Assessment of biodiversity, distribution, and abundance of deep sea scavenging megafauna

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Introduction

The deep-sea (oceans deeper than 200 m) is unexplored. The deep-sea makes up 98% of the oceans, and of that 98% humans have only explored 5% (Gage, 1991). Recent studies have been conducted in various regions and depths of the deep-sea, but knowledge on its ecosystem remains limited.

An expansion of fisheries into deeper waters since the early 1970s as a result of overexploitation of shallow water fish populations (Norse at al., 2012) has further threatened deep-sea species. Deep-sea species mature slowly and have low fecundity due to nutrient deficiency and low temperature at such depths (Brooks at al., 2015), most species, therefore, have very low resilience and are vulnerable to overexploitation (Norse at al., 2012). It is likely that many species are overfished and extirpated before scientists identify them. Bottom-trawling is a particularly invasive fishing method, as its bycatch has extremely high mortality rates. The high seas are considered outside of Exclusive Economic Zones (EEZ) and are therefore unprotected by governments and difficult to regulate (Norse et al., 2012).

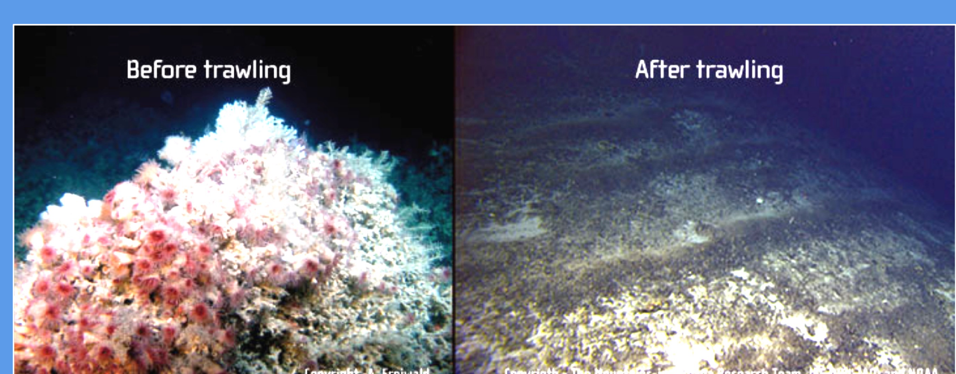

Figure 1: A deep sea coral reef before and after bottom-trawling.

Figure 2. One rig being hand- hauled from 1000 m.

Purpose

This study's objective was to collect baseline data on the deep-sea species to advocate for protection, management, and future research. Using a trapping method, this study assessed the biodiversity, abundance, and distribution of deep-sea scavenging megafauna in the Exuma Sound, Eleuthera, The Bahamas.

Methods

Figure 3. Eleuthera and our study site, the Exuma Sound, an inlet of the Atlantic Ocean.

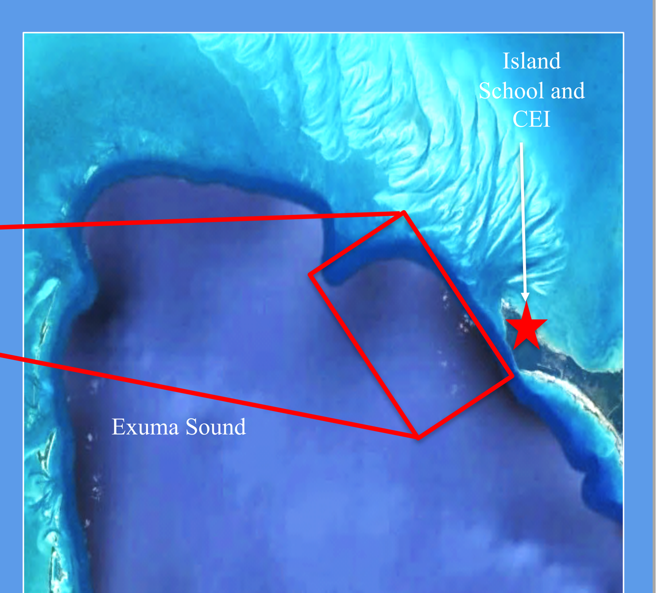

Figure 4. The study site in relation to the Island School and CEI. Depths of 1000m can be accessed as close as 4km off shore

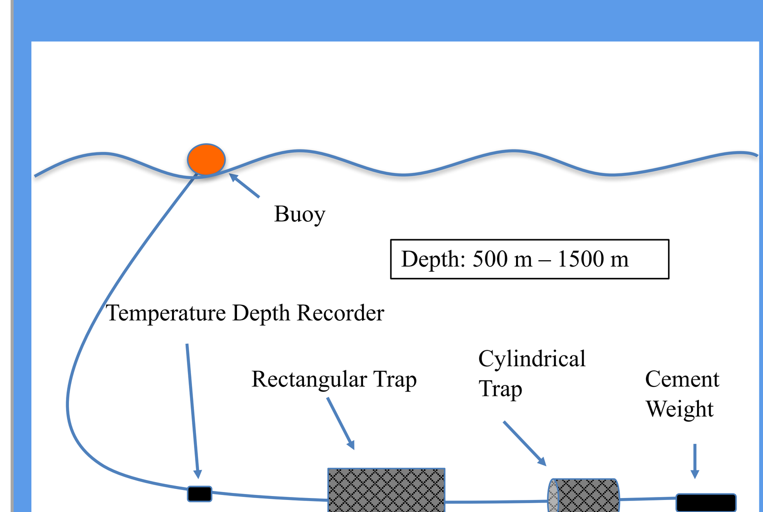

Figure 5.The rig consisted of a cement weight, followed by a cylindrical trap, followed by a rectangular trap. A temperature depth recorder provided accurate data for each rig once it surfaced. Each trap contained a Bonita tuna as bait.

Figure 6. Once dropped, each rig was left for a 24-hour soak. The rig was then hauled to the surface using an electronic winch.

Figure 7. Once the captured, organisms were collected and brought back to the lab for processing. Morphometric measurements along with taxonomic description, sex and weight of each organism were recorded.

Results

Table 1. Species found at ranging depths and temperature in addition to the total abundance caught of each species.

Species	Depth Range (m)	Temperature Range (˚C)	Total Abundance Caught
Bathynomus giganteus	637-1051	4-12	141
Booralana tricarinata	403-717	10-17	272
Bathynomus maxeyorum	637-717	10-12	45
Booralana nov sp.	403-717	10-17	223
Heterocarpus ensifer	637-1010	12-5	23
Lamoha sp.	754	8	2
Nephropides caribaea	678	11	1
Synaphobranchus affinis	764	10	1
Simenchely parasitica	1050	5	2
Homola sp.	523	15	1

Figure 8. Specimen of *Synaphobrancus affinis* caught at 764 m.

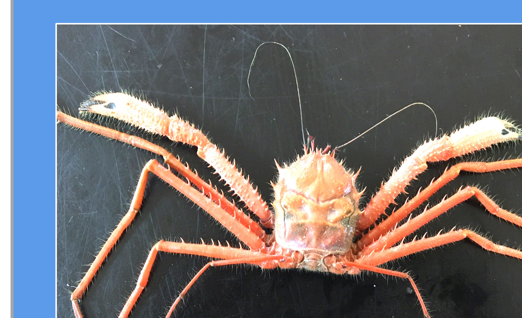

Figure 9. Specimen of *Lamoha spp.* caught at 754 m.

Figure 10. Specimen of *Nephropides caribaea* caught at 678 m.

Figure 11. Specimen of *Bathynomus giganteus* caught at 1051 m.

A total of 22 rigs was set at depths between 403 m to 1050 m over a three-month period. Seven hundred and eleven organisms were caught and 10 species were identified. The abundance graph relates the number of organisms caught to the depths in meters. The highest abundance of organisms caught were found at depths ranging from 523.75 m to 678.25 m and the abundance of the organisms decreased as depth increased. Species richness represents the abundance of individual species at a given depth. As depth increased, the species richness decreased and was most abundant at 67 m. In studying the trends of the species caught, it can be determined that the organisms of the genus of *Booralana* and *Bathynomus* were found at varying depths. The highest abundance of the two species within the *Booralana* genus were found at 678 m deep. As depth increases, their abundance increases, though they were not found at depths exceeding 764 m. The highest abundance of *Bathynomus maxeyorum* was found at 706 m and the highest abundance of the *Bathynomus giganteus* was found at 1050 m. The trend of the two species of the *Bathynomus* genus showed that as depth increases, abundance decreases and can be found at depths ranging between 678 m to 1050 m.

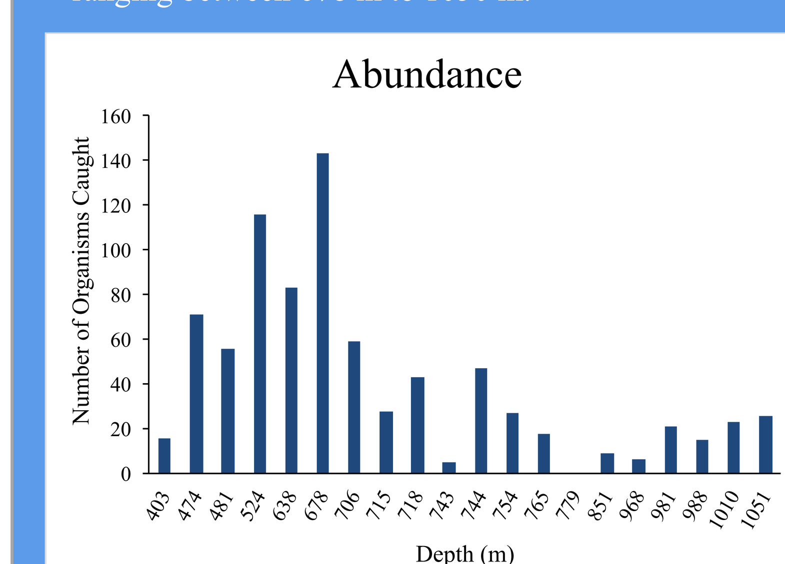

Figure 12. Abundance of organisms caught in comparison to the depth at which the species were caught. The maximum organisms caught were at 678.25 m. The minimum organisms caught were at 778.5m.

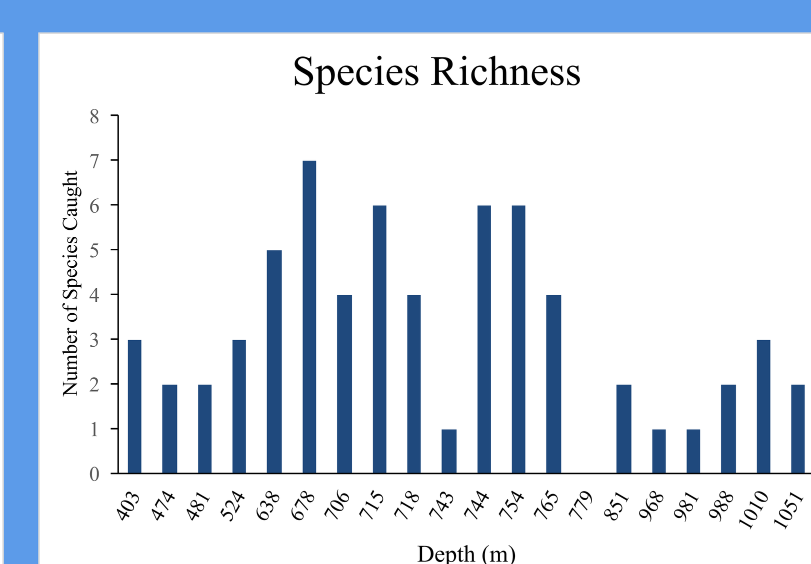

Figure 13. Species richness is abundance of species in comparison to depth. The highest abundance of species was at 678m and the lowest was at 779m.

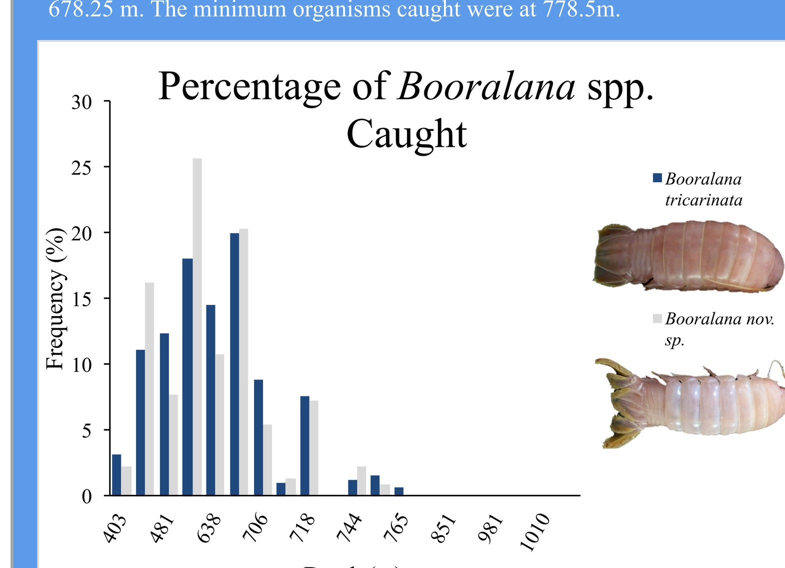

Figure 14. The percentage or frequency of *Booralana* genus caught in comparison to depth. The *Booralana tricarinata* and *Booralana nov. sp.* are compared and are found at similar depths.

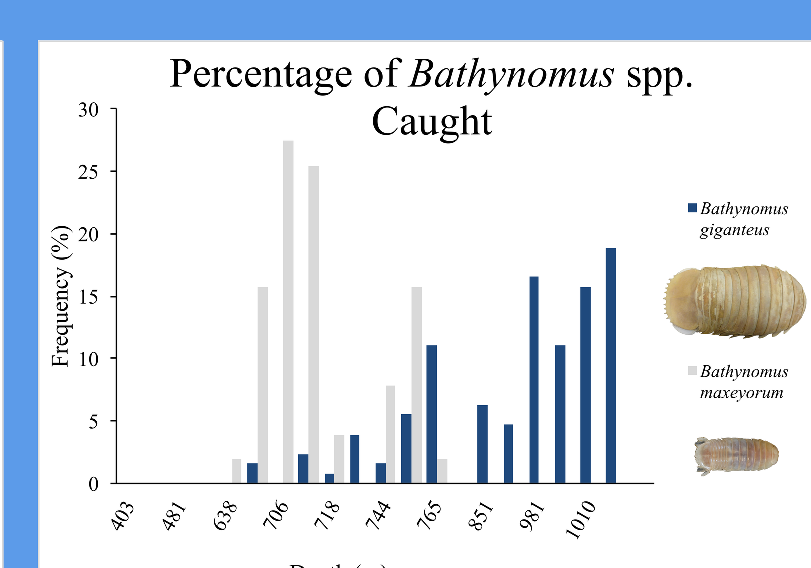

Figure 15. The percentage or frequency of *Bathynomus* genus caught and the depth they were caught at. This graph compares frequency of capture of *Bathynomus giganteus* to that of *Bathynomus maxeyorum*.

Discussion

This study focused on the effects of depth on the species richness and abundance of the organisms found. The four most abundant species caught were *Bathynomus giganteus, Bathynomus maxeyorum* and *Booralana tricarinata* and *Booralana nov. sp.*, as shown in Table 1 and were the primary focus of the data.

As shown in Figure 14, *Bathynomus* spp. were found at different depths, *Bathynomus giganteus* at lower depths than *Bathynomus maxeyorum.* This could be a result of competition or different environmental preferences between the species such as temperature or depth. As shown in Figure 15, *Booralana* spp. were found at relatively similar depths, which could imply that they are competing for the same resources or have similar environmental preferences.

Previous studies showed a decline in species richness of crustaceans at deeper depths (Angel et al., 1996). This trend showed up in the data, as shown in Figure 13, but only deeper than approximately 700m. This implies that deeper sampling must be conducted to fully understand the decline in species richness. Figure 12 showed that the abundance of species decreased as the depth increased, which could imply that there are fewer resources present for organisms at deeper depths.

While this research did fill in knowledge gaps, there were drawbacks worth noting. Firstly, the data collected was not sufficient enough to show that the found trends were significant. The selective nature of the trapping method used may have limited our results. It is also worth noting that data was collected over one season in a specific location and depth range. Additionally, the depths with 0% organisms caught in Figure 14 and Figure 15 could imply that because no organisms of the respective genus were caught, there could be harsh environmental conditions at such depths.

Figure 16. Average catch in a rectangular trap.

Figure 17. Trap being hauled up under the boat.

Further Studies

In future studies, samples should be collected at deeper depths and locations outside of just the Exuma Sound for comparison. Adding bathymetric mapping will provide further understanding of species assemblages and ecosystems. Additionally, because of the selectivity and invasiveness of trapping, other data collection methods such as deep sea cameras can be used. Future studies should also consider comparing data over different seasons to analyze for trends in seasonality.

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