Assessing Relative Abundance and Biodiversity of Deep-Sea Fauna in the Exuma Sound, Eleuthera, The Bahamas

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Introduction

The deep-sea is a foreign world of which there is very limited knowledge. It is dark, has very high pressure, low temperatures (from 4˚C-10˚C), little oxygen, high salinity, and very dense waters (Norse *et al*. 2011). Because of these conditions it is extremely difficult to study the deep-sea.

As coastal and shallow water ecosystems are being depleted, fisheries have been transitioning to the deep-sea. As a result, overfishing in the deep-sea has become an increasingly large problem. Deep-sea fish have different characteristics and qualities than shallow water fish. For example, they have significantly longer life spans, low fecundity rates, and low metabolisms (Norse *et al.* 2011). As a result of these characteristics, deep-sea species are highly vulnerable to fishing pressure.

There is not much previous research on the deep-sea in the Bahamas. Through this research, baseline data on a relatively healthy deep-sea ecosystem can be collected because the Bahamian deep-sea has minimal anthropogenic impacts. This data will be compared to the ones from other areas with similar geographical ecosystems. One example is the Gulf of Mexico, a relatively similar ecosystem with heavy deep-sea fishing.

This research could potentially benefit the greater scientific community as well as the Department of Marine Resources in The Bahamas. It could provide concrete baseline evidence that could help create regulations to help with economic, environmental and conservational issues.

Objectives

1. Gather data on species relative abundance and distribution in the Exuma Sound.
2. Explore depth related trends in relative abundances of deep-sea species in the Exuma Sound.

Study Site

Figure 1. Eleuthera

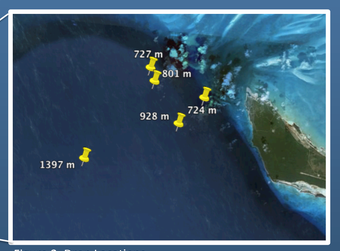

Figure 2. Drop Locations

This study was conducted in the Exuma Sound (a relatively unimpacted deep-sea ecosystem) off the coast of Cape Eleuthera.

Results

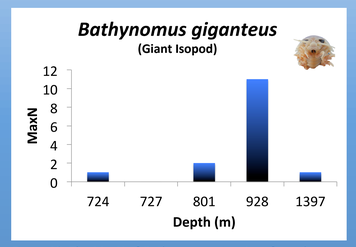

Figure 10. The MaxN of *Bathynomus giganteus* from drop depths of 724m, 727m, 801m, and 928m

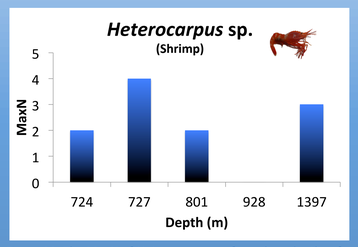

Figure 11. The MaxN of *Heterocarpus sp.* from drop depths of 724m, 727m, 801m, and 928m

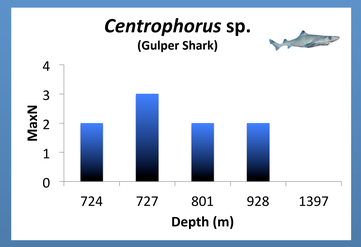

Figure 12. The MaxN of *Centrophorus sp.* from drop depths of 724m, 727m, 801m, and 928m.

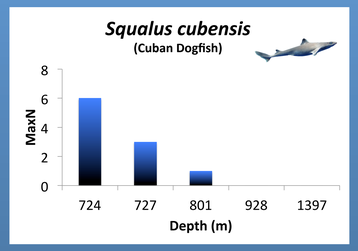

Figure 13. The MaxN of *Squalus cubensis* from drop depths of 724m, 727m, 801m, and 928m.

This study examined several trends of deep-sea fauna in Exuma Sound, Eleuthera, The Bahamas. Although there was no remarkable change in biodiversity at different drop depths (Table 1), changes in species composition between each drop were observed. The MaxN of *Bathynomus giganteus* increased as depth increased (Figure 10). At 801m, one *Bathynomus giganteus* was recorded and there was a large increase at 928m where a MaxN of 11 *Bathynomus giganteus* was recorded. Figure 11 demonstrates a higher abundance of *Heterocarpus* spp. which is shown through a defined bell curve. No *Heterocarpus* spp. were observed at 928m. The MaxN of *Centrophorus* spp. remained relatively constant at 724m, 727m, 801m and 928m (Figure 13). Figure 14 exhibits a clear negative linear regression, representing a higher abundance of *Squalus cubensis* in shallower depths. Contrasting to the six *Squalus cubensis* that were observed at 724m, only one *Squalus cubensis* was observed at 801m and none were observed at 928m.

Methods

Baited remote underwater video surveys (BRUVs) are effective and non-invasive ways to study the deep-sea (Brooks et. al. 2011). The Medusa (BRUV), a specialized camera for depths of 2,000 meters, was used in this study. Throughout this study The Medusa was deployed six times between 700-1,400m.

Table 1. MaxN of deep-sea fauna observed and the total number of species observed at increasing drop depth using The Medusa in the Exuma Sound, Eleuthera, The Bahamas.

Depth	Species	MaxN	Depth	Species	MaxN
724 m	Hexanchidae *Hexanchus nakamurai*	1	**801 m**	Centrophoridae *Centrophorus sp*	2
	Cirolanidae *Bathynomus giganteus*	1		Cirolanidae *Bathynomus sp*	2
	Cirolanidae *Borralana sp*	4		Pandalidae *Heterocarpus sp*	2
	Cirolanidae *Borralana tricarinata*	3		Squalidae *Squalus cubensis*	1
	Squalidae *Squalus cubensis*	6	**Total**		**4**
	Synaphobranchidae sp	1			
	Centrophoridae *Centrophorus sp*	2	**928 m**	Centrophoridae *Centrophorus sp*	2
	Pandalidae Heterocarpus	2		Cirolanidae *Bathynomus giganteus*	11
Total		**8**		Gempylidae *Promethichtyes prometheus*	1
				Pholidoteuthidae *Pholidoteuthis adami*	1
727 m	*Centrophidae Centrophorus*	3	**Total**		**4**
	Gempylidae *Promethichtyes sp*	1			
	Pandalidae Heterocarpus	4	**1397 m**	Somniosidae *Centroscymnus owstonii*	1
	Squalidae Squalus cubensis	3		Cirolanidae *Bathynomus giganteus*	1
	Gempylidae *Promethichtyes sp*	1		Pandalidae *Heterocarpus sp*	3
Total		**5**		Synaphobranchidae *Simenchely parasitica*	2
				Synaphobranchidae *Synaphobranchus oregoni*	3
			Total		**5**

Discussion

Depth-related trends were observed for four specific species: *Bathynomus giganteus, Heterocarpus* sp., *Squalus cubensis*, *Centrophorus* sp. The opposite trends of the relative abundances of *Bathynomus giganteus* (Figure 1) and *Heterocarpus* sp. (Figure 2) could be explained by the fact that both of these species are scavengers; they compete for the same resource for food. To limit this competition, they potentially avoid each other living at different depths. *Squalus cubensis* were found at shallower depths (maximum 801 m) than *Centrophorus* sp. (maximum 928 m). This could be because *Centrophorus* sp. is more resilient than *Squalus cubensis* to the harsh living conditions of the deep-sea (Bailey *et al*. 2007). It is also interesting to note that *Squalus cubensis* were thought not to live deeper than 380 meters (Monzini 2006). However, we found some at 801 meters. We assume that this is because the thermocline in The Bahamas is at much deeper than in most parts of the world, so *Squalus cubensis* were able to live in deeper water.

However, final conclusions cannot be made from this data due to lack of replicate drops. In the future, additional replicate drops need to be conducted at the same depths to confirm our speculations. Also, different bait could be used to attract different species.

This data is extremely important because this study was performed in the Exuma Sound, where commercial deep-sea fishing has not yet been established. The abundances found here can be assumed to be the representative of normal, healthy environment. This data can be used to inform future regulation on deep-sea fishing to help minimize shifting baselines of these species' abundances.

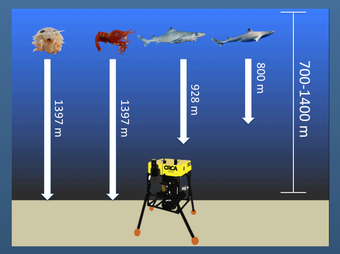

Figure 14. Maximum depths where each species was observed

The Medusa

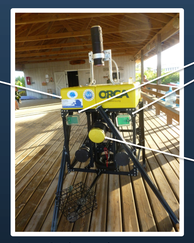

Figure 3. The Medusa Front

Figure 4. The Medusa Back

The flotation makes the Medusa positively buoyant and the near infrared lights allow the fauna to be seen in footage but the lights cannot be seen by the deep-sea organisms. The camera records 12 hours of footage which is the main source of data, and the CABO is a satellite beacon. The CTD and PAR measure conductivity, temperature, and depth, and the Port sends acoustic signals to communicate with a transducer to record The Medusa's depth.

Acknowledgements

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Deployment

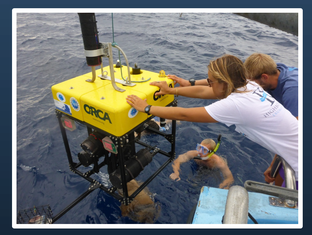

Figure 5. The Medusa Deployment

Figure 6. The Medusa on a research Vessel

Once The Medusa was ready to be deployed, it was attached to a steel crane and dropped into the water. The Medusa recorded 12 hours of footage during its time underwater and was retrieved the next day.

Retrieval

Figure 7. Communication with the Medusa

Figure 8. Deck Box and Transducer

Through the deck box, a way to communicate with The Medusa's Port, a signal was sent to release the sandbags that weigh it down. Once the sandbags were released, the flotation device made The Medusa float to the surface. Once it surfaced, The Medusa was attached to the steel crane and brought back onto the boat. It was then returned to the lab at Cape Eleuthera Institute and video footage was downloaded and analyzed.

Analysis

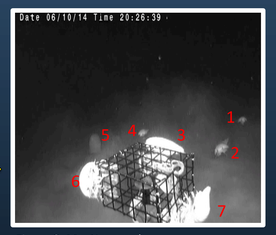

Figure 8. MaxN example

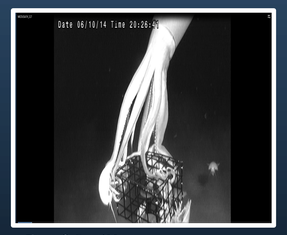

Figure 9. EventMeasure

The analysis was done through EventMeasure, a computer software. This software allows the user to pause the footage whenever a species appears on the screen and tag the species along with other details and information. EventMeasure calculates MaxN, which is a conservative estimate of relative abundance. Figure 8 is an example of MaxN. In this case, the MaxN of *Bathynomus giganteus* is 7.

Literature Cited

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