Point Count
A transect image during habitat analysis in Coral Point Count showing overlaid environmental data: depth (D, m), temperature (T, °C), dissolved oxygen concentration (C, ml/l), salinity (S, PSU). Green points represent categorized points, yellow points are yet to be categorized, and the red point represents the point currently being analyzed. Classification options (Table 4) are listed below the image and when recorded are listed on the table to the right.

Figure 7: BIIGLE
Video annotation using BIIGLE. Annotation points are shown as yellow and orange points on the image and on the timeline at the bottom of the screen. Annotation options are available in the toolbar above the timeline and include several types of annotations (point, circle, etc.) and annotation functions (delete, edit, move etc.). annotation labels are displayed in the label tree on the right side of the screen and include a number of morphospecies options within taxonomic or functional groups (fish, arthropods, sponges, etc.).

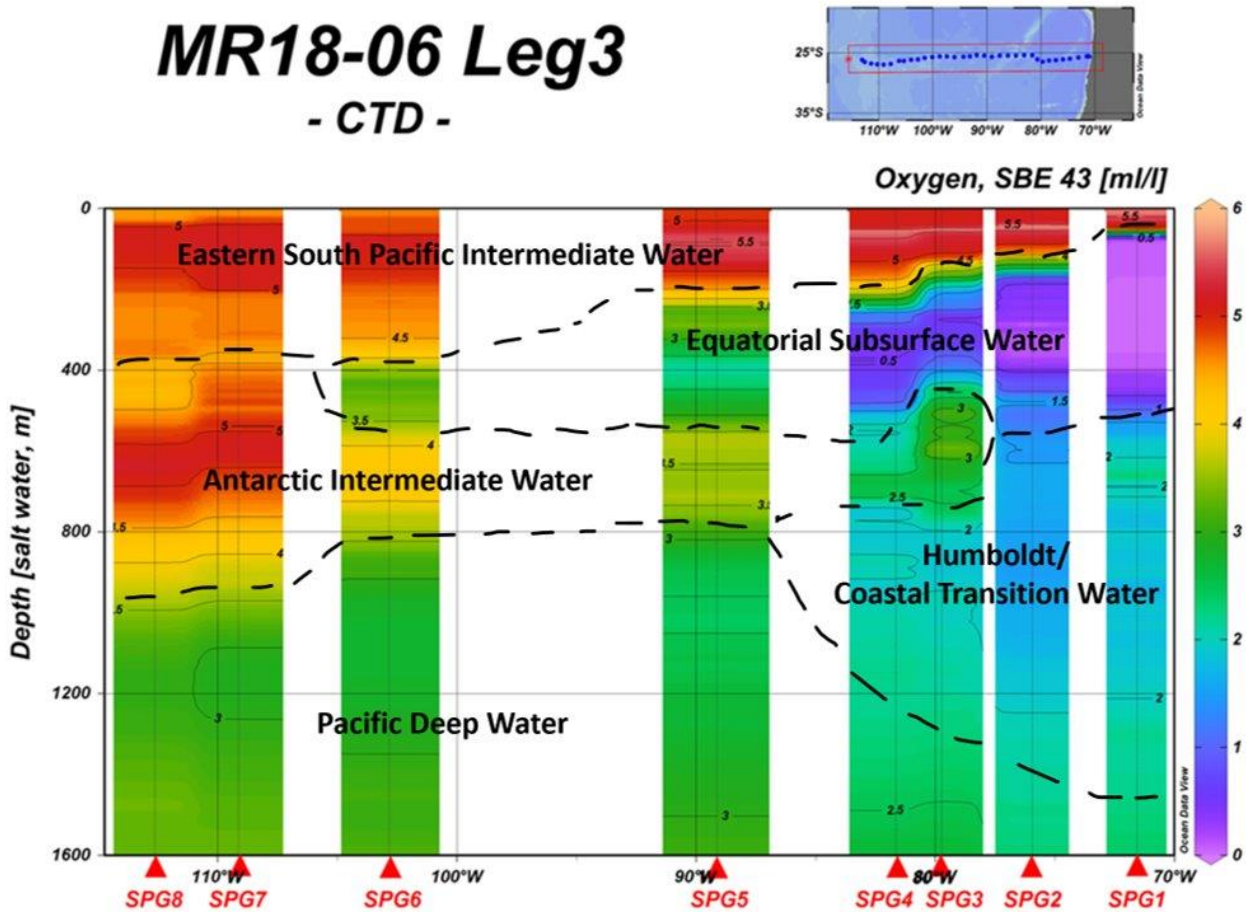

Figure 8: Estimated Water Masses
Estimated water masses in the Salas y Gómez Ridge region estimated using oxygen depth profiles. Dotted black line represents the distinction between water masses, and names of each water mass are overlaid on the oxygen by depth and longitude image produced onboard by Wolfgang Schneider and Dhugal Lindsay. Oxygen data was collected by a SBE43 dissolved oxygen sensor during CTD casts (Table 3).

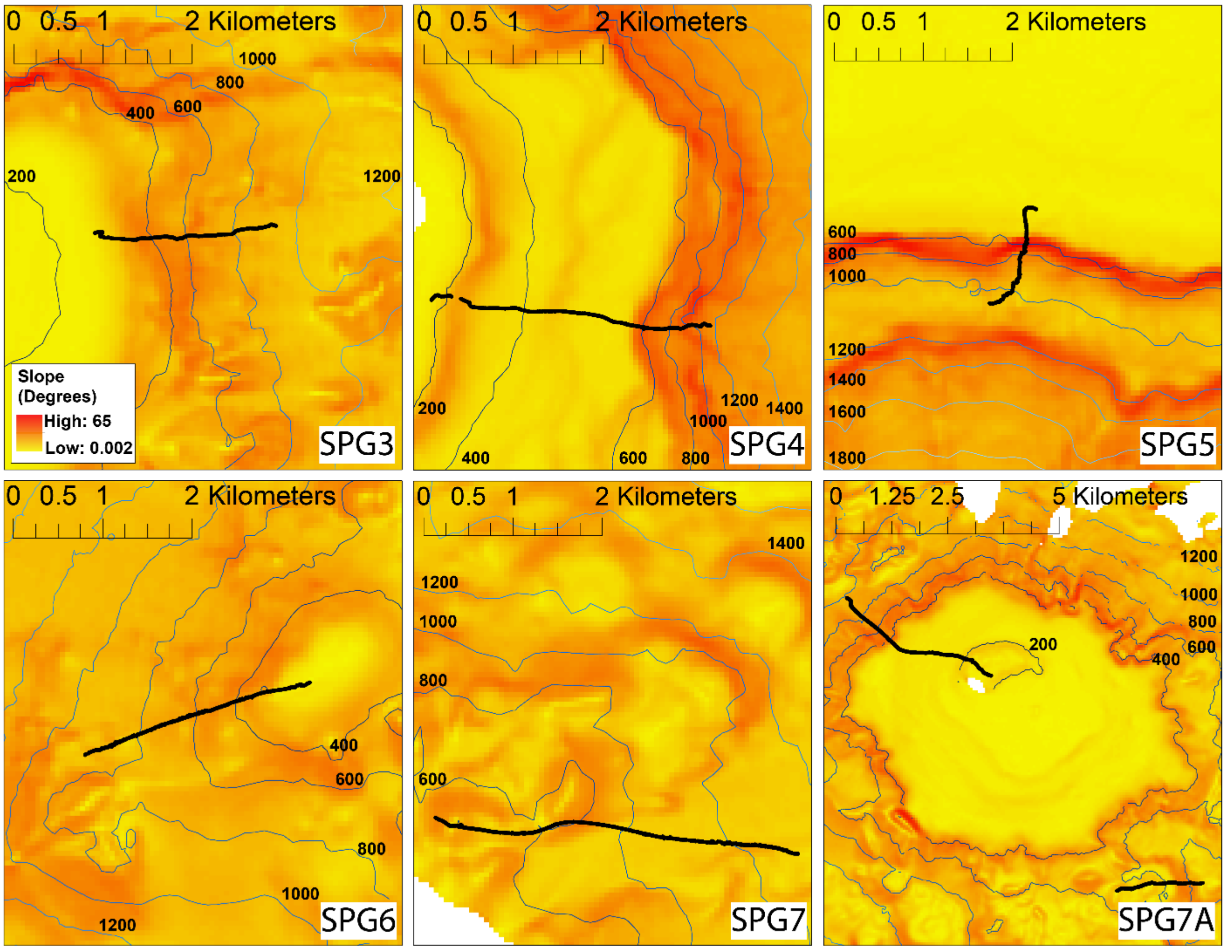

Figure 9: Transect Slope
Slope in degrees for each transect, color legend is displayed in the first frame (SPG3). The thick black lines represent the survey transects, and the thin lines of varying shades of blue show the bathymetry in 200 m increments.

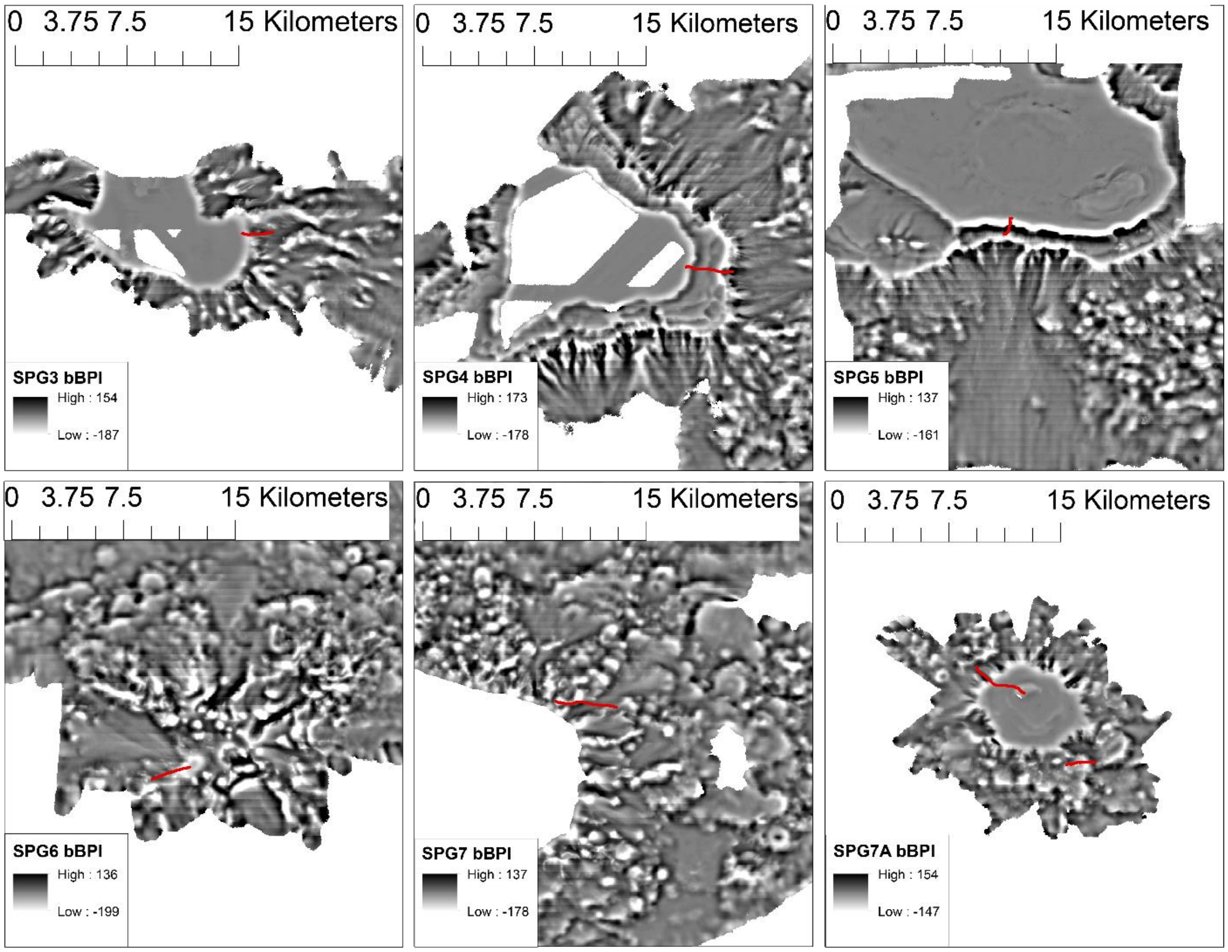

Figure 10: Station bBPI
Broad-scale bathymetric position index (BPI) for survey stations, created using 50 m grids. The black to white color gradient represents broad-scale BPI and red lines show the transects. Color ramps differ by station for best detail and were created using 2.5 standard deviations.

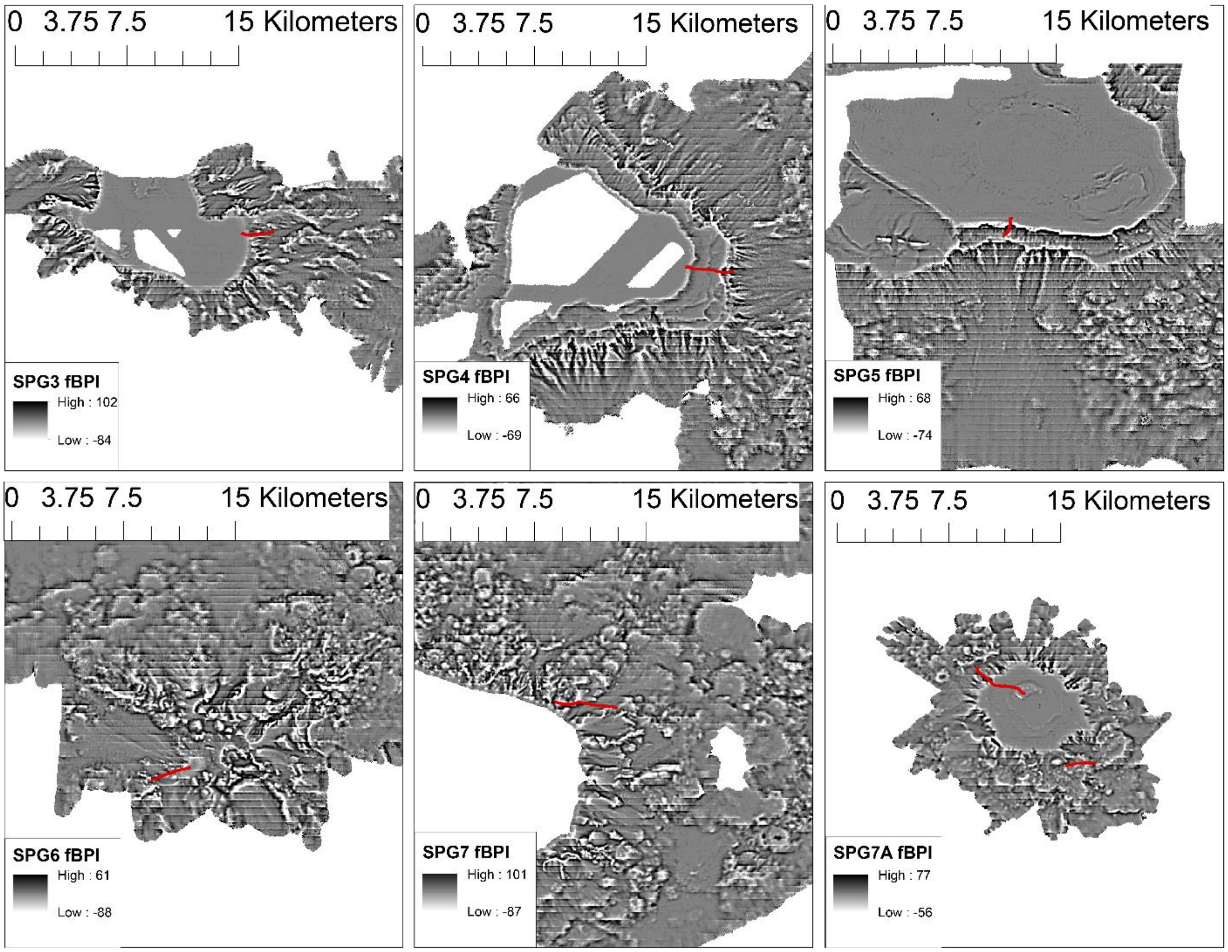

Figure 11: Station fBPI
Fine-scale bathymetric position index (BPI) for survey stations, created using 50 m grids. The black to white color gradient represents fine-scale BPI and red lines show the transects. Color ramps differ by station for best detail and were created using 2.5 standard deviations.

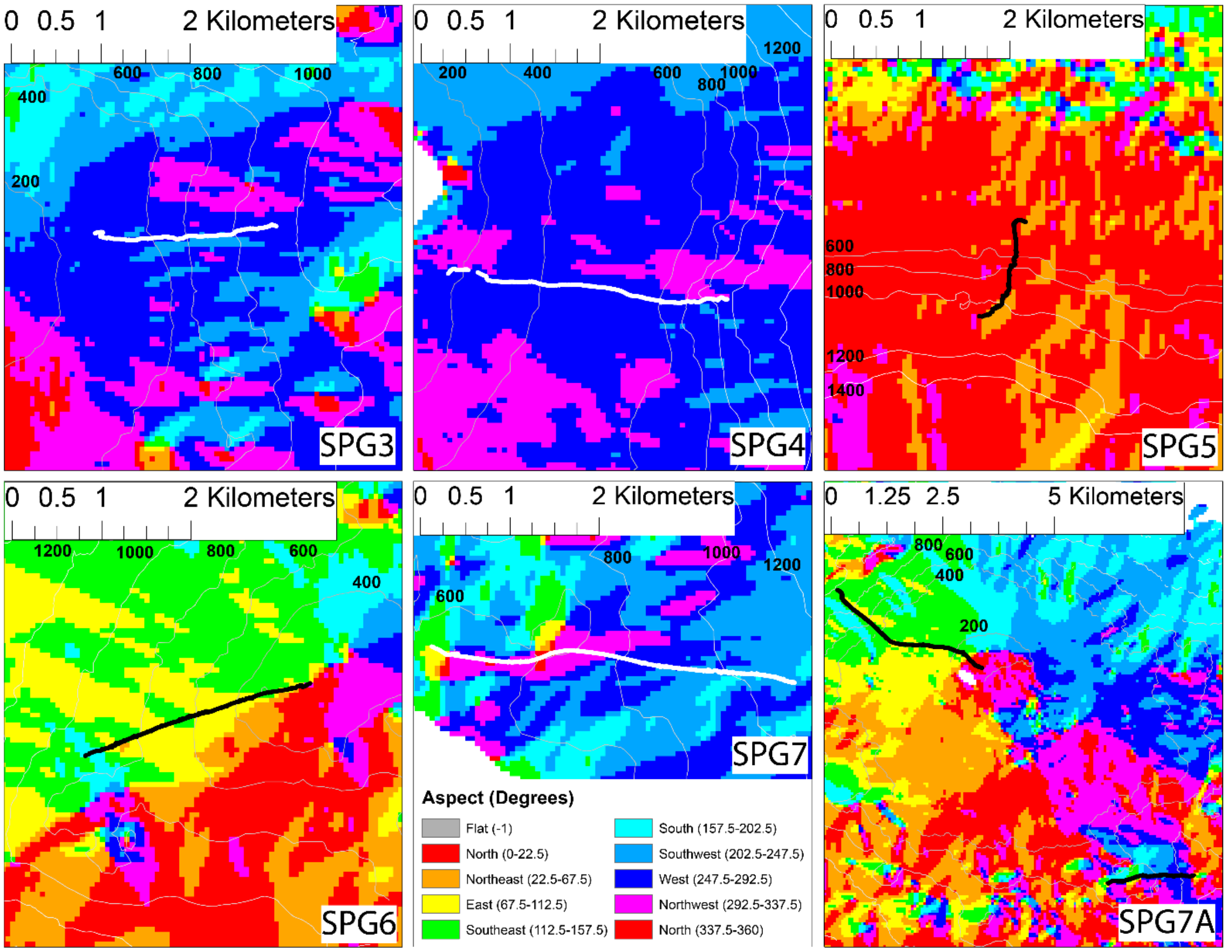

Figure 12: Transect Aspect
Aspect along each transect from 0 to 360 degrees representing the direction of a slope. Color legend is displayed in the frame with SPG7. The thick black or white lines represent the survey transects, and the thin lines of varying shades of white and gray show the bathymetry in 200 m increments.

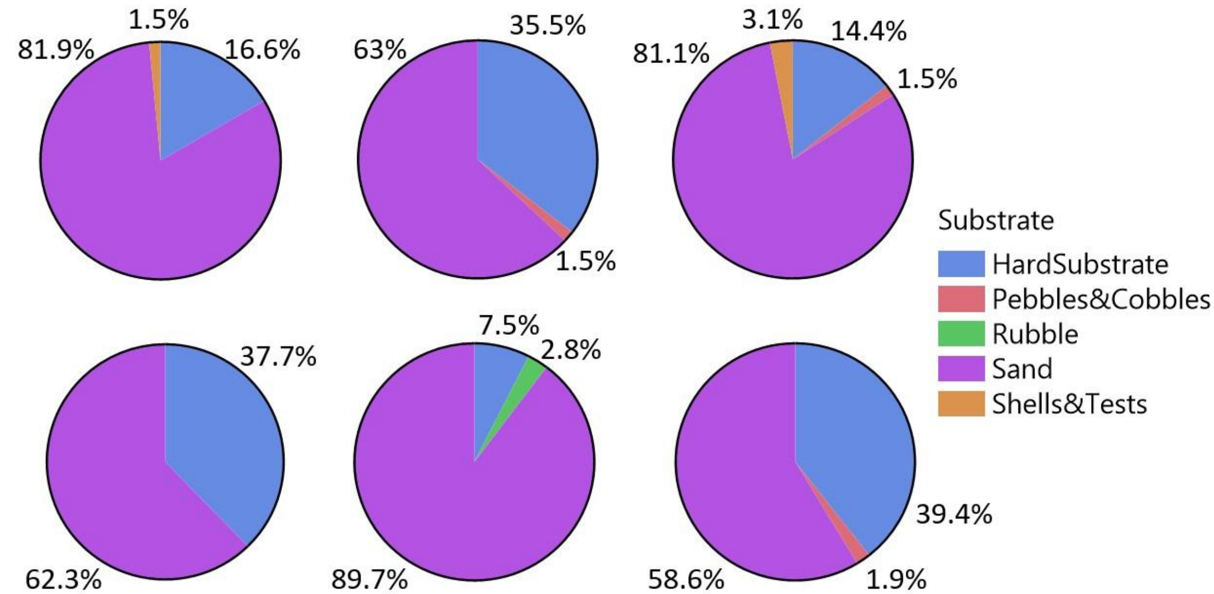

Figure 13: Taxa Code by Station
Percentage of substrate by each station from BIIGLE video annotations. Substrates less than 1% were excluded. Top row L-R: SPG3, SPG4, SPG5; bottom row L-R: SPG6, SPG7, SPG7A.

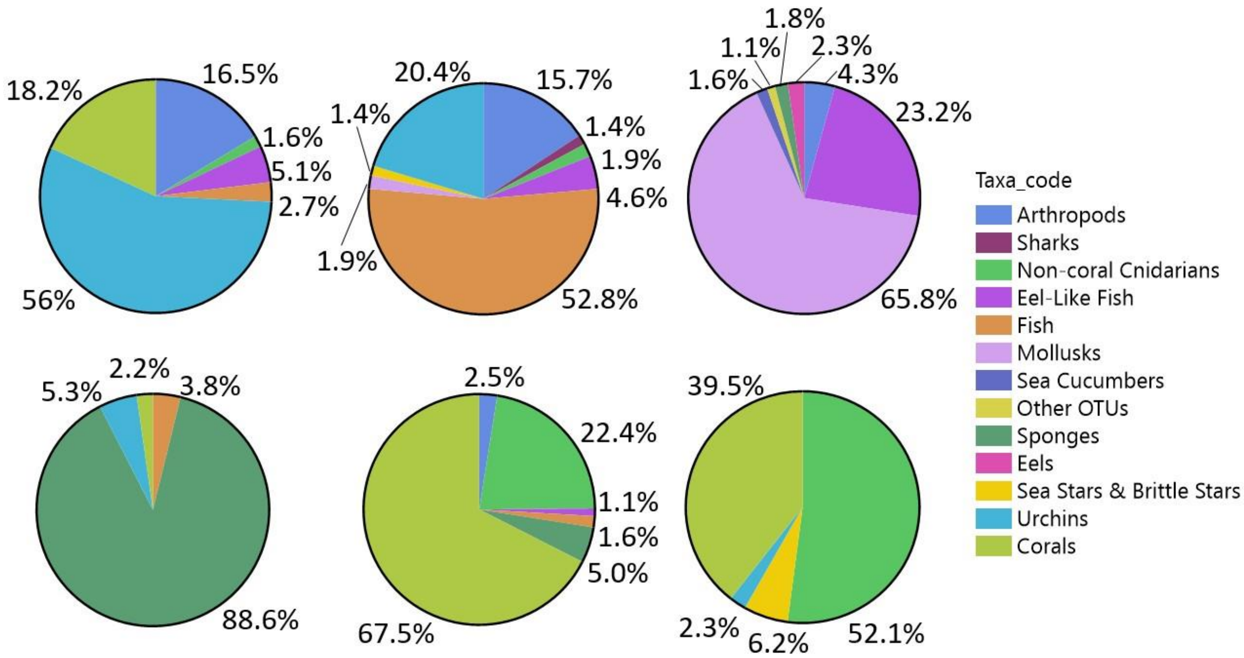

Figure 14: OTU Groups by Station
Percentage of faunal abundance groups of operational taxonomic units (which represent higher-level taxonomic or functional groupings of observed morphospecies) present at each station from BIIGLE video annotations. Operational taxonomic unit groups consisting of less than 1% were excluded; excluded OTU groups made up <2% of annotations at a station with the exception of SPG5, which consisted of 3.2%. Top row L-R: SPG3, SPG4, SPG5; bottom row L-R: SPG6, SPG7, SPG7A.

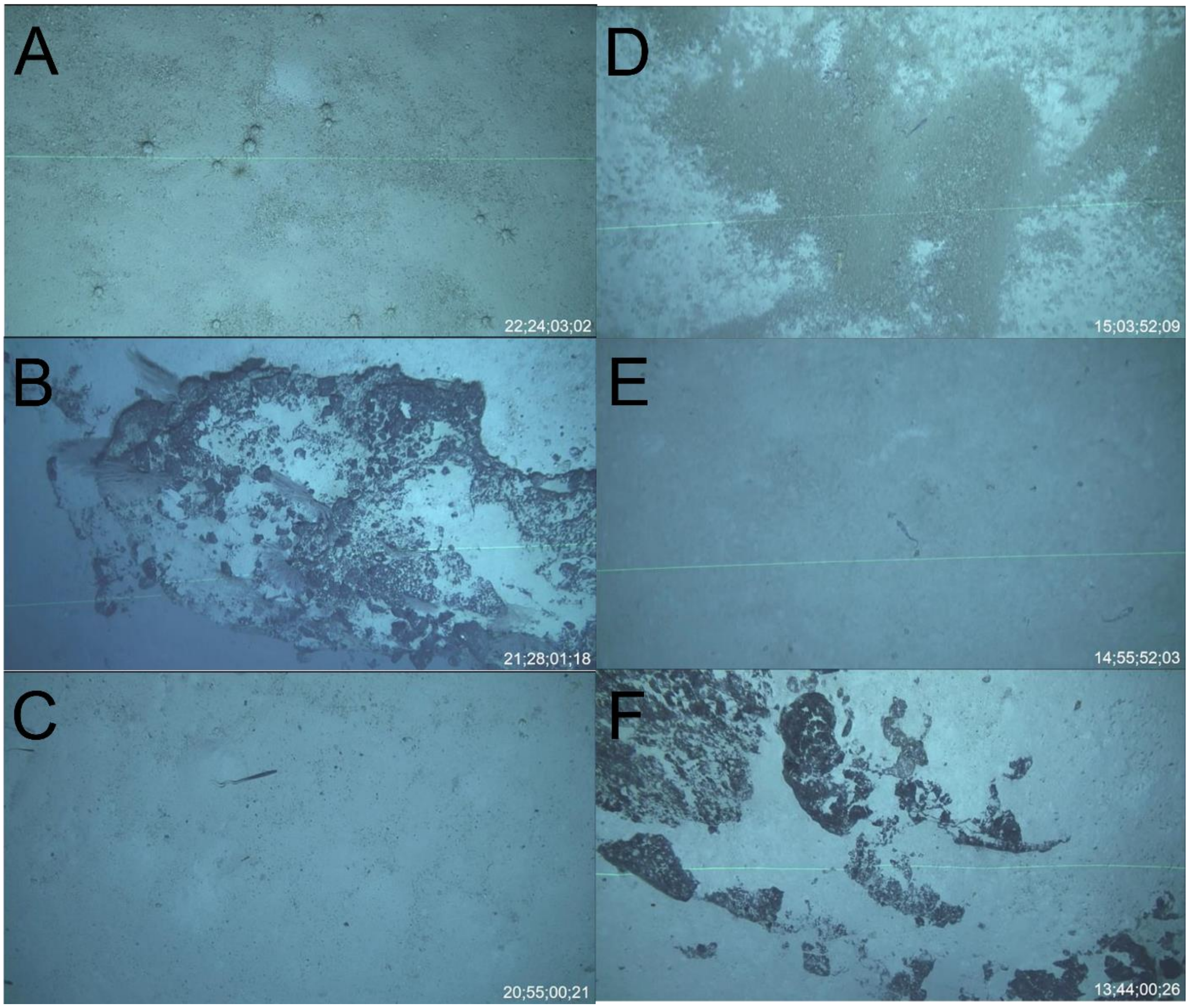

Figure 15: SPG3 and SPG4 Habitat Photos
SPG3 (A, B, C), mixed grain size sand dominated by sea urchins (A), rocky habitat with sand deposition and corals (B), deep sandy habitat with Halosauridae sp. (C). SPG4 (D, E, F) mixed sediment with fish and crustaceans (D), flat sandy habitat dominated by fish (E), and rocky slopes with sand (F).

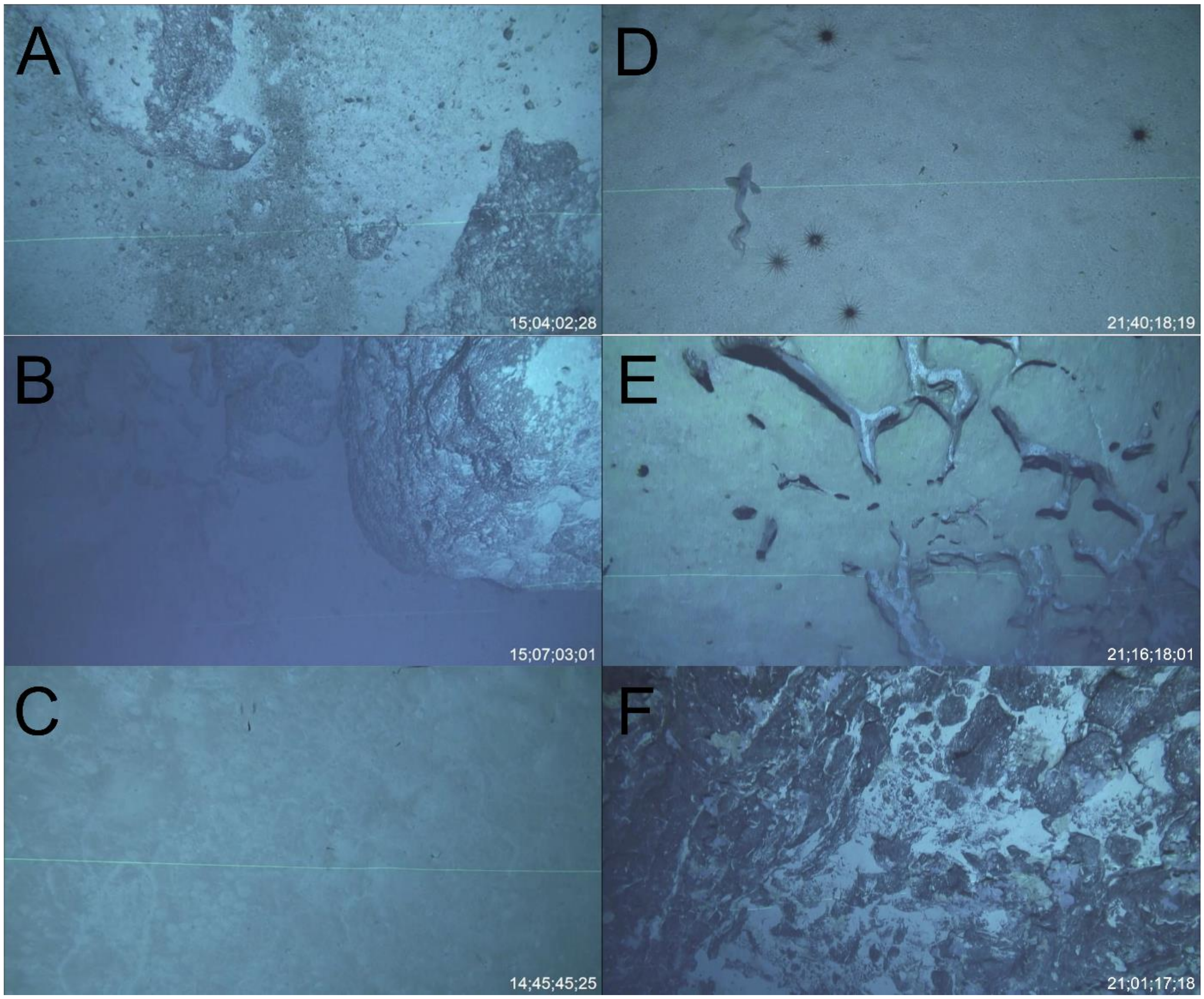

Figure 16: SPG5 and SPG6 Habitat Photos
SPG5 (A, B, C) rock substrate, dominated by sea urchins (A), rocky cliffs (B), mixed sediment and deep sandy habitat bioturbation (C). SPG5 (D, E, F) shallow sandy plateau with fish and sea urchins (D), old reef habitat (E), and rocky slopes dominated by sponges (F).

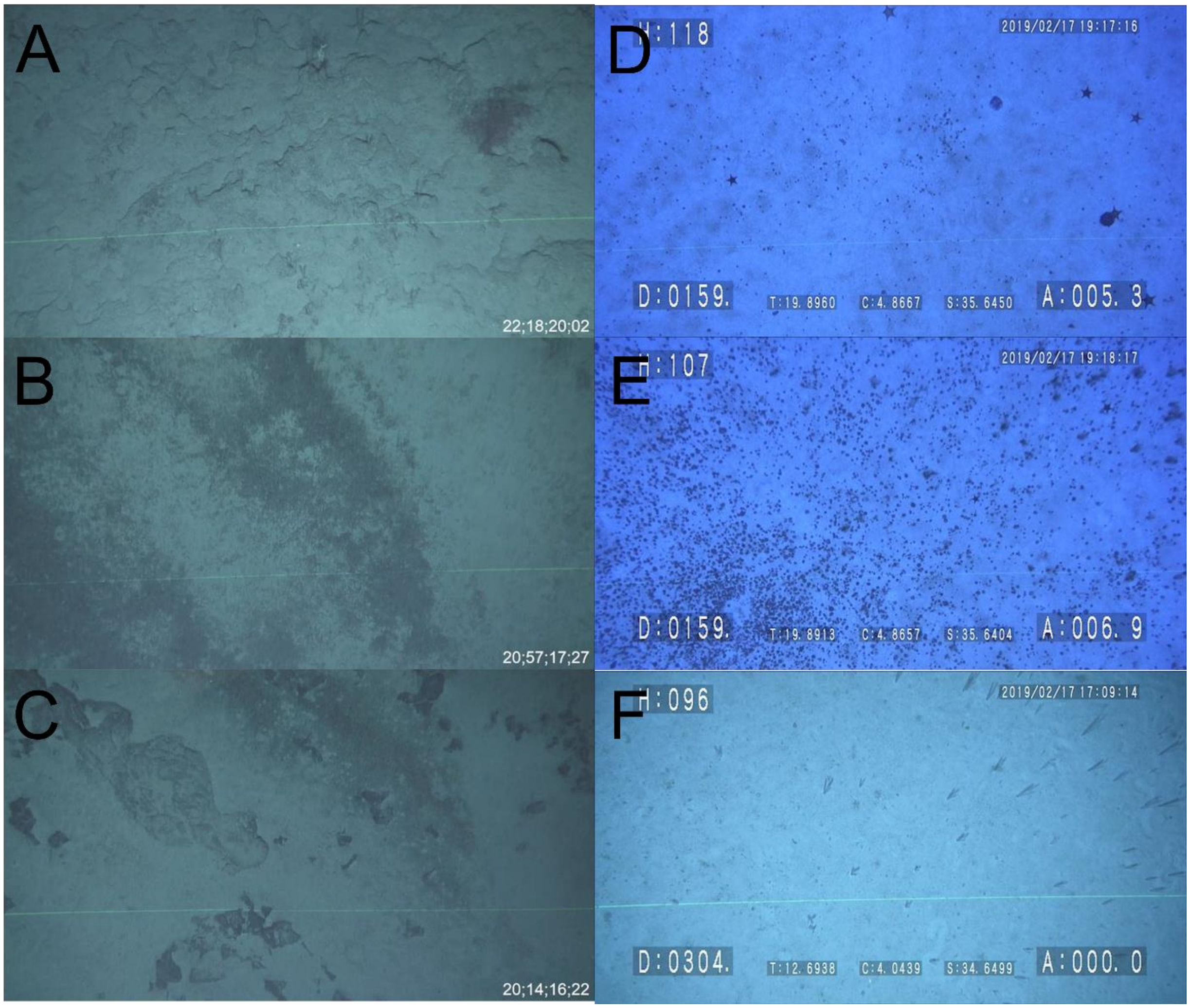

Figure 17: SPG7 and SPG7A Habitat Photos
SPG7 (A, B, C) flat sandy habitat with rubble and erosional features, dominated by coral (A) sand with mixed grain size (B), and mixed sediment types and rock substrate (C). SPG7A (D, E, F) flat sandy sediment with sea urchins and sea stars (D), flat sandy habitat with rhodoliths and anemones (E), and flat sandy habitat dominated by sea pens (F).

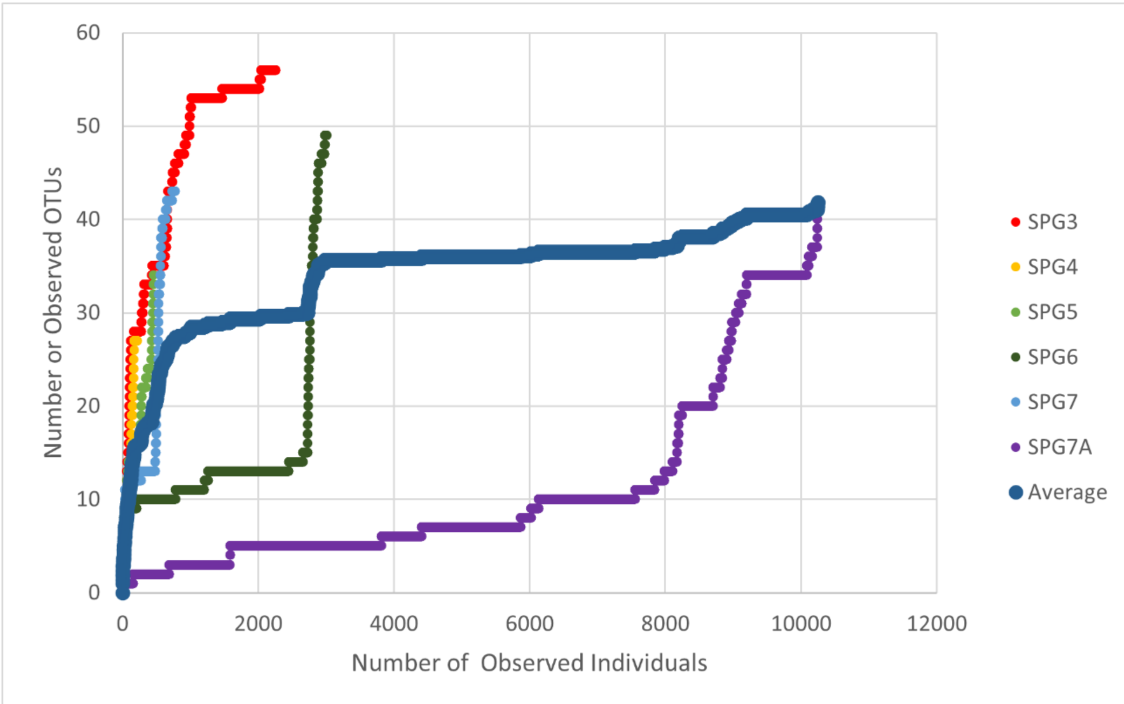

Figure 18: Operational Taxonomic Unit Accumulation
Increase in observed species by the accumulation in total observed organisms across all stations.

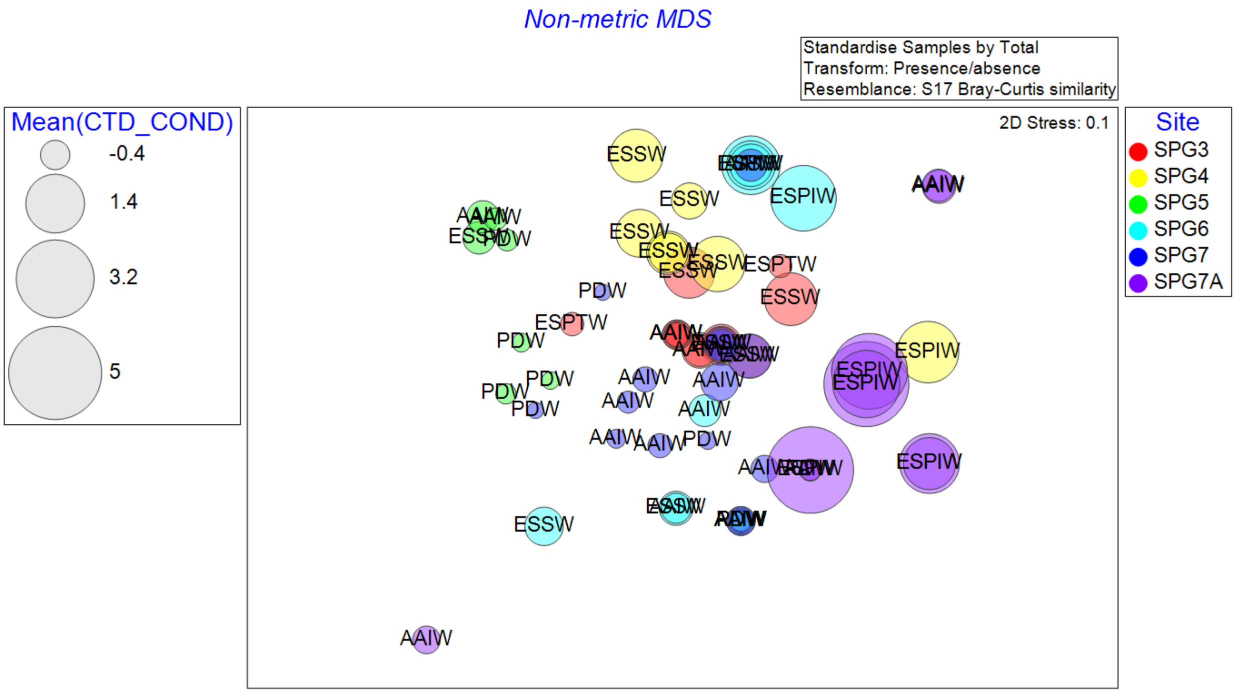

Figure 19: Water Mass nMDS Plot
Non-metric multidimensional scaling plot with water mass bubble plots. Each bubble represents the average and standardized dissolved oxygen concentration by 50 m depth categories, color represents stations, and letters represent water mass: ESPIW = Eastern South Pacific Intermediate Water, ESSW = Equatorial Subsurface Water (also the Eastern South Pacific Oxygen Minimum Zone), AAIW = Antarctic Intermediate Water, ESPTW = Coastal/Transition Water, and PDW = Pacific Deep Water.

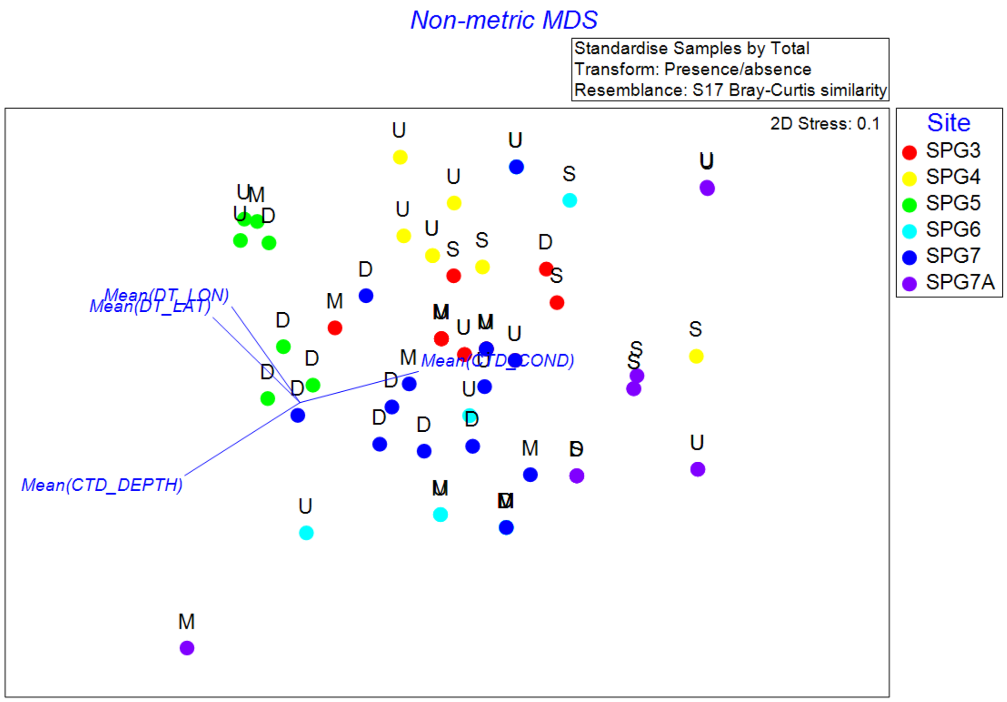

Figure 20: Depth Break nMDS Plot
Non-metric multidimensional scaling plot showing stations with each point representing an individual 50 m depth category using presence/absence data and Bray-Curtis similarity. Overlaid are vectors with a 0.4 or greater correlation between the faunal community patterns and the average of the labeled environmental variable. Points are labeled by letters representing expected assemblage depth breaks: S = shallow, U = upper-slope, M = mid-slope, D = deep.

APPENDIX B

APPENDIX B

DATA COMPILATION CODE

```
In [ ]: #import conda upgrade notebook
        #pip install notebook --upgrade
        #jupyter notebook --NotebookApp.iopub_data_rate_limit=1.0e10
        pip install pip --upgrade

In [ ]: import numpy as np
        import matplotlib.pyplot as plt
        import pandas as pd
        import xarray as xr
        from scipy import stats
        import datetime
        import pip

In [ ]: #Importing Files
        #37 refers to the location, 37 is a seamount near Easter Island.
        #The Hab files are the habitat analysis that I did, CTD contains the CTD data
         by timecode, and DT contains the latitude and longitude data by timecode.
        CTD31 = pd.read_csv('C:/Users/Kara/Documents/UTRGV/Research Code/31_FullCTD_Ed
        it.csv')
        CTD33 = pd.read_csv('C:/Users/Kara/Documents/UTRGV/Research Code/33_FullCTD_Ed
        it.csv')
        CTD35 = pd.read_csv('C:/Users/Kara/Documents/UTRGV/Research Code/35_FullCTD_Ed
        it.csv')
        CTD37 = pd.read_csv('C:/Users/Kara/Documents/UTRGV/Research Code/37_FullCTD_Ed
        it.csv')
        CTD39 = pd.read_csv('C:/Users/Kara/Documents/UTRGV/Research Code/39_FullCTD_Ed
        it.csv')
        CTD40 = pd.read_csv('C:/Users/Kara/Documents/UTRGV/Research Code/40_FullCTD_Ed
        it.csv')
        CTD41 = pd.read_csv('C:/Users/Kara/Documents/UTRGV/Research Code/41_FullCTD_Ed
        it.csv')
        BIIGLE = pd.read_csv('C:/Users/Kara/Documents/UTRGV/Research Code/BIIGLE.csv')
        dt31 = pd.read_csv('C:/Users/Kara/Documents/UTRGV/Research Code/31_DT.csv')
        dt33 = pd.read_csv('C:/Users/Kara/Documents/UTRGV/Research Code/33_DT.csv')
        dt35 = pd.read_csv('C:/Users/Kara/Documents/UTRGV/Research Code/35_DT.csv')
```

```
        dt37 = pd.read_csv('C:/Users/Kara/Documents/UTRGV/Research Code/37_DT.csv')
        dt39 = pd.read_csv('C:/Users/Kara/Documents/UTRGV/Research Code/39_DT.csv')
        dt40 = pd.read_csv('C:/Users/Kara/Documents/UTRGV/Research Code/40_DT.csv')
        dt41 = pd.read_csv('C:/Users/Kara/Documents/UTRGV/Research Code/41_DT.csv')
In [ ]: CTD = pd.concat([CTD31, CTD33, CTD35, CTD37, CTD39, CTD40, CTD41],
ignore_index=True, sort=False)

In [ ]: CTDd = CTD.dropna()

In [ ]: DT = pd.concat([dt31, dt33, dt35, dt37, dt39, dt40, dt41], ignore_index=True, sort=False)

In [ ]: #DT.to_csv('DTall.csv')
        #CTDd.to_csv('CTDall.csv')

In [ ]: DTall = pd.read_csv('C:/Users/Kara/Documents/UTRGV/Research Code/DTall.csv')
        CTDall = pd.read_csv('C:/Users/Kara/Documents/UTRGV/Research Code/CTDall.csv')
        BIIGLE = pd.read_csv('C:/Users/Kara/Documents/UTRGV/Research Code/BIIGLE.csv')

In [ ]: ##CHANGE DATE

        #Add the date of the dive as a string plus the timestamp column so that they can be made
into a datetime index.
        CTDall['dte'] = CTDall['DATE'] + str(' ') + CTDall['TIME']

In [ ]: CTDp = pd.DataFrame(CTDall)

In [ ]: CTDp['dte'] = pd.to_datetime(CTDp['dte'], format='%m/%d/%Y %H:%M:%S')

In [ ]: #Setting the datetimes as the index
        CTDp = CTDp.set_index(['dte'])

In [ ]: ##CHANGE DATE

        #Add the date of the dive as a string plus the timestamp column so that they can be made
into a datetime index.
        DTall['dte'] = DTall['DATE'] + str(' ') + DTall['TIME']

In [ ]: DTp = pd.DataFrame(DTall)

In [ ]: DTp['dte'] = pd.to_datetime(DTp['dte'], format='%m/%d/%Y %H:%M:%S')

In [ ]: #Setting the datetimes as the index
        DTp = DTp.set_index(['dte'])

In [ ]: #The latitude and longitude files are in degrees and minutes, so I converted them to
degrees only. To do this I first split the data into two columns using the hyphen separating the
```

degrees and minutes. This created a new dataframe 'split,' and I did this for both latitude and longitude.

```
split = DTp['Latitude'].str.split('-', n = 1, expand = True)
split_lon = DTp['Longitude'].str.split('-', n = 1, expand = True)
```

```
In [ ]: #Then used str.rstrip() to remove the remaining non-numerical characters from
         the string.
        split[1] = split[1].str.strip(' , S')
        split_lon[1] = split_lon[1].str.rstrip(' , W')

In [ ]: #And then converted the columns to integers and floats as needed for the calcu
        lations.
        split[1] = split[1].astype(float)
        split[1]

In [ ]: split[0] = split[0].astype(int)
        split[0]

In [ ]: #Calculating the latitude and adding it back to the original dataframe as a new column.
        DTp['LAT'] = -1*((split[0])+((split[1])/60))

In [ ]: #And then dropping the NaN values.
        DTp['LAT'].dropna()

In [ ]: #And now doing the same for longitude as well.
        split_lon[1] = split_lon[1].astype(float)
        split_lon[1]

In [ ]: split_lon[0] = split_lon[0].astype(int)
        split_lon[0]

In [ ]: #Calculating the longitude and adding it back to the original dataframe as a n
        ew column.
        DTp['LON'] = -1*((split_lon[0])+((split_lon[1])/60))

In [ ]: DTp['Depth'] = (DTp['Depth']).str.strip(' , Z, =')
        DTp['Depth']

In [ ]: #BIIGLE

In [ ]: #For first frame

        BIIGLE['dte1'] = BIIGLE['Date'] + str(' ') + BIIGLE['F1_Time']

In [ ]: #For second frame
```

```
        BIIGLE['dte2'] = BIIGLE['Date'] + str(' ') + BIIGLE['FE_Time']

In [ ]: BIIGLE['dte1'] = pd.to_datetime(BIIGLE['dte1'], format='%m/%d/%Y %H:%M:%S')

In [ ]: BIIGLE['dte2'] = pd.to_datetime(BIIGLE['dte2'], format='%m/%d/%Y %H:%M:%S')

In [ ]: ##WILL NEED TO BE DONE AGAIN FOR FE_TIME

        BIIGLE = BIIGLE.set_index(['dte2'])

In [ ]: ##CHANGE NUM

        #This is for indexing the DT files using the datetime index of the CTD files. It'll let me
combine everything into one file.
        #Starting with just getting the index time from the DT file
        #num comes from the number of images in the file

        BIIG = []
        num = 0
        while num < 20036:

           B2 = DTp.index[DTp.index.get_loc(BIIGLE.index[num], method='nearest')]
           BIIG.append(B2)
           num = num +1
        print(BIIG)

In [ ]: #Adding that time to the Hab37 dataframe

        BIIGLE['LTIME'] = BIIG
In [ ]: ##CHANGE NUM

        #Now getting the series with the latitude and longitude data, but they'll need
        some cleaning up.

        BIIG = []
        num = 0
        while num < 20036:

           B2 = DTp.iloc[DTp.index.get_loc(BIIGLE.index[num], method='nearest')][[9,
        13, 14]]
           BIIG.append(B2)
           num = num +1
        print(BIIG)

In [ ]: ##CHANGE NUM
```

```
#I make a df column to work with, then make that a string to make it easier to work with
#Then split it, get rid of the extra index, and remove the letters and extra characters.
#Turn those into floats rather than strings, and then add them to the original df to the corresponding row.
#dfmi.loc[:, ('one', 'second')]

num = 0
BIIGLE['DEPTH'] = ''
BIIGLE['LAT'] = ''
BIIGLE['LON'] = ''

while num <20036:

    BIIGLE['LDATE'] = BIIG
    st = str(BIIGLE['LDATE'][num])
    spl = st.split('\n')
    #del(spl[2])
    spl = pd.DataFrame(spl)
    spl = spl[0].str.strip(' ,L,A,T,O,N, S, R, =, D, e, p, t, h')
    spl[0] = spl[0]
    spl[1] = float(spl[1])
    BIIGLE['DEPTH'][num] = spl[0]
    BIIGLE['LAT'][num] = spl[1]
    BIIGLE['LON'][num] =spl[2]

    num = num + 1
print(BIIGLE)
```

```
In [ ]: BIIGLE.to_csv('BIG_DT2.csv')
```

```
In [ ]: ##CHANGE NUM

#Trying to add depth
#############################################Already got depth above for BIIGLE
num = 0
BIIGLE['DT_Depth'] = ''

while num < 20036:

    BIIGLE['LDATE'] = BIIG
    st = str(BIIGLE['LDATE'][num])
    spl = st.split('\n')
    del(spl[0])
    del(spl[0])
    del(spl[1])
    spl = pd.DataFrame(spl)
```

```
        spl = spl[0].str.strip(' ,n, \, D, e, p, t, h')
        spl[0] = float(spl[0])
        BIIGLE['DT_Depth'][num] = spl[0]

        #Hab40['LDATE'] = Hab_40
        #st = str(Hab40['LDATE'][num])
        #spl = st.split('n/')
        #SPL = spl[0].split(' ')
        #Hab40['DT_Depth'][num] = SPL[3]

        num = num + 1
    print(BIIGLE)
```

```
In [ ]: #Had to add this bit for an issue with non-unique values - it just skips any a
    dditional non-unique values but keeps the first.
    CTDp = CTDp.loc[~CTDp.index.duplicated(keep = 'first')]
```

```
In [ ]: #Resetting my index - having an error belowing about it not being a monotonic
     increase or decrease.

    #CTD40['dte'].to_datetime(times.reset_index(drop=True).iloc)
    #Hab40.reset_index()
    #CTD40.sort_index()
    CTDp.dropna(axis=0, how='all')
```

```
In [ ]: #BIIGLE.to_csv('big_dt')
In [ ]: BIIGLE = pd.read_csv('C:/Users/Kara/Documents/UTRGV/Research
Code/BIG_DT2.csv')
```

```
In [ ]: BIIGLE = BIIGLE.set_index(['dte2'])
```

```
In [ ]: BIIGLE.sort_index
```

```
In [ ]: #Had to add this bit for an issue with non-unique values - it just skips any a
    dditional non-unique values but keeps the first.
    CTDv = CTDp.loc[~CTDp.index.duplicated(keep = 'first')]
```

```
In [ ]: #Resetting my index - having an error belowing about it not being a monotonic
     increase or decrease.

    #CTD40['dte'].to_datetime(times.reset_index(drop=True).iloc)
    #Hab40.reset_index()
    #CTD40.sort_index()
    CTDv = CTDv.dropna(axis=0, how='all')
```

```
In [ ]: ctd = CTDv.sort_index(axis=0)
```

```
In [ ]: ##CHANGE NUM

        #Now to start on the CTD data

        BIIG = []
        num = 0
        while num < 20036:

            B2 = ctd.index[ctd.index.get_loc(BIIGLE.index[num], method='nearest')]
            BIIG.append(B2)
            num = num +1
        print(BIIG)

        ################################

In [ ]: BIIGLE['CTIME2'] = BIIG
        BIIGLE
In [ ]: #Resetting my index - having an error belowing about it not being a monotonic
         increase or decrease.

        #CTD40['dte'].to_datetime(times.reset_index(drop=True).iloc)
        #Hab40.reset_index()
        #CTD40.sort_index()
        #CTDp = CTDp.dropna(axis=0, how='all')

In [ ]: ##CHANGE NUM

        #Now getting the series with the latitude and longitude data, but they'll need
        some cleaning up.
        #Same process as I used for the DT data, but just some modifications for the d
        ifferent data.

        BIIG = []
        num = 0
        while num < 20036:

            B2 = ctd.iloc[ctd.index.get_loc(BIIGLE.index[num], method='nearest')]
            BIIG.append(B2)
            num = num +1
        print(BIIG)

In [ ]: #BIIGLE['CTIME2'] = BIIG

In [ ]: BIIGLE
```

```
In [ ]: ##CHANGE NUM

        #Only required a small modification, but now it's good. These loops are defini
        tely getting easier, that's for sure.

        num = 0
        BIIGLE['ALT2'] = ''
        BIIGLE['COND2'] = ''
        BIIGLE['TEMP2'] = ''
        BIIGLE['cDEPTH2'] = ''
        BIIGLE['SAL2'] = ''

        while num <20036:

            BIIGLE['CDATE2'] = BIIG
            st = str(BIIGLE['CDATE2'][num])
            spl = st.split('\n')
            #del(spl[-1])
            spl = pd.DataFrame(spl)
            spl = spl[0].str.strip(' , a, T, I, M, E, C, D, P, H, S, A, L, O, N, _, W, O')
            spl[1] = spl[1]
            spl[2] = spl[2]
            spl[3] = spl[3]
            spl[4] = float(spl[4])
            spl[5] = float(spl[5])
            #spl[6] = spl[6]
            #spl[7] = spl[7]
            #BIIGLE['CTIME2'][num] = spl[2]
            BIIGLE['ALT2'][num] = spl[3]
            BIIGLE['COND2'][num] = spl[4]
            BIIGLE['TEMP2'][num] = spl[5]
            BIIGLE['cDEPTH2'][num] = spl[6]
            BIIGLE['SAL2'][num] = spl[7]

          num = num + 1
        print(BIIGLE)

In [ ]: BIIGLE

In [ ]: #CHANGE NAME

        BIIGLE.to_csv('BIIGLE2.csv')
```

BIOGRAPHICAL SKETCH

Kara Eckley attended Seattle Pacific University in Seattle, Washington, where she completed a B.S. degree in Ecology, focusing on marine ecology. While at Seattle Pacific University, Kara worked as a teaching assistant, as well as in laboratory preparation, and graduated summa cum laude in the Spring of 2019. She then completed several diving courses including deep, nitrox, and rescue courses before beginning a marine conservation internship and divemaster training course in January 2020 while living on the island of Koh Tao in Thailand. Kara completed her divemaster's training in June 2020, and continued research working and diving with the marine conservation program until August 2020. Then, she began working on her M.S. in Ocean, Coastal, and Earth Studies at the University of Texas – Rio Grande Valley. While there, she worked as a research assistant in the laboratory of Dr. Erin E. Easton studying benthic ecology along the Salas y Gómez Ridge in the southeast Pacific. Kara completed her degree in December 2022.

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