A COMPARATIVE STUDY ON THE DISTRIBUTION AND RELATIVE ABUNDANCE OF THE DOMINANT MACRO-FAUNA FOUND ON THE ROCKY SHORE OF THE NAMIBIAN COASTLINE BETWEEN WALVIS BAY AND SWAKOPMUND

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A report in the Department of Fisheries & Aquatic Sciences in the Faculty of Agriculture and Natural Resources

Submitted to the Department of Fisheries and Aquatic Sciences, University of Namibia, in partial fulfillment of the requirements for the award of the degree of Bachelor of Science in Fisheries and Aquatic Sciences of the University of Namibia

November 2010

DECLARATION

I hereby declare that this work is the product of my own research efforts, undertaken under the supervision of Mr. F. P. Nashima and has not been presented elsewhere for the award of a degree or certificate. All sources have been duly and appropriately acknowledged.

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CERTIFICATION

This is to certify that the report has been examined and approved for the award of Bachelor of Science in Fisheries and Aquatic Sciences of the University of Namibia.

External examiner: …………………………………..

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Head of Department: ………………………………...

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Firstly it is important that I thank God for his blessings throughout the duration of my research, without them I would not have been able to complete this project. Secondly I would like to thank my friends and family for their consistent and unwavering support and belief, it is humbling and I am truly blessed.

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DEDICATION

This research project is dedicated to Mr. H. M. Ssemakula, my father and role model, and his loving wife Grace, my best friend.

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ABSTRACT

A study on the distribution and relative abundance of the dominant macro-fauna found on the rocky shore of the Namibian coastline was conducted between Walvis Bay and Swakopmund. This study aims to determine which organisms are present in the different zones on the rocky shore; and further compare the presence of these organisms in three different sampling areas. Three different sites situated along the coastline were identified based on the difference in activities taking place among the three sites. A survey method using transects and calculations of relative percentage cover was used to calculate population density of the organisms present; and the data were analyzed using a *GENSTAT* statistical package to determine whether there is a significant difference between the occurrence, abundance and diversity of organisms on the three different rocky shores. Results indicated that there is no significant difference in the abundance and diversity of macro-fauna in the intertidal zones of Dolphin Park, Long Beach and the “Shipwreck” beaches. This might be due to the fact that the three areas are very similar in topographic orientation, creating similar environments and habitats at all three sites. Although the duration of the study was short it clearly showed no significant difference in relative abundance and diversity of macro-fauna at the three sites.

Key words: Relative abundance, Species diversity, Macro fauna, Namibia

CHAPTER 1

1.1 INTRODUCTION

Namibia has a coastline that spans a distance of 1572 km, along the western side of the country and is entirely embedded in the Namib Desert. The Namibian coastline is characterized by its high productivity, which occurs due to the upwelling generated in the Benguela current system. Geographically, the Benguela system extends from the southwestern margin of Africa, from Cape Agulhas 34°S in the south through Namibia into Angola at 10°S in the north (***Markovina, 2009*)**. The cold current system off the shore of Namibia works in such a way that the winds directed by Coriollis force push water away from the shore (offshore transport), and this water is replaced by nutrient rich bottom water.

As a result of the upwelling, there is a high abundance of marine life, although species diversity may not be as high here as it is in other places (Van Zyl, 2000), species richness is very high, and this makes the Namibian coastline an ideal place for fishing. The fishing industry is the second largest economic contributor to GDP after mining and therefore is closely monitored by the government and interested parties. The Namibian coastline is characterized by both sandy and rocky shores; this research covers the rocky shores and the organisms that are found in the rocky shores, specifically in the intertidal zone. Organisms in the intertidal zone of the rocky shore have adapted to this environment, and there is a large amount of plant and animal diversity. Since there is a substrate most of the organisms are sessile, and attach themselves to the substrate.

They are mostly filter feeders that depend on the tides and waves to carry their food. Closest to the sea, there is more water present and organisms there remain submerged and the dominant organisms are mussels and algae, with a small number of anemones present. Further from the shore, on the rocks, there is exposure to sunlight, and sometimes no water cover, just the occurrence of rock pools. This exposed area is not suitable for the mussels, and is therefore dominated by barnacles, which thrive due to lack of competition from mussels as they are filter feeders and rely on the tides and wave movements to provide them with food. Other organisms present are such as the sea anemone, limpets, and sea urchins, grazing snails, sea stars, sea cucumber as well as worms that hide in crevices and under rocks. Thus their distribution is governed by the competition for living space and the need to find food and shelter while avoiding predators, without desiccating or suffering from intolerable extremes in heat or cold. This study attempts to investigate changes in species diversity, relative abundance and distribution of intertidal organisms and to compare these three factors between the three selected areas.

1.2 JUSTIFICATION/ PROBLEM STATEMENT

Human interaction with the intertidal coastal areas may have positive and negative effects on the environment and its surroundings. The three different rocky shores were identified and have been affected in different ways and as such this has affected the organisms found in these areas. So far little is known about small-scale temporal and spatial patterns in the diversity, abundance and distribution of intertidal species along the Namibian coast. Thus, this study aims to identify the similarities and differences in the relative abundance and distribution of the macro-fauna at the three separate sites.

1.3 RESEARCH AIMS

This research project aims to determine the distribution and relative abundance of the dominant macro-fauna found on the rocky shore of the Namibian Coastline between Walvis Bay and Swakopmund.

1.4 SPECIFIC OBJECTIVES

a) To determine which organisms are found on the three sampling sites on the rocky shore.

b) To determine and compare the abundance, species diversity and distribution of intertidal organisms along the transect line at each sampling site.

c) To determine and compare the abundance, species diversity and distribution of intertidal organisms at three different sampling sites.

1.5 SPECIFIC QUESTIONS RELATED TO THE RESEARCH

a) Which organisms are found in the three sampling sites on the rocky shore?

b) What are the abundance, species diversity and distribution of intertidal organisms areas along the transect line at each sampling site?

c) Are the intertidal organisms found in a particular sampling area specific to one particular sampling site or found at more than one sampling site?

1.6 WORKING HYPOTHESIS

a) The intertidal organisms found on the rocky shore of the three sampling sites are mostly the sessile organisms that attach to the substrate; such as bisexual mussels, limpets, barnacles and sea anemone.

b) The intertidal organisms found in the three sampling areas are in equal abundance and distribution in all three sampling Areas.

c) The intertidal organisms found in the three sampling areas showed no significant differences in their species diversities in all three sampling areas.

1.7 LITERATURE REVIEW

The intertidal zone includes sandy and rocky shores, and experiences wide changes in environmental conditions due to the rising and falling of the tides along the coastline. This zone is that area of the coast exposed to sunlight and wind during a low tide, and covered by water and waves during high tide (Mathews 2007). It is a unique area containing plants and animals that have evolved over the time to adapt to life in this specific region. According to Matthews (2007), the rocky shore is made up of different micro-zones based on proximity to the sea and the amount of exposure to the elements. Since there is a substrate most of the organisms are sessile, and attach themselves to the substrate. They are mostly filter feeders that depend on the tides and waves to carry their food.

The intertidal rocky shore zonation more or less follows that of the South African west coast, i.e. the Littorina, upper Balanoid and lower Balanoid zones. The Cochlear-Argenvillei zone is not found off the coast of central and northern Namibia (Molloy and Reinikainen, 2003). The rock pools that form during low tide in the intertidal zone are important to organisms that have to prevent desiccation when exposed to air. Rock pools also provide shelter to organisms that have to hide from their predators. They are usually protected from the harsh conditions which are experienced by the surrounding exposed rocky surfaces, and they also catch and store nutrients brought in by the wave action (Mathews 2007).

The organisms found in the rock pools are sessile, and firmly attached themselves to the substrate to prevent being washed away by waves and tidal movement. These organisms are firmly attached and it is difficult to remove them from the rocks. Their restricted movement forces them to be filter feeders, relying on the waves and incoming tides to provide them with food. The barnacles are dominant in areas where the mussels are absent, because they need open space and slightly warmer temperatures in order to feed and thrive. Creatures found in the rock pools are largely sessile and hence have hard shells or outer layers to prevent them from being easily susceptible to predators; examples of these are the Limpets, bisexual mussels and barnacles. One organism that does not have a protective layer is the sea anemone, and in order to protect itself it retracts its tentacles inwards and reduces its size considerably, protecting its most vulnerable regions. Sea anemones are cnidarians closely related to corals and jellyfish.

Barnacles and mussels are also R-strategists, and produce large amounts of offspring, multiplying rapidly in order to compensate for predation, competition and the unstable environment within which they are found.

CHAPTER 2

2. MATERIALS AND METHODS

2.1 Study area

Figure 1: Picture of the study area (Source: Google Earth, 2010)

The study was conducted between Swakopmund and Walvis Bay at three areas the Dolphin Park, Langstrand (also known as Long beach) and Shipwreck area. The three areas are roughly 4 km apart and are characterized by rocky outcrops with different topographic orientation and were again characterized by different activities taking place.

The Dolphin Park area is characterized by a relatively large rocky shore, dominated by mussels in the area closest to the low water mark, and barnacles towards the end of the rocky shore. The area also contains several rock pools, containing anemones and other intertidal organisms. The Shipwreck area is famous for the ship that sunk near the shoreline in that area, and a project was undertaken to remove the ship bit by bit in order to reduce the impact that the shipwreck had on the environment; this removal is another interaction which may have had an effect on the environment.

Shipwreck area consisted of patchy rocky outcrop which block tide waves thus, most rocks were exposed while at Langstrand the area tend to be formed by a uniform rock layer along the coast and most of its rock where found submerged even during low water tides. Both the Langstrand/Long beach area and the ‘Shipwreck’ area are dominated by mussels and barnacles in varying distribution and abundance. Both areas are subjected to disturbances such as human trampling, past and current development (i.e. building construction) especially at Langstrand, and all these might have affected the ecology and biological composition of intertidal organisms.

2.2 STUDY DESIGN AND DATA COLLECTION

Sampling was done at three different sites. The first point of data collection was the rocky shore at Dolphin Park. The other two sites are Langstrand and the “Shipwreck” located on the outskirts of Swakopmund.

The methods used in order to collect the organisms found in the chosen sampling area, are outlined in the steps below;

- Determine the reference points of the areas that are to be surveyed on three different rocky shores.
- Starting from the low water mark, insert a marker every 2.5 m up to the end of the rocky shore in a straight line. These will be the reference points. The number of reference points depends on the distance of the rocky shore from low water mark.

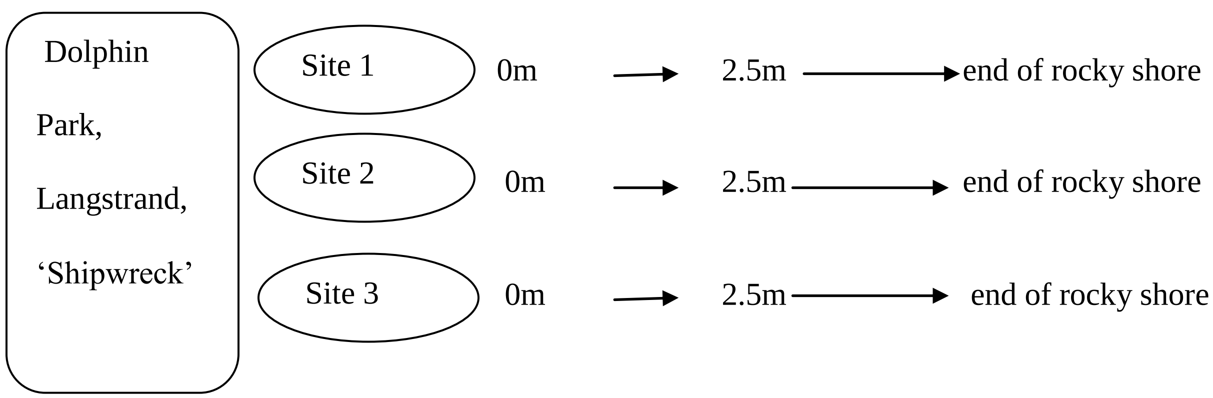

Figure 2: A diagrammatic representation of the sampling design

- A quadrant was placed at each marker.
- The given quadrant was in line with some permanent and identifiable feature, for example a permanent rock. It ran out normal to the shore in a straight line and convenient reference points on it were be marked.

- Starting from the low water mark, the reference points are marked 0m, 2.5m, 5m etc. (every 2.5 m up to the end of the rocky shore), and three pictures of the transect were taken at each reference point.

Figure 3: A photograph of a quadrant, along a transect line taken at Dolphin Park Site 1

To determine the distribution and relative abundance of the dominant plants and animals on the rocky shore surface;

- The distribution of the dominant macro-fauna was determined by identifying the animals within the given quadrant. This was done by starting from the low-water mark using quadrants (30cm x 30cm) that were moved after every recording forward towards the high water mark or up until the rocky shore ends.

- Organisms were collected and placed in separate jars filled with a solution of 4% formalin and seawater for identification. The relative abundance was assessed as the relative percentage covers of each species within the quadrant.
- A photograph of the quadrant was taken and divided into smaller squares in order to accurately determine the relative abundance of the organisms found within the quadrant.
- The distribution and relative abundance of the organisms found on the three different sampling sites was compared using statistical analysis.

2. 3 DATA MANIPULATION AND ANALYSIS

The Shannon-Weiner diversity index was used to determine the diversity of intertidal organism using *Primer 5* programme. The data was analyzed using the *SPSS 16.0* statistical package, and the data used consisted of observations from 0m up until the 7.5m mark, this was done in order to give an accurate comparison between the different sampling sites. A two way analysis of variance (ANOVA) test was carried out to determine the effects of distance along the transect line (within the intertidal zone) and sampling site on species diversity and relative abundance respectively.

CHAPTER 3

3.1 RESULTS

A total of seven (7) intertidal species which includes; *Aulactinia reynaudi* (sea anemone), *Chthamalus denatatus* (barnacles), *M. galloprovincialis* (Mediterranean mussels), *Perna perna* (Brown mussels), *Choromytilus meridionalis* (Black mussels), *Semimytilus agosus* (Bisexual mussel) and *Scutellastra granularis* (Granular Limpets) were observed at the three sampled sites and these species varied in abundance and occurrence within the transects and between the three sites.

Table1: Phylogenetic Classification of the Organisms Found in the Rocky Shore Sample

Common Name	Phylum	Family	Genus	Species
Sea anemone	Cnidaria	Actiniaria	*Aulactinia*	*reynaudi*
Barnacles	Arthropods	Crustacea	*Chthamalus*	*denatatus*
Black Mussels	Mollusca	Bivalvia	*Choromytilus*	*meridionalis*
Brown Mussels	Mollusca	Bivalvia	*Perna*	*perna*
Mediterranean Mussels	Mollusca	Bivalvia	*Mytilus*	*galloprovincialis*
Bisexual Mussels	Mollusca	Bivalvia	*Semimytilus*	*agosus*
Granular Limpets	Mollusca	Gastropoda	*Scutellastra*	*granularis*

3.1.1 Relative Abundance of intertidal organisms per site

(a) Langstrand / Long beach area

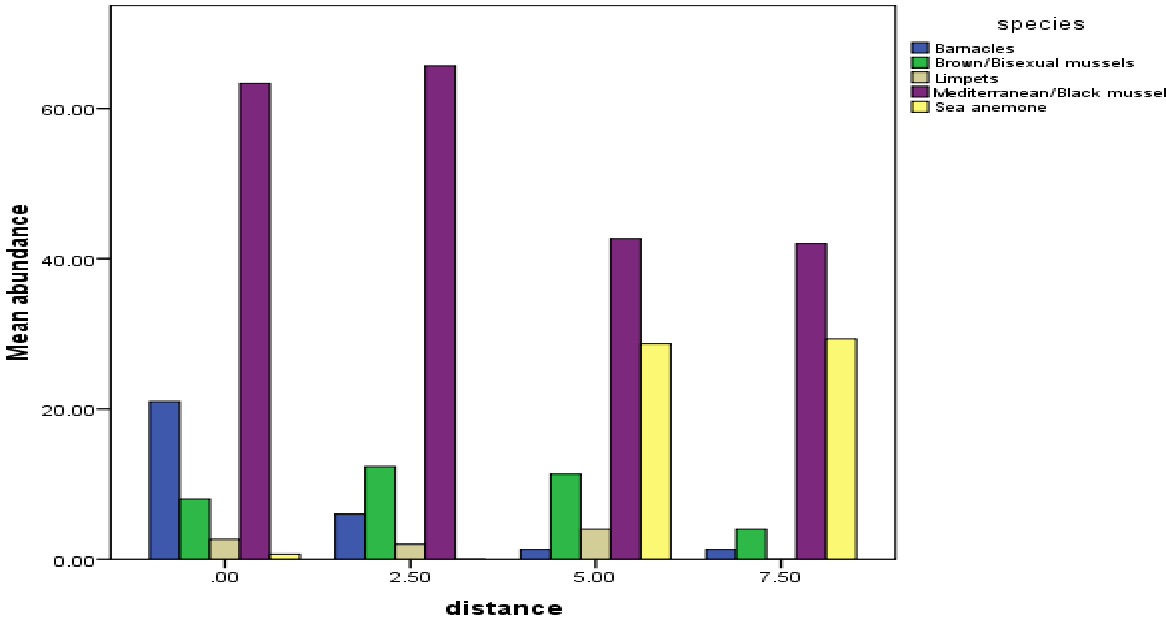

Figure 4: The comparison of mean in relative abundance of intertidal organism along the transect line at Langstrand

The graph above shows that intertidal organisms found at Langstrand consisted of different organism which tends to varies in abundance sampled point. *M. galloprovincialis* (Mediterranean mussels) and *Choromytilus meridionalis* (Black mussels) were the dominant species in this area, especially closer to the shoreline at distances of 0m and 2.5m respectively. *Aulactinia reynaudi* (sea anemone) was also present at the 5m and 7.5m points in almost equal abundance. This was the only site where they were found within the given quadrants.

There was very few *Scutellastra granularis* (Granular Limpets) found, and the abundance of *Chthamalus denatatus* (Barnacles) decreased steadily as the high water mark was approached. Although graphically such differences can be depicted there was however non-significant (p=1.109) differences in relative abundance of intertidal species observed with regard to changes in distance from a low water mark (i.e. 0m) to high water mark (7.5m).

(b) Dolphin Park area

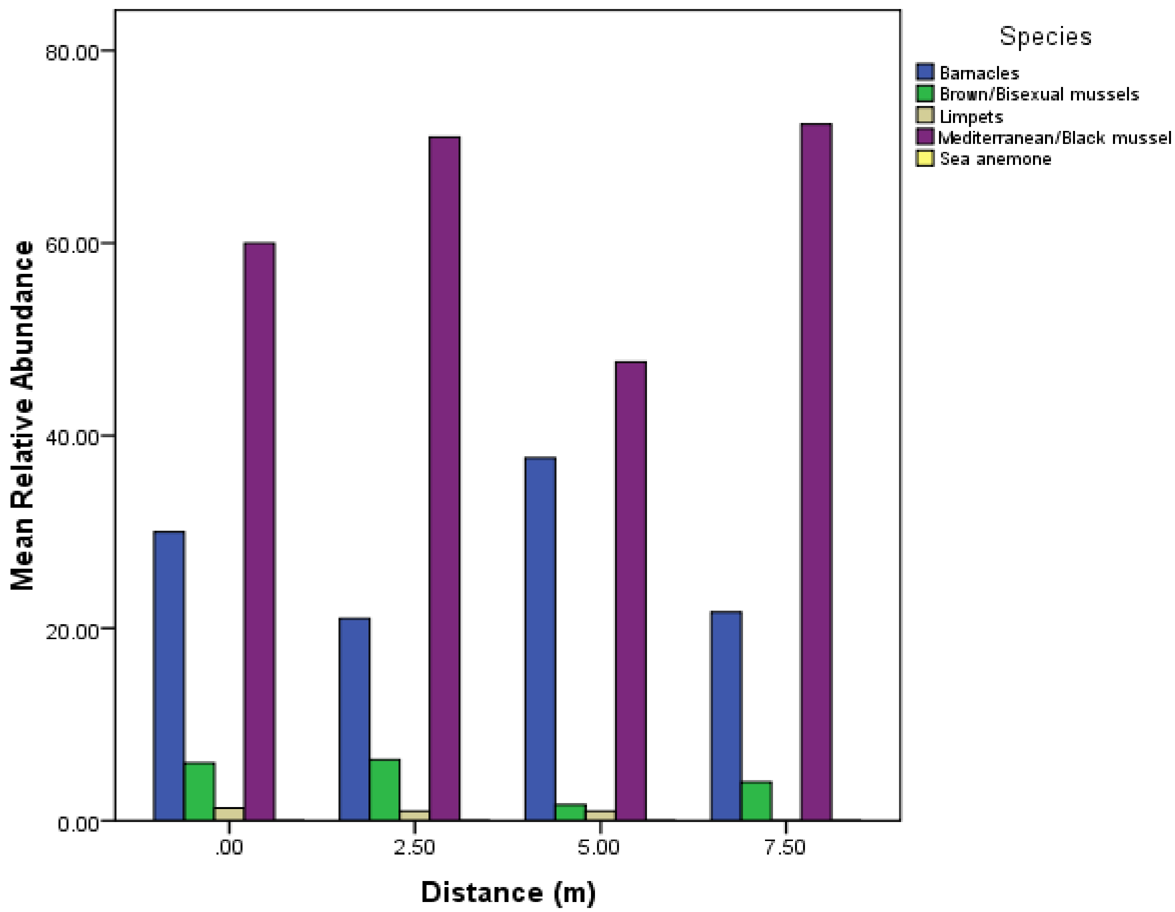

Figure 5: The comparison of mean in relative abundance of intertidal organism along the transect line at Dolphin Park

The graph above shows that *M. galloprovincialis* (Mediterranean mussels) and *Choromytilus meridionalis* (Black mussels) were the dominant species in Dolphin Park, and they increase as they approach the shoreline, with the highest values at 2.5m (mean abundance = 71%) and 7.5m (mean abundance = 72.3%) respectively. There was no significant difference between the relative abundance of the different species at the 4 depths (p=0.907)

(c) 'Shipwreck'

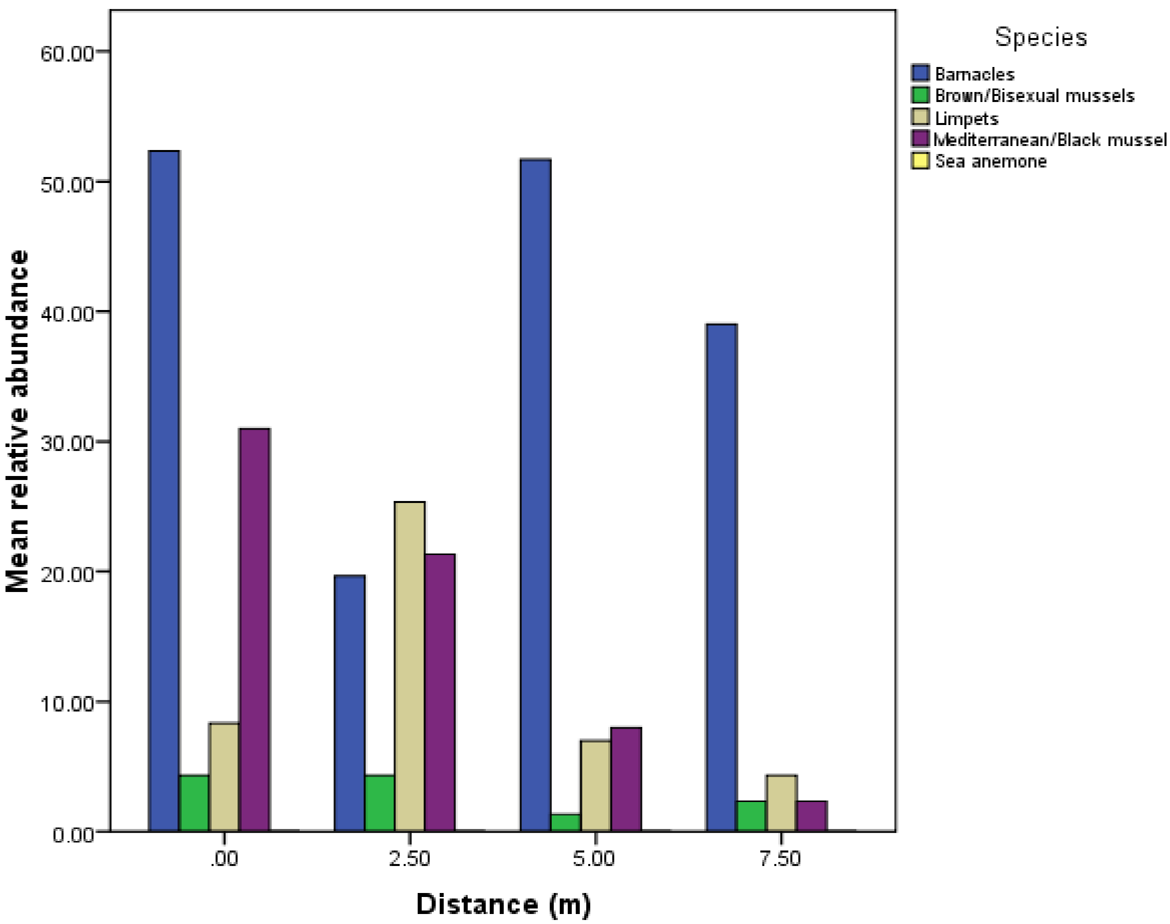

Figure 6: The comparison of mean in relative abundance of intertidal organism along the transect line at Shipwreck area

The graph above shows that *Chthamalus denatatus* (Barnacles) were the dominant species in the Shipwreck area, especially towards the lower mark, with the highest values at 0m (mean abundance = 52.3%) and 5m (mean abundance = 51.7%) respectively. The abundance of *M. galloprovincialis* (Mediterranean mussels) and *Choromytilus meridionalis* (Black mussels) decreased steadily as the distance from the shoreline increases. The data found here was normally distributed, and there was no significant difference between the relative abundance of the different species at the 4 depths (p=0.128).

3.1.2 Comparison of relative abundance of intertidal organisms between sites

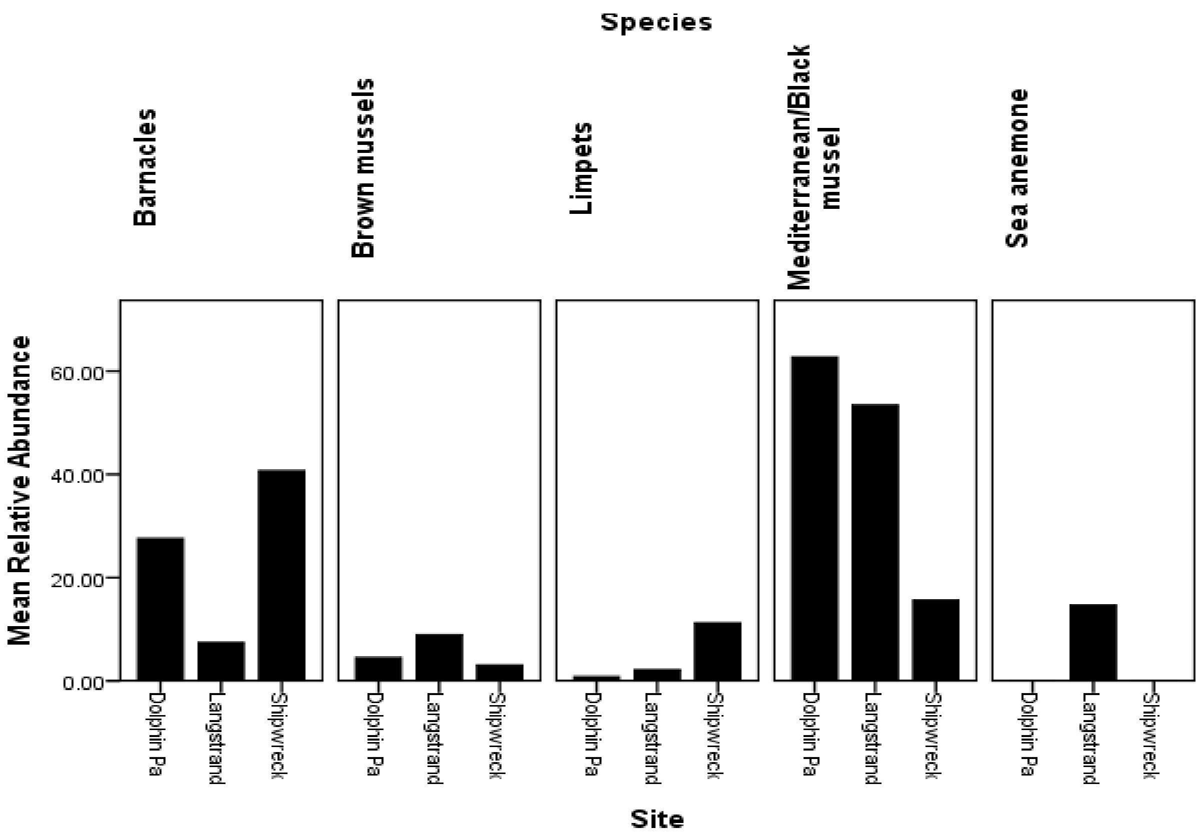

Figure 7: Comparison of mean Relative abundance of intertidal organisms between the three different sampling sites

The ANOVA indicated non-significant differences in mean of intertidal species abundance between the three sampling sites. It is evident from figure 7, that *Aulactinia reynaudi* (sea anemone) was only present in the quadrants sampled at Langstrand area but in small amounts. *M. galloprovincialis* (Mediterranean mussels) were abundant at Dolphin Park and Langstrand areas, but they were not as abundant at the Shipwreck area, where the *Chthamalus denatatus* (Barnacles) are the more dominant organisms. *Scutellastra granularis* (Granular Limpets) and *Perna perna* (Brown mussels) were not dominant in any of the sampled areas.

3.1.3 Comparison of Species Diversity of intertidal organisms per site

(a) Langstrand area

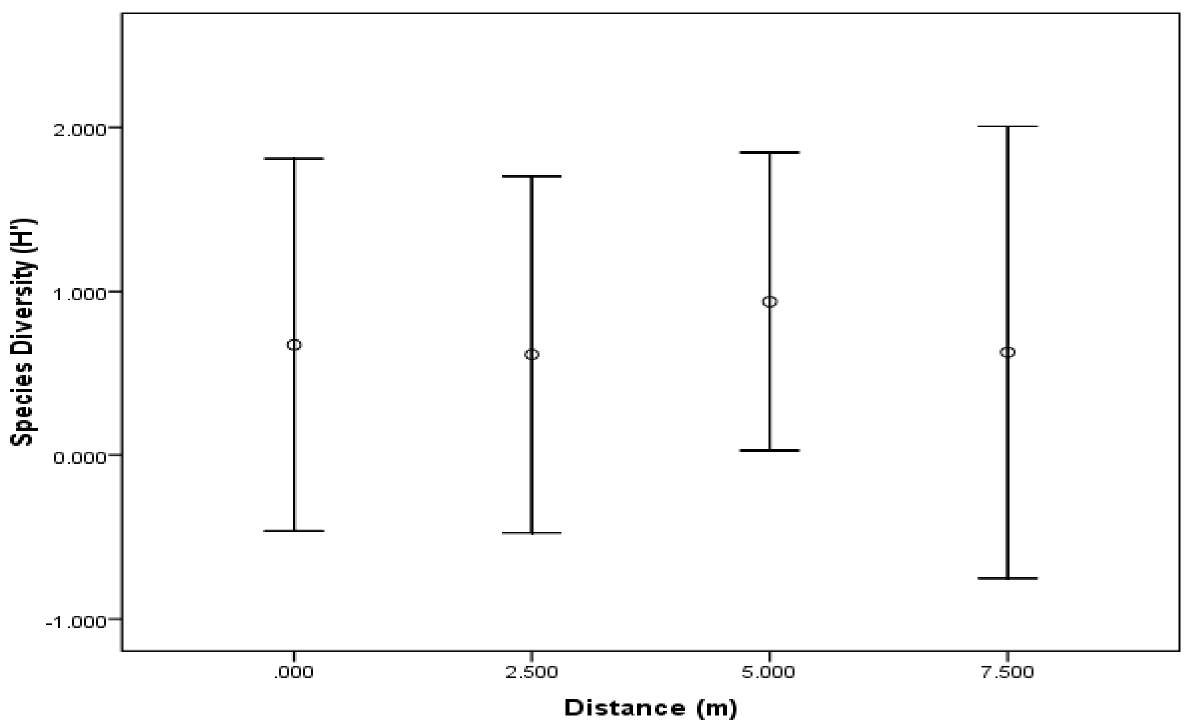

Figure 8: Comparison of mean Species Diversity along the transect line at Langstrand

It is evident from figure 8 above that there is no significant difference between the species diversity at the different distance along the transect line at Langstrand area ($p = 0.798$).

(b) Dolphin Park

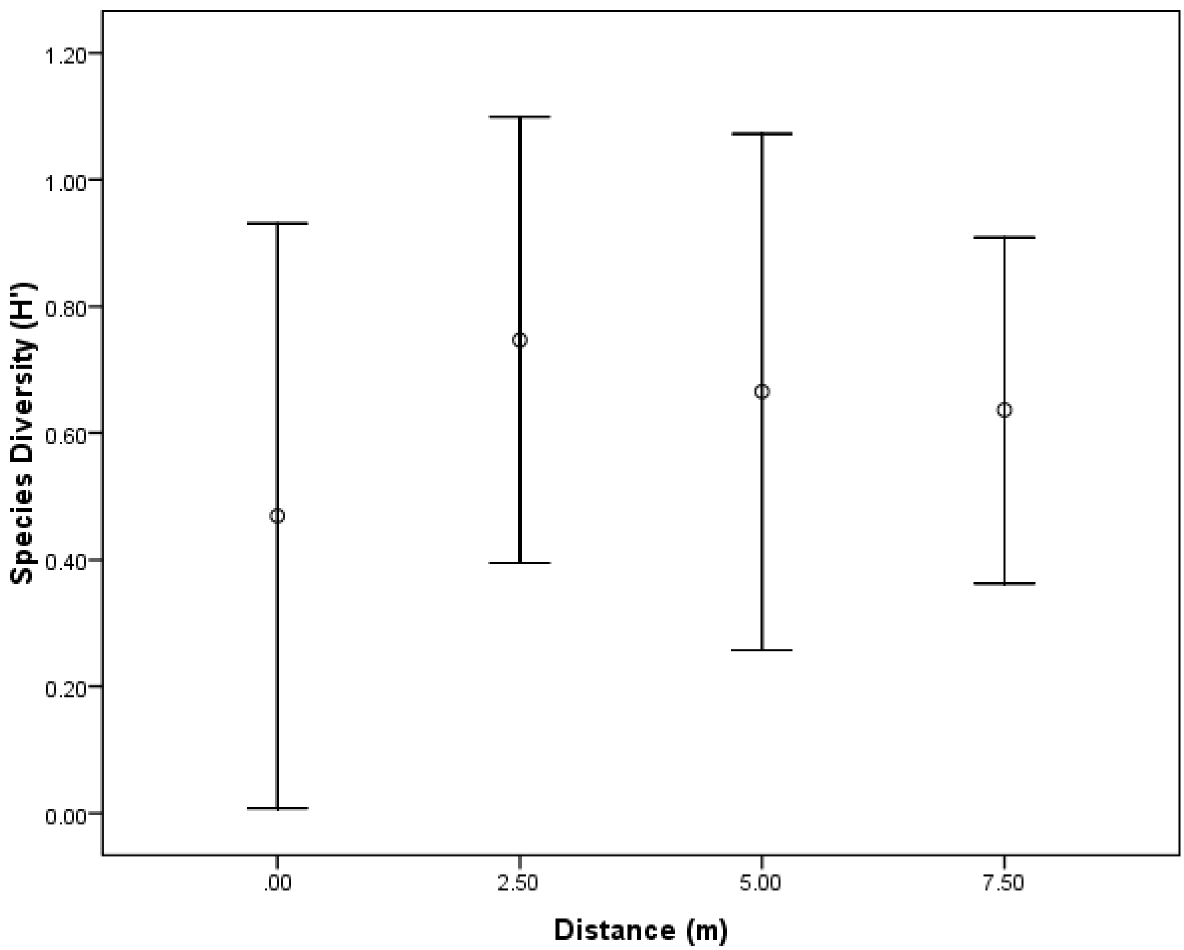

Figure 9: Comparison of mean Species Diversity along the transect line at Dolphin Park

The graph above indicates that there is no significant difference in species diversity of intertidal organisms along the transect line at Dolphin Park sampling site ($p = 0.922$).

(c) Shipwreck

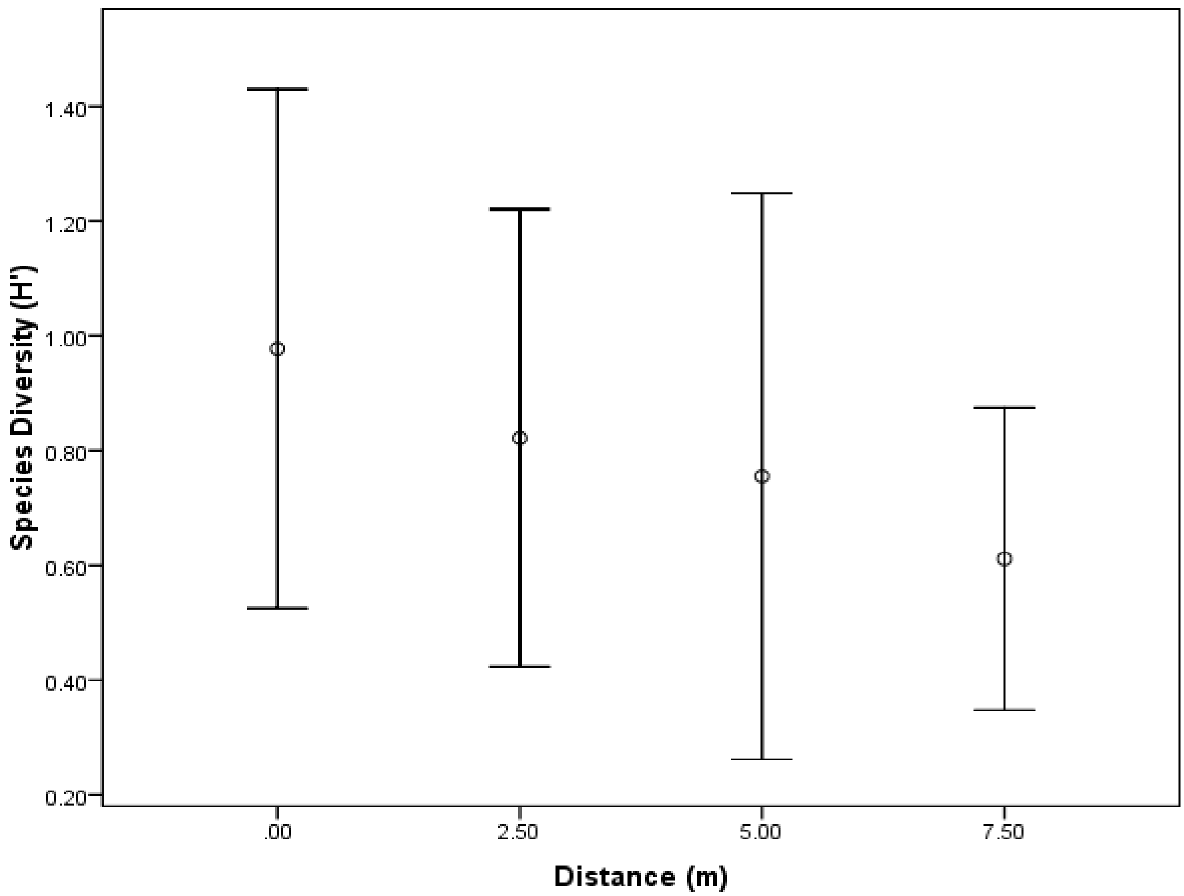

Figure 10: Comparison of mean Species Diversity along the transect line at Shipwreck

The general trends observed in figure 10 above indicates that there tend to be a decline in the mean species diversity of intertidal organism along the transect line (toward the high water mark). However, this was statistically non significant (p = 0.999).

3.1.4 Species Diversity Comparison between the three sampling sites

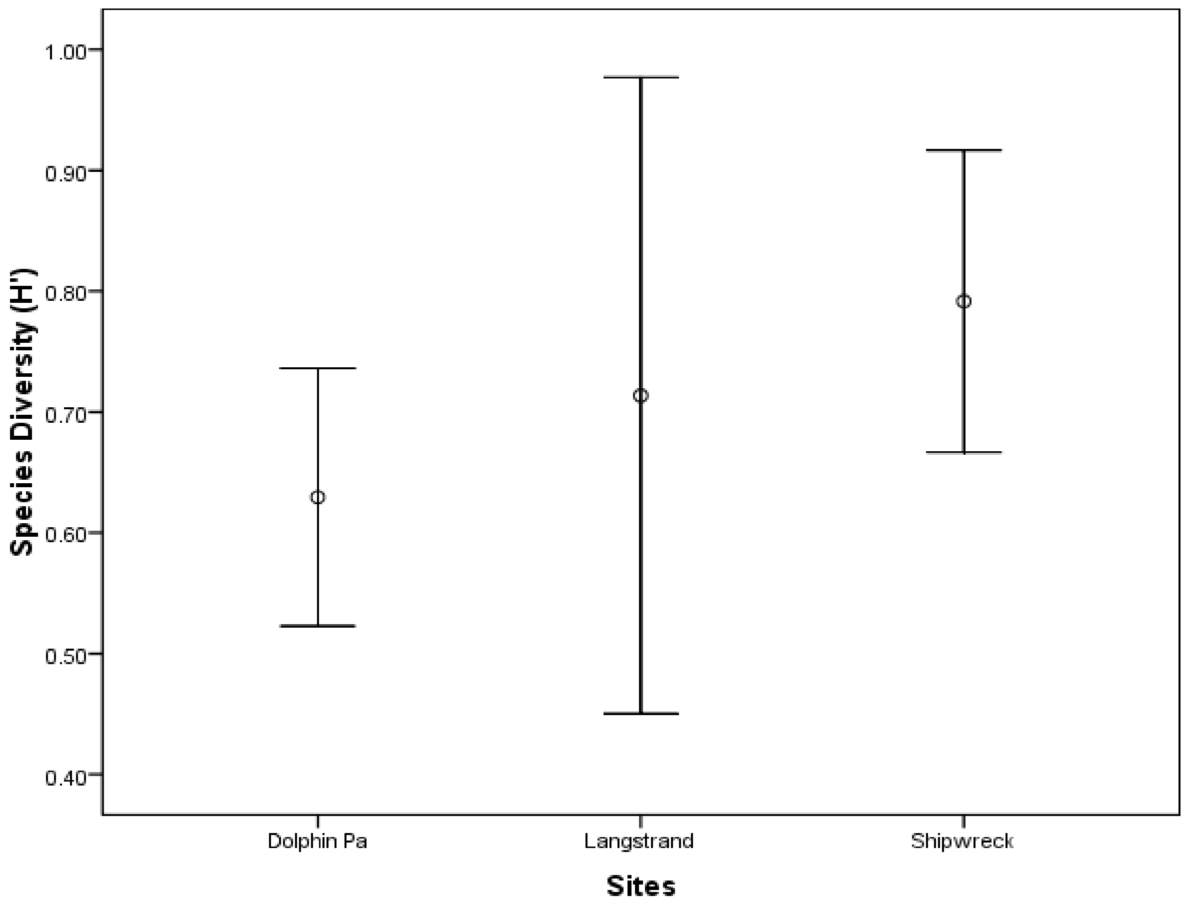

Figure 11: Comparison of mean species diversity at the three different sampling sites

The graph above shows changes in mean species diversity at the three different sampling sites. It is evident that there are no significant difference in the diversity of intertidal species found at the three sites ($p = 0.897$).

CHAPTER 4

4.1 DISCUSSION

4.1.1 Relative abundance

Generally, the abundance of intertidal species may vary as influenced by various factors such as competition, disturbance and their ability to withstand harsh environmental conditions as subjected to by continuous changes in tides. Although there were no significant difference observed in relative abundance of intertidal species at all three sampling sites it is evident that some species were dominant in certain area within the shoreline.

At Langstrand results showed a high abundance of *M. galloprovincialis* (Mediterranean mussels) and *Choromytilus meridionalis* (Black mussels) at the distances of 0m and 2.5m respectively, and a relatively high abundance at the 5m and 7.5m distances. This was also the only location or sampling site in which *Aulactinia reynaudi* (sea anemone) were found within the sampled quadrants, with relatively high abundances at 5m (mean abundance = 28.6%) and 7.5m (mean abundance = 29.3%) respectively. This could be due to the fact that Langstrand is characterized by deeper rock pools that are exposed to water for longer period of time and anemone require a substrate to which they can attach themselves. They can however be found at all three sampling site and along the Namibian coastline.

At Dolphin Park area high abundance of *M. galloprovincialis* (Mediterranean mussels) and *Choromytilus meridionalis* (Black mussels), were found particularly at the distances of 2.5m and 7.5m with mean abundance values of 71% and 72.3% respectively. *Chthamalus denatatus* (Barnacles) were also abundant in the Dolphin Park sampling site at with the highest abundance occurring at 0m and 5m respectively, with values of 30% and 37.7% respectively. *Chthamalus denatatus* (Barnacles) were in higher abundance when the abundance of mussels was lower, this is may be indication that the two organisms compete for habitat space on the rocky shore, and are not able to co-exist in high abundance. However it could also indicate that the sampling area at "Shipwreck" was a more conducive environment for Barnacles as they can survive with a little or limited exposure to water and a long duration of time exposed to sunlight. *Scutellastra granularis* (Granular Limpets) and *Perna perna* (Brown mussels) were in negligible amounts while sea anemones were absent within the quadrants sampled. They were however present in the Dolphin Park area.

The results for the Shipwreck area indicated an abundance of *Chthamalus denatatus* (Barnacles) at this sampling site, with mean abundance of over 50% at 0m at 5m, with values of 54.3% and 51.7% respectively. The abundance of *M. galloprovincialis* (Mediterranean mussels) and *Choromytilus meridionalis* (Black mussels) at decreased as the distance from the shoreline increased, reaching a low at the high water mark, 7.5m. Limpets were also found in relatively high abundance at 2.5m, with a mean abundance of 25.3%, while *Perna perna* (Brown Mussels) were found in low abundance at all the four distances.

The comparison of relative abundance of species between three sites was not significant and this might indicate that the three areas tend to be resilient to perturbation, and the effects on the natural environment will only be shown or evident if the impacts are severe and sustained over a long period of time (Molloy and Reinikainen, 2003). Another reason may be that the three areas are very similar in topographic orientation, creating similar environments and habitats at all three sites. This would result in the occurrence of similar organisms. In the comparison between the abundance of the species found at the three sampling sites, it was observed that Mediterranean mussels and Black mussels were generally the most abundant species in the three sampling sites, with the greatest abundance of this species being found at Dolphin Park. Barnacles are also in relatively high abundance across the three sampling sites, with the highest abundance of Barnacles being found at Shipwreck, followed by Dolphin Park.

One of the most dominant species is *M. galloprovincialis* (Mediterranean mussels) an alien species introduced to South Africa in the late 1970's that has spread to the Namibian shoreline and dominated the indigenous intertidal species (Barnard, P. 1998). It is thought that at the moment marine molluscs are one of the least endangered organisms with a greater reduction of their population coming from commercial exploitation, this could account for their high abundance along the Namibian coastline (Shanmugam, A. and Rajagopal, S., 2007). It is worth noting that the area with the highest abundance of Barnacles is also the sampling site with the lowest abundance of *M. galloprovincialis* (Mediterranean mussels) and *Choromytilus meridionalis* (Black mussels), which supports the earlier assumption that the two organisms may be directly competing for habitat space. *Scutellastra granularis* (Granular Limpets) are also in greater in abundance where *Chthamalus denatatus* (Barnacles) are in greater abundance, indicating a slightly positive correlation been the habitat preference of the two organisms.

4.1.2 Species Diversity

Although it can be expected species diversity to varies with regard to changes in distance along the transect and with sites due to changes in conditions (i.e. submersion), food availability and sites morphology and characteristic this was however not the observed pattern. With regard to sites this may imply that no particular site had generally different species composition, although the only relative difference observed is in the abundance of the organism, and the only presence of *Aulactinia reynaudi* (sea anemone) at the Long Beach sampling area, although this may be due to the sampling methods, as sea anemone is known to be found at all three sampling sites.

4.2 CONCLUSION

The human interaction that has occurred at the three sites, namely; the construction and housing developments in Long Beach, the removal of the ship wreckage, and the construction of a water park at the Dolphin Park sampling area have not had an effect on the species diversity when the three sites are compared. Most marine and coastal environments, especially those as dynamic as the Benguela current area, are very active and are resilient to human induced environmental impacts. The beaches and shores are also resilient but only to a certain extent; the impacts should not be overly severe. Although the duration of the study was short it clearly showed no significant difference in relative abundance and diversity of macro-fauna at the three sites, a further study, taking into account previous data collection, seasonal changes/patterns, human activity and environmental conditions, would help to identify whether or not this is due to resistance to perturbation, and whether human interaction has any long lasting effect on species diversity and abundance on the Namibian rocky shore.

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APPENDIX

Relative abundance

Table of results for the relative abundance across the three sampling sites

Site	Species	Distance (m)	Point	Relative Abundance (%)
Langstrand	Mediterranean/Black mussel	0	1	95
Langstrand	Brown mussels	0	1	0
Langstrand	Sea anemone	0	1	2
Langstrand	Barnacles	0	1	2
Langstrand	Limpets	0	1	0
Langstrand	Mediterranean/Black mussel	0	2	67
Langstrand	Brown mussels	0	2	15
Langstrand	Sea anemone	0	2	0
Langstrand	Barnacles	0	2	7
Langstrand	Limpets	0	2	0
Langstrand	Mediterranean/Black mussel	0	3	28
Langstrand	Brown mussels	0	3	9
Langstrand	Sea anemone	0	3	0
Langstrand	Barnacles	0	3	54
Langstrand	Limpets	0	3	8
Langstrand	Mediterranean/Black mussel	2.5	1	98
Langstrand	Brown mussels	2.5	1	0
Langstrand	Sea anemone	2.5	1	0
Langstrand	Barnacles	2.5	1	1
Langstrand	Limpets	2.5	1	1
Langstrand	Mediterranean/Black mussel	2.5	2	56
Langstrand	Brown mussels	2.5	2	35
Langstrand	Sea anemone	2.5	2	0
Langstrand	Barnacles	2.5	2	9
Langstrand	Limpets	2.5	2	0
Langstrand	Mediterranean/Black mussel	2.5	3	43
Langstrand	Brown mussels	2.5	3	2
Langstrand	Sea anemone	2.5	3	0
Langstrand	Barnacles	2.5	3	8

Langstrand	Limpets	2.5	3	5
Langstrand	Mediterranean/Black mussel	5	1	54
Langstrand	Brown mussels	5	1	0
Langstrand	Sea anemone	5	1	15
Langstrand	Barnacles	5	1	0
Langstrand	Limpets	5	1	0
Langstrand	Mediterranean/Black mussel	5	2	44
Langstrand	Brown mussels	5	2	31
Langstrand	Sea anemone	5	2	25
Langstrand	Barnacles	5	2	0
Langstrand	Limpets	5	2	0
Langstrand	Mediterranean/Black mussel	5	3	30
Langstrand	Brown mussels	5	3	3
Langstrand	Sea anemone	5	3	46
Langstrand	Barnacles	5	3	4
Langstrand	Limpets	5	3	12
Langstrand	Mediterranean/Black mussel	7.5	1	43
Langstrand	Brown mussels	7.5	1	0
Langstrand	Sea anemone	7.5	1	0
Langstrand	Barnacles	7.5	1	0
Langstrand	Limpets	7.5	1	0
Langstrand	Mediterranean/Black mussel	7.5	2	48
Langstrand	Brown mussels	7.5	2	8
Langstrand	Sea anemone	7.5	2	40
Langstrand	Barnacles	7.5	2	4
Langstrand	Limpets	7.5	2	0
Langstrand	Mediterranean/Black mussel	7.5	3	35
Langstrand	Brown mussels	7.5	3	4
Langstrand	Sea anemone	7.5	3	48
Langstrand	Barnacles	7.5	3	0
Langstrand	Limpets	7.5	3	0
Langstrand	Mediterranean/Black mussel	10	1	*
Langstrand	Brown mussels	10	1	*
Langstrand	Sea anemone	10	1	*

Langstrand	Barnacles	10	1	*
Langstrand	Limpets	10	1	*
Langstrand	Mediterranean/Black mussel	10	2	18
Langstrand	Brown mussels	10	2	0
Langstrand	Sea anemone	10	2	0
Langstrand	Barnacles	10	2	80
Langstrand	Limpets	10	2	0
Langstrand	Mediterranean/Black mussel	10	3	24
Langstrand	Brown mussels	10	3	0
Langstrand	Sea anemone	10	3	0
Langstrand	Barnacles	10	3	73
Langstrand	Limpets	10	3	0
Langstrand	Mediterranean/Black mussel	12.5	1	*
Langstrand	Brown mussels	12.5	1	*
Langstrand	Sea anemone	12.5	1	*
Langstrand	Barnacles	12.5	1	*
Langstrand	Limpets	12.5	1	*
Langstrand	Mediterranean/Black mussel	12.5	2	13
Langstrand	Brown mussels	12.5	2	0
Langstrand	Sea anemone	12.5	2	52
Langstrand	Barnacles	12.5	2	0
Langstrand	Limpets	12.5	2	0
Langstrand	Mediterranean/Black mussel	12.5	3	*
Langstrand	Brown mussels	12.5	3	*
Langstrand	Sea anemone	12.5	3	*
Langstrand	Barnacles	12.5	3	*
Langstrand	Limpets	12.5	3	*
Langstrand	Mediterranean/Black mussel	15	1	*
Langstrand	Brown mussels	15	1	*
Langstrand	Sea anemone	15	1	*
Langstrand	Barnacles	15	1	*
Langstrand	Limpets	15	1	*
Langstrand	Mediterranean/Black mussel	15	2	5
Langstrand	Brown mussels	15	2	0

Langstrand	Sea anemone	15	2	0
Langstrand	Barnacles	15	2	34
Langstrand	Limpets	15	2	0
Langstrand	Mediterranean/Black mussel	15	3	*
Langstrand	Brown mussels	15	3	*
Langstrand	Sea anemone	15	3	*
Langstrand	Barnacles	15	3	*
Langstrand	Limpets	15	3	*
Langstrand	Mediterranean/Black mussel	17.5	1	*
Langstrand	Brown mussels	17.5	1	*
Langstrand	Sea anemone	17.5	1	*
Langstrand	Barnacles	17.5	1	*
Langstrand	Limpets	17.5	1	*
Langstrand	Mediterranean/Black mussel	17.5	2	0
Langstrand	Brown mussels	17.5	2	0
Langstrand	Sea anemone	17.5	2	0
Langstrand	Barnacles	17.5	2	26
Langstrand	Limpets	17.5	2	9
Langstrand	Mediterranean/Black mussel	17.5	3	*
Langstrand	Brown mussels	17.5	3	*
Langstrand	Sea anemone	17.5	3	*
Langstrand	Barnacles	17.5	3	*
Langstrand	Limpets	17.5	3	*
Dolphin Park	Mediterranean/Black mussel	0	1	75
Dolphin Park	Brown mussels	0	1	10
Dolphin Park	Sea anemone	0	1	0
Dolphin Park	Barnacles	0	1	5
Dolphin Park	Limpets	0	1	2
Dolphin Park	Mediterranean/Black mussel	0	2	13
Dolphin Park	Brown mussels	0	2	0
Dolphin Park	Sea anemone	0	2	0

Dolphin Park	Barnacles	0	2	85
Dolphin Park	Limpets	0	2	2
Dolphin Park	Mediterranean/Black mussel	0	3	92
Dolphin Park	Brown mussels	0	3	8
Dolphin Park	Sea anemone	0	3	0
Dolphin Park	Barnacles	0	3	0
Dolphin Park	Limpets	0	3	0
Dolphin Park	Mediterranean/Black mussel	2.5	1	75
Dolphin Park	Brown mussels	2.5	1	5
Dolphin Park	Sea anemone	2.5	1	0
Dolphin Park	Barnacles	2.5	1	18
Dolphin Park	Limpets	2.5	1	0
Dolphin Park	Mediterranean/Black mussel	2.5	2	69
Dolphin Park	Brown mussels	2.5	2	1
Dolphin Park	Sea anemone	2.5	2	0
Dolphin Park	Barnacles	2.5	2	30
Dolphin Park	Limpets	2.5	2	0
Dolphin Park	Mediterranean/Black mussel	2.5	3	69
Dolphin Park	Brown mussels	2.5	3	13
Dolphin Park	Sea anemone	2.5	3	0
Dolphin Park	Barnacles	2.5	3	15
Dolphin Park	Limpets	2.5	3	3
Dolphin Park	Mediterranean/Black mussel	5	1	60

Dolphin Park	Brown mussels	5	1	2
Dolphin Park	Sea anemone	5	1	0
Dolphin Park	Barnacles	5	1	33
Dolphin Park	Limpets	5	1	3
Dolphin Park	Mediterranean/Black mussel	5	2	28
Dolphin Park	Brown mussels	5	2	0
Dolphin Park	Sea anemone	5	2	0
Dolphin Park	Barnacles	5	2	72
Dolphin Park	Limpets	5	2	0
Dolphin Park	Mediterranean/Black mussel	5	3	55
Dolphin Park	Brown mussels	5	3	3
Dolphin Park	Sea anemone	5	3	0
Dolphin Park	Barnacles	5	3	8
Dolphin Park	Limpets	5	3	0
Dolphin Park	Mediterranean/Black mussel	7.5	1	76
Dolphin Park	Brown mussels	7.5	1	2
Dolphin Park	Sea anemone	7.5	1	0
Dolphin Park	Barnacles	7.5	1	22
Dolphin Park	Limpets	7.5	1	0
Dolphin Park	Mediterranean/Black mussel	7.5	2	83
Dolphin Park	Brown mussels	7.5	2	8
Dolphin Park	Sea anemone	7.5	2	0
Dolphin Park	Barnacles	7.5	2	7

Dolphin Park	Limpets	7.5	2	0
Dolphin Park	Mediterranean/Black mussel	7.5	3	58
Dolphin Park	Brown mussels	7.5	3	2
Dolphin Park	Sea anemone	7.5	3	0
Dolphin Park	Barnacles	7.5	3	36
Dolphin Park	Limpets	7.5	3	0
Dolphin Park	Mediterranean/Black mussel	10	1	19
Dolphin Park	Brown mussels	10	1	0
Dolphin Park	Sea anemone	10	1	0
Dolphin Park	Barnacles	10	1	81
Dolphin Park	Limpets	10	1	0
Dolphin Park	Mediterranean/Black mussel	10	2	82
Dolphin Park	Brown mussels	10	2	4
Dolphin Park	Sea anemone	10	2	0
Dolphin Park	Barnacles	10	2	13
Dolphin Park	Limpets	10	2	0
Dolphin Park	Mediterranean/Black mussel	10	3	55
Dolphin Park	Brown mussels	10	3	0
Dolphin Park	Sea anemone	10	3	0
Dolphin Park	Barnacles	10	3	42
Dolphin Park	Limpets	10	3	0
Dolphin Park	Mediterranean/Black mussel	12.5	1	4
Dolphin Park	Brown mussels	12.5	1	0

Dolphin Park	Sea anemone	12.5	1	0
Dolphin Park	Barnacles	12.5	1	90
Dolphin Park	Limpets	12.5	1	6
Dolphin Park	Mediterranean/Black mussel	12.5	2	*
Dolphin Park	Brown mussels	12.5	2	*
Dolphin Park	Sea anemone	12.5	2	*
Dolphin Park	Barnacles	12.5	2	*
Dolphin Park	Limpets	12.5	2	*
Dolphin Park	Mediterranean/Black mussel	12.5	3	38
Dolphin Park	Brown mussels	12.5	3	0
Dolphin Park	Sea anemone	12.5	3	0
Dolphin Park	Barnacles	12.5	3	6
Dolphin Park	Limpets	12.5	3	0
Dolphin Park	Mediterranean/Black mussel	15	1	72
Dolphin Park	Brown mussels	15	1	1
Dolphin Park	Sea anemone	15	1	2
Dolphin Park	Barnacles	15	1	25
Dolphin Park	Limpets	15	1	0
Dolphin Park	Mediterranean/Black mussel	15	2	*
Dolphin Park	Brown mussels	15	2	*
Dolphin Park	Sea anemone	15	2	*
Dolphin Park	Barnacles	15	2	*
Dolphin Park	Limpets	15	2	*

Dolphin Park	Mediterranean/Black mussel	15	3	*
Dolphin Park	Brown mussels	15	3	*
Dolphin Park	Sea anemone	15	3	*
Dolphin Park	Barnacles	15	3	*
Dolphin Park	Limpets	15	3	*
Dolphin Park	Mediterranean/Black mussel	17.5	1	33
Dolphin Park	Brown mussels	17.5	1	0
Dolphin Park	Sea anemone	17.5	1	0
Dolphin Park	Barnacles	17.5	1	77
Dolphin Park	Limpets	17.5	1	0
Dolphin Park	Mediterranean/Black mussel	17.5	2	*
Dolphin Park	Brown mussels	17.5	2	*
Dolphin Park	Sea anemone	17.5	2	*
Dolphin Park	Barnacles	17.5	2	*
Dolphin Park	Limpets	17.5	2	*
Dolphin Park	Mediterranean/Black mussel	17.5	3	*
Dolphin Park	Brown mussels	17.5	3	*
Dolphin Park	Sea anemone	17.5	3	*
Dolphin Park	Barnacles	17.5	3	*
Dolphin Park	Limpets	17.5	3	*
Shipwreck	Mediterranean/Black mussel	0	1	15
Shipwreck	Brown mussels	0	1	0
Shipwreck	Sea anemone	0	1	0
Shipwreck	Barnacles	0	1	69

Shipwreck	Limpets	0	1	12
Shipwreck	Mediterranean/Black mussel	0	2	36
Shipwreck	Brown mussels	0	2	8
Shipwreck	Sea anemone	0	2	0
Shipwreck	Barnacles	0	2	47
Shipwreck	Limpets	0	2	5
Shipwreck	Mediterranean/Black mussel	0	3	42
Shipwreck	Brown mussels	0	3	5
Shipwreck	Sea anemone	0	3	0
Shipwreck	Barnacles	0	3	41
Shipwreck	Limpets	0	3	8
Shipwreck	Mediterranean/Black mussel	2.5	1	42
Shipwreck	Brown mussels	2.5	1	5
Shipwreck	Sea anemone	2.5	1	0
Shipwreck	Barnacles	2.5	1	0
Shipwreck	Limpets	2.5	1	6
Shipwreck	Mediterranean/Black mussel	2.5	2	15
Shipwreck	Brown mussels	2.5	2	7
Shipwreck	Sea anemone	2.5	2	0
Shipwreck	Barnacles	2.5	2	6
Shipwreck	Limpets	2.5	2	56
Shipwreck	Mediterranean/Black mussel	2.5	3	7
Shipwreck	Brown mussels	2.5	3	1
Shipwreck	Sea anemone	2.5	3	0
Shipwreck	Barnacles	2.5	3	53
Shipwreck	Limpets	2.5	3	14
Shipwreck	Mediterranean/Black mussel	5	1	5
Shipwreck	Brown mussels	5	1	0
Shipwreck	Sea anemone	5	1	0
Shipwreck	Barnacles	5	1	48
Shipwreck	Limpets	5	1	4
Shipwreck	Mediterranean/Black mussel	5	2	13
Shipwreck	Brown mussels	5	2	2
Shipwreck	Sea anemone	5	2	0

Shipwreck	Barnacles	5	2	73
Shipwreck	Limpets	5	2	9
Shipwreck	Mediterranean/Black mussel	5	3	6
Shipwreck	Brown mussels	5	3	2
Shipwreck	Sea anemone	5	3	0
Shipwreck	Barnacles	5	3	34
Shipwreck	Limpets	5	3	8
Shipwreck	Mediterranean/Black mussel	7.5	1	3
Shipwreck	Brown mussels	7.5	1	0
Shipwreck	Sea anemone	7.5	1	0
Shipwreck	Barnacles	7.5	1	15
Shipwreck	Limpets	7.5	1	1
Shipwreck	Mediterranean/Black mussel	7.5	2	2
Shipwreck	Brown mussels	7.5	2	0
Shipwreck	Sea anemone	7.5	2	0
Shipwreck	Barnacles	7.5	2	76
Shipwreck	Limpets	7.5	2	12
Shipwreck	Mediterranean/Black mussel	7.5	3	2
Shipwreck	Brown mussels	7.5	3	7
Shipwreck	Sea anemone	7.5	3	0
Shipwreck	Barnacles	7.5	3	26
Shipwreck	Limpets	7.5	3	0
Shipwreck	Mediterranean/Black mussel	10	1	*
Shipwreck	Brown mussels	10	1	*
Shipwreck	Sea anemone	10	1	*
Shipwreck	Barnacles	10	1	*
Shipwreck	Limpets	10	1	*
Shipwreck	Mediterranean/Black mussel	10	2	*
Shipwreck	Brown mussels	10	2	*
Shipwreck	Sea anemone	10	2	*
Shipwreck	Barnacles	10	2	*
Shipwreck	Limpets	10	2	*
Shipwreck	Mediterranean/Black mussel	10	3	8
Shipwreck	Brown mussels	10	3	5

Shipwreck	Sea anemone	10	3	0
Shipwreck	Barnacles	10	3	18
Shipwreck	Limpets	10	3	2
Shipwreck	Mediterranean/Black mussel	12.5	1	*
Shipwreck	Brown mussels	12.5	1	*
Shipwreck	Sea anemone	12.5	1	*
Shipwreck	Barnacles	12.5	1	*
Shipwreck	Limpets	12.5	1	*
Shipwreck	Mediterranean/Black mussel	12.5	2	*
Shipwreck	Brown mussels	12.5	2	*
Shipwreck	Sea anemone	12.5	2	*
Shipwreck	Barnacles	12.5	2	*
Shipwreck	Limpets	12.5	2	*
Shipwreck	Mediterranean/Black mussel	12.5	3	24
Shipwreck	Brown mussels	12.5	3	11
Shipwreck	Sea anemone	12.5	3	0
Shipwreck	Barnacles	12.5	3	19
Shipwreck	Limpets	12.5	3	8
Shipwreck	Mediterranean/Black mussel	15	1	*
Shipwreck	Brown mussels	15	1	*
Shipwreck	Sea anemone	15	1	*
Shipwreck	Barnacles	15	1	*
Shipwreck	Limpets	15	1	*
Shipwreck	Mediterranean/Black mussel	15	2	*
Shipwreck	Brown mussels	15	2	*
Shipwreck	Sea anemone	15	2	*
Shipwreck	Barnacles	15	2	*
Shipwreck	Limpets	15	2	*
Shipwreck	Mediterranean/Black mussel	15	3	13
Shipwreck	Brown mussels	15	3	4
Shipwreck	Sea anemone	15	3	0
Shipwreck	Barnacles	15	3	57
Shipwreck	Limpets	15	3	8
Shipwreck	Mediterranean/Black mussel	17.5	1	*

Shipwreck	Brown mussels	17.5	1	*
Shipwreck	Sea anemone	17.5	1	*
Shipwreck	Barnacles	17.5	1	*
Shipwreck	Limpets	17.5	1	*
Shipwreck	Mediterranean/Black mussel	17.5	2	*
Shipwreck	Brown mussels	17.5	2	*
Shipwreck	Sea anemone	17.5	2	*
Shipwreck	Barnacles	17.5	2	*
Shipwreck	Limpets	17.5	2	*
Shipwreck	Mediterranean/Black mussel	17.5	3	*
Shipwreck	Brown mussels	17.5	3	*
Shipwreck	Sea anemone	17.5	3	*
Shipwreck	Barnacles	17.5	3	*
Shipwreck	Limpets	17.5	3	*

Genstat output

Table: Analysis of variance of the relative abundance of the difference species at distances from 0m to 7.5m at the three different sites

***** Analysis of variance *****

Variate: Relative Abundance_%

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Site	2	768.7	384.3	0.60	0.548
Distance_m	3	461.2	153.7	0.24	0.867
Site.Distance_m	6	394.6	65.8	0.10	0.996
Residual	168	106897.1	636.3		
Total	179	108521.5			

Table: Table of means for the relative abundance from 0m to 7.5m

***** Tables of means *****

Variate: Relative Abundance_%

Grand mean 16.9

Site	Dolphin Park	Langstrand	Shipwreck
	19.1	17.3	14.1

Distance_m	0.00	2.50	5.00	7.50
	19.3	17.1	16.3	14.8

Site	Distance_m 0.00	2.50	5.00	7.50
Dolphin Park	19.5	19.9	17.6	19.6
Langstrand	19.1	17.2	17.6	15.3
Shipwreck	19.2	14.1	13.6	9.6

Species diversity

Table of results for the species diversity across the three sampling sites

Site	Distance	Point	Species Diversity
Langstrand	0	1	0.198
Langstrand	0	2	0.714
Langstrand	0	3	1.109
Langstrand	2.5	1	0.112
Langstrand	2.5	2	0.909
Langstrand	2.5	3	0.822
Langstrand	5	1	0.524
Langstrand	5	2	1.071
Langstrand	5	3	1.218
Langstrand	7.5	1	0.000
Langstrand	7.5	2	1.050
Langstrand	7.5	3	0.836
Langstrand	10	1	*
Langstrand	10	2	0.477
Langstrand	10	3	0.560
Langstrand	12.5	1	*
Langstrand	12.5	2	0.501
Langstrand	12.5	3	*

Langstrand	15	1	*
Langstrand	15	2	0.383
Langstrand	15	3	*
Langstrand	17.5	1	*
Langstrand	17.5	2	0.570
Langstrand	17.5	3	*
Dolphin Park	0	1	0.649
Dolphin Park	0	2	0.481
Dolphin Park	0	3	0.278
Dolphin Park	2.5	1	0.668
Dolphin Park	2.5	2	0.663
Dolphin Park	2.5	3	0.911
Dolphin Park	5	1	0.853
Dolphin Park	5	2	0.593
Dolphin Park	5	3	0.549
Dolphin Park	7.5	1	0.62
Dolphin Park	7.5	2	0.535
Dolphin Park	7.5	3	0.753
Dolphin Park	10	1	0.487
Dolphin Park	10	2	0.553
Dolphin Park	10	3	0.684
Dolphin Park	12.5	1	0.393
Dolphin Park	12.5	2	*
Dolphin Park	12.5	3	0.399
Dolphin Park	15	1	0.709
Dolphin	15	2	*

Park			
Dolphin Park	15	3	*
Dolphin Park	17.5	1	0.567
Dolphin Park	17.5	2	*
Dolphin Park	17.5	3	*
Shipwreck	0	1	0.767
Shipwreck	0	2	1.079
Shipwreck	0	3	1.086
Shipwreck	2.5	1	0.654
Shipwreck	2.5	2	0.974
Shipwreck	2.5	3	0.837
Shipwreck	5	1	0.544
Shipwreck	5	2	0.784
Shipwreck	5	3	0.938
Shipwreck	7.5	1	0.633
Shipwreck	7.5	2	0.497
Shipwreck	7.5	3	0.707
Shipwreck	10	1	*
Shipwreck	10	2	*
Shipwreck	10	3	1.084
Shipwreck	12.5	1	*
Shipwreck	12.5	2	*
Shipwreck	12.5	3	1.300
Shipwreck	15	1	*
Shipwreck	15	2	*
Shipwreck	15	3	0.919
Shipwreck	17.5	1	*
Shipwreck	17.5	2	*
Shipwreck	17.5	3	*

Table: Analysis of variance of the species diversity at distances from 0m to 7.5m at the three different sites

***** Analysis of variance *****

Variate: Species Diversity

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Distance	3	0.11884	0.03961	0.45	0.716
Site	2	0.15802	0.07901	0.91	0.417
Distance. Site	6	0.41684	0.06947	0.80	0.581
Residual	24	2.08973	0.08707		
Total	35	2.78344			

Table: Table of means for the species diversity at distances from 0m to 7.5m at the three different sites

***** Tables of means *****

Variate: Species Diversity

Grand mean 0.712

Distance	0.00	2.50	5.00	7.50
	0.707	0.728	0.786	0.626

Site	Dolphin Park	Langstrand	Shipwreck
	0.629	0.714	0.792

Distance	Site Dolphin Park	Langstrand	Shipwreck
0.00	0.469	0.674	0.977
2.50	0.747	0.614	0.822
5.00	0.665	0.938	0.755
7.50	0.636	0.629	0.612

SPSS output

Table: One-Sample Kolmogorov-Smirnov Test

		Diversity Langstrand
N		12
Normal Parameters	Mean	.71358
	Std. Deviation	.414456
Most Extreme Differences	Absolute	.187
	Positive	.143
	Negative	-.187
Kolmogorov-Smirnov Z		.646
Asymp. Sig. (2-tailed)		.798

a. Test distribution is Normal.

					95% Confidence Interval for Mean			
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
0	3	.67367	.456837	.263755	-.46118	1.80851	.198	1.109
2.5	3	.61433	.437203	.252419	-.47174	1.70041	.112	.909
5	3	.93767	.365708	.211142	.02920	1.84614	.524	1.218
7.5	3	.62867	.554856	.320346	-.74967	2.00701	.000	1.050
Total	12	.71358	.414456	.119643	.45025	.97692	.000	1.218

DIVERISTY					
	Sum of Squares	d.f.	Mean Square	F	Sig.
Between Groups	.207	3	.069	.327	.806
Within Groups	1.683	8	.210		
Total	1.890	11			

Table: descriptive statistics of the species diversity data for Dolphin Park

	N	Mean	Std. Deviation	Minimum	Maximum
Diversity dolphin park	12	.6294	.16784	.28	.91

Table: One-Sample Kolmogorov-Smirnov Test

		Diversity Dolphin Park
N		12
Normal Parameters	Mean	.6294
	Std. Deviation	.16784

Most Extreme Differences	Absolute	.159
	Positive	.159
	Negative	-.120
Kolmogorov-Smirnov Z		.551
Asymp. Sig. (2-tailed)		.922

a. Test distribution is Normal.

The table above table shows that the data is normally distributed as the p value is greater than 0.05

Table: Descriptive statistics for Dolphin Park species diversity data

					95% Confidence Interval for Mean			
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
0	3	.4693	.18577	.10726	.0078	.9308	.28	.65
2.5	3	.7473	.14176	.08185	.3952	1.0995	.66	.91
5	3	.6650	.16429	.09485	.2569	1.0731	.55	.85
7.5	3	.6360	.10988	.06344	.3630	.9090	.54	.75
Total	12	.6294	.16784	.04845	.5228	.7361	.28	.91

Table: Analysis of variance table for Species diversity at Dolphin Park

Diversity

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.123	3	.041	1.744	.235
Within Groups	.187	8	.023		
Total	.310	11			

Table: descriptive statistics of the species diversity data for Shipwreck

	N	Mean	Std. Deviation	Minimum	Maximum
diversity ship	12	.7914	.19702	.50	1.09

Table 9: One-Sample Kolmogorov-Smirnov Test

		diversity ship
N		12
Normal Parameters	Mean	.7914

	Std. Deviation	.19702
Most Extreme Differences	Absolute	.105
	Positive	.098
	Negative	-.105
Kolmogorov-Smirnov Z		.363
Asymp. Sig. (2-tailed)		.999

a. Test distribution is Normal.

The above table shows that the data collected at Shipwreck for the species diversity is normally distributed with a p value of 0.999

Table: Descriptive statistics for Shipwreck species diversity data

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
0	3	.9773	.18219	.10519	.5248	1.4299	.77	1.09
2.5	3	.8217	.16055	.09269	.4228	1.2205	.65	.97
5	3	.7553	.19856	.11464	.2621	1.2486	.54	.94
7.5	3	.6113	.10624	.06134	.3474	.8752	.50	.71
Total	12	.7914	.19702	.05688	.6662	.9166	.50	1.09

Table: Analysis of Variance table for Species diversity at Shipwreck

Diversity

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.208	3	.069	2.524	.131
Within Groups	.219	8	.027		
Total	.427	11			

Table: One-Sample Kolmogorov-Smirnov Test

		diversity
N		36
Normal Parameters	Mean	.7116
	Std. Deviation	.28201
Most Extreme Differences	Absolute	.096
	Positive	.052
	Negative	-.096
Kolmogorov-Smirnov Z		.574
Asymp. Sig. (2-tailed)		.897

a. Test distribution is Normal.