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Lembeh Resort – House Reef Project

Introduction

Over the six week period from 10th October to 22nd November 2009, I conducted over 30 dives observing, cleaning and helping reconstruct parts of the Lembeh Resort House Reef. When I arrived at the resort, there were seven man made reef structures increasing the structural complexity of the reef. An eighth was put in place on my first day. These structures include three Biorocks (pagoda, dome and tunnel), reef balls (18), fish houses (23), the 'fish net', a small wreck, and the new concrete blocks (7).
Over my six week stay in Lembeh Resort my activities included; transplantation of 50+ coral and sponge colonies from the reef to the fishnet, new concrete blocks, several fish houses and all three Biorocks; cleaning algae, colonial ascidian, and the purple coral eating sponge *Nara nemifatera,* from the three Biorocks; rubbish pickup in the House Reef, at local dive sites and for PADI 'clean up the ocean' day in a bay close by; adding the new concrete blocks to the reef; tying a network of ropes on the new concrete blocks to increase stability and structural complexity; and completing a study on the species composition of the artificial structures in Lembeh Resort House Reef.

Species Composition

I have completed a species composition of all the artificial structures on the House Reef. The aim of this study was to give a baseline of the Lembeh Resort House Reef inhabitants as of October/November 2009, and to act as a reference for future studies concerning the change in species composition of the artificial reef structures in Lembeh Resort House Reef.

Materials

- scuba gear
- underwater slate
- pencil
- species identification reference books

Methods

At every site I recorded the name and number of every animal I could see. If I did not know the name I would write a description or draw a picture and find it in the reference books as soon as the dive was over. I would only record those animals associated with the structure being assessed (eg. Hiding in or eating from the structure), not those that just drift past (eg. A passing school of fish). Some larger structures were first divided in half or thirds and then analysed.
In my analysis I used population (total number of animals present), family abundance (total number of families present) and species abundance (total number of species present) as indicators of structure effectiveness to attract animal life. Due to the many differences in size, shape, depth, location and materials used to make the artificial structures it is difficult to compare the differences in results between structures as there

are too many varying factors. My conclusions from these results therefore are quite broad but hopefully informative.

Current State of Lembeh Resort House Reef Project and discussion of the Species composition.

Biorocks

Description

There are three Biorock structures (Tunnel, Dome and Pagoda) submerged in 5.5 to 7.5 meters depth about 50 meters NW of the Lembeh Resort shore. They were installed in December 2007 so had had just under two years to establish before this study. A Biorock is a steel metal matrix frame with a low voltage electricity current running from a battery source through underwater cables, anodes and finally to the Biorocks. This provides the structure with energy that attracts minerals dissolved in the seawater like calcium carbonate and magnesium hydroxide. These minerals accrete on the steel structure and create a layer of minerals on the outside which we call a Biorock or 'living rock'. This also increases the accretion of these materials on the transplanted and naturally settled corals, and so increases their growth and survival.

Current State

When I arrived at Lembeh Resort the electicity current ran from 8am to 5pm, by being switched on and off at the start and end of the working day. By my fourth week the electricity circuit had failed and the battery had run out. Once the battery was replaced we realized that there was an issue with the current reaching the Biorocks. Although we could not pinpoint the issue we think it was some problem with the underwater cable. Due to expense and lack of knowledge of what exactly was wrong, we chose to leave the Biorock as is, because the corals appeared to be surviving well without the electricity. Structures have not been in place for long enough to provide a sufficient amount of growth to act similarly to a natural reef system, even with the aid of coral transplants. However there is a pleasant amount of life already inhabiting the area.

Species Composition Discussion

The Biorocks have the highest species abundance out of all the artificial reef structures. These include some species of Ribbon Eel, Blue Spotted Rays, Coral Crab, Hovering Gobies, Trumpetfish, Spadefish, Seastars and many more. Out of the three structures the dome represents the greatest species and family abundance but not the greatest population. The reason behind this is most likely due to the larger size of this structure and not the shape itself. It is in slightly deeper water but not so much that it would make a major difference to the species composition. The tunnel structure has the highest population with the main contributors being small coral hovering gobies and coral crabs.

The pagoda represents the smallest population and species and family abundance most likely because of its significantly smaller size. The complexity of the structure does appear to increase the number of creatures associated with it. Based on further

observations I think when the data was taken there were significantly fewer animals present than the true number associated with the Pagoda.
I completed both sponge and coral transplants on all three structures, which have so far been successful (although it is too early to ensure continued survival). There is still much room for more transplants especially once more of the unsuccessful transplants have been removed. Also there is a significant amount of naturally settled coral growing on the tunnel structure. The greatest threat to the survival of these small corals and that of the transplanted corals is the presence of the purple, encrusting, coral eating sponge, *Nara Nematifera.* This sponge continuously outcompetes the transplanted and naturally settled coral on all three Biorocks. It tends to first grow where there is no coral and little light, typically on the undersides of new Pocilpora sp.. It will then expand, first growing over the underside of the coral where it is difficult to see and clean. This sponge is especially destructive to newly settled coral and appears to be most active on the tunnel structure, although this could easily and quickly change.

Maintenance and future suggestions

Nara Nematifera should be cleaned from the Biorock as often as possible. Care must be taken when cleaning it off the coral itself as the polyps are extremely fragile. A toothbrush and wire brush proved to be the most effective tools. The structures should be cleaned thoroughly at least once a month to ensure survival of the coral.
Observation is critical to indicate if cleaning is necessary more often.
Coral transplants are surviving quite well here and should be continued as well as the removal of the unsuccessful corals.
Repair of the electric current is ideal although as the corals appear to be healthy there is no immediate urgency.

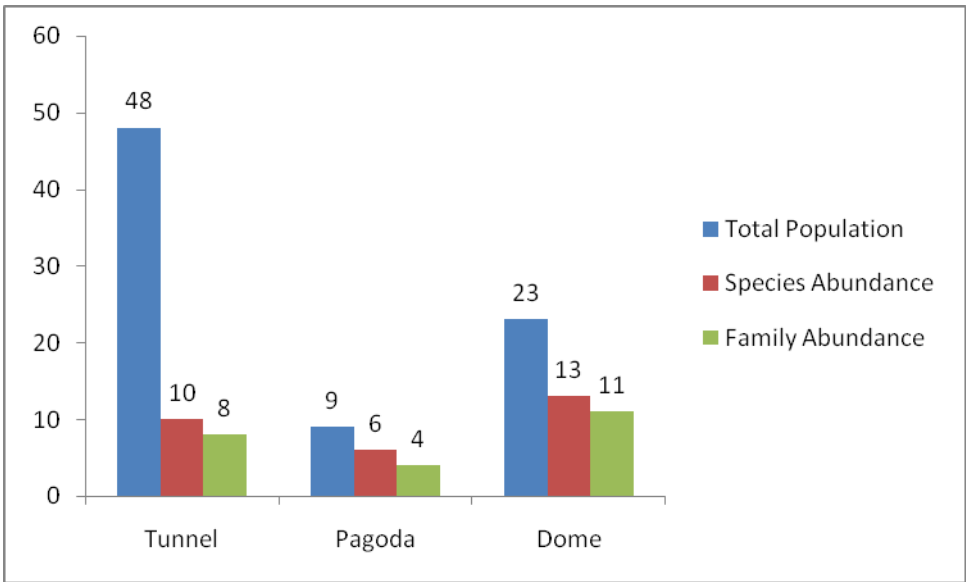

Figure 1; Histogram of the total population, species abundance and family abundance of the three Biorocks located at Lembeh Resort House Reef, Lembeh Island, Sulawesi, Indonesia.

Wreck

Description

A small wooden boat was sunk in about 25m depth on December 2007, representing the deepest artificial reef structure of the Lembeh Resort House Reef Project. The boat is approximately 12 meters long and was previously used as a village fishing boat. There is also one horizontal rope and four vertical ropes placed in close proximity to the wreck. These ropes are purposely too short to reach the surface so that fishing boats will not moor on them and fish on the House Reef. They were created to attract squid to the house reef by resembling a good egg laying environment. In my time here I have not seen any eggs on the ropes, however I am told they have been laid on them in previous years.

Current State

Some of the wooden planks are falling off the main structure decreasing its stability. Little benthic marine life has established on this structure, however considering the depth and the high level of sedimentation it is expected that little or no macro-algae will grow and even less coral. Having said this there is some benthic life such as ascidians, sponges, and wood boring organisms which are surviving quite well.

Species Composition Discussion

Schooling fish are attracted here, which accounts for the remarkably high population. There is a resident school of cardinalfish (*Archamia goni*) with 900 plus members, as well as regular passing schools of sweetlip (*Plectorhincus flavomaculatus*) and catfish (*Plototus lineatus*). The species and family abundance is not so high, however considering the level of benthic growth and complexity there is a lot of life associated with this structure. The species I have seen here include broadclub cuttlefish (*Sepia latimanus*), puffer fish (*Arothron* sp.), cowfish (*Lactoria fornasisi*) plus many more.

Maintenance and future suggestions

The shipwreck is slowly and naturally establishing itself. Although it is falling apart a little bit, I suggest it is best left to its own devices, and at this point maintenance need only include observation.

Fish Net and Washing Machines

Description

Four washing machines sit in approximately 17m depth in between the Biorocks and the wreck. Between the washing machines is strung a series of ropes crossed over each other forming a net like matrix (hence the name fishnet).

Species Composition

This structure had the lowest population of all the artificial reef structures in the Lembeh Resort House Reef Project. It is comprised of only eight individual animals which also accounted for the low species abundance of the structure. This was most

likely due to the spaciousness and the lack of complexity of the structure. Following my study approximately 25 sponge transplants were attached to this structure to attempt to increase the number of inhabitants of the area. It will take time for these transplants to establish however they do appear to be working as the population more than doubled overnight. It will be interesting to see whether the animals quickly attracted to this area are passing opportunists or lifelong migrants.

Maintenance and future suggestions

As the sponge transplants have survived well so far, I suggest more should be transplanted although not too many that they must compete for space. Otherwise the structure is doing well.

Reef Balls

Description

Two sets of concrete balls are situated north of the Biorocks. They are all hollow spheres with a large hole on the top and several around the sides to increase structural complexity. All balls are approximately one meter in diameter. They are made with coarse grain cement which is a good substrate for the successful settlement of coral larvae. One set consists of 8 balls in about 16-17.5 meters. The second set is approximately 20 meters north of the first and consists of 10 balls in about 17.5-19 meters. There are also several balls randomly scattered over this part of the reef. The reef balls were initially placed in the water in May 2003 however they were randomly placed with little positive effect. In June 2006 they were moved again to the two clusters which are seen today.

Species Composition

Considering that the area covered by the reef balls is so small, the large population, species and family abundance is commendable. There are several lively large coral bommies adjacent to the more shallow structure which could be responsible for the large population. However the deeper structure is not adjacent to lively coral bommies but still has a high proportion of animal life. It is quite possible that the unusual shape and close positioning of the balls combined with the large sponges, plating corals and massive corals, create such an attractive habitat for many different species of animal, that this is one of the areas of highest species abundance.

The Reef Balls appear to be one of the better if not the most successful artificial reef structure in the Lembeh Resort House Reef Project. The benthic growth is of a good level considering the conditions of the area, and combined with the shape of the reef balls ample life is attracted here.

Maintenance and future suggestions

I recommend that this structure is best left alone to develop naturally. There is no need for any maintenance at this point.

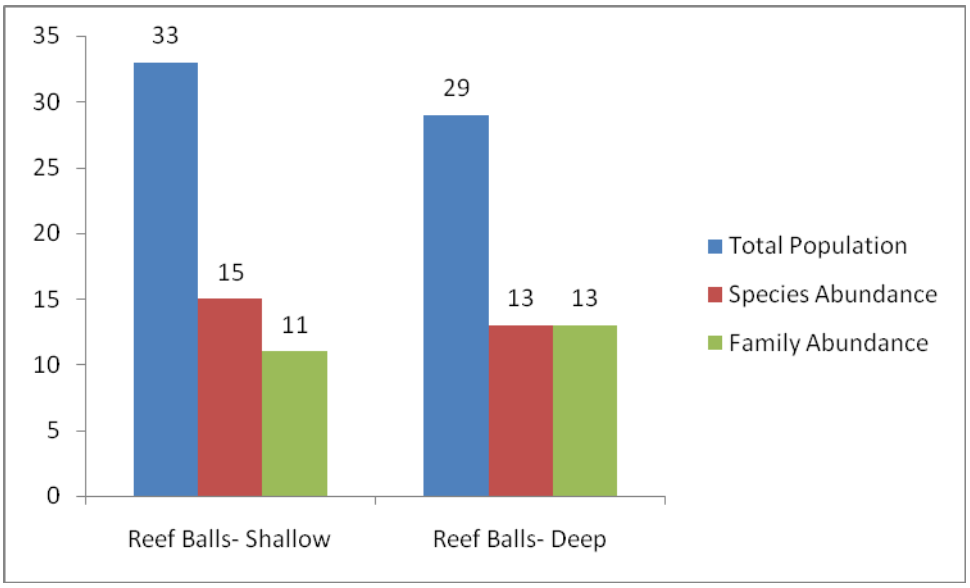

Figure 2; Histogram of the total population, species abundance and family abundance of the two groups of reef balls located at Lembeh Resort House Reef, Lembeh Island, Sulawesi, Indonesia.

New Concrete Blocks

Description

Seven slabs of concrete with various decorative attachments were dropped in the house reef on my first day at Lembeh Resort. They are the most recent addition to the House Reef Project. Six of these structures are clustered together just north of the fishnet in approximately 22 meters depth while the seventh was dropped a little deeper in approximately 25 meters depth 20 meters NW of the cluster.

The structures are heavy slabs of concrete with various household objects stuck in them so that they sit in and above the heavy concrete. The objects include anything from a computer and printer to a cooking strainer. An eighth concrete block was removed because the gas cylinders attached made it float.

Species Composition

There were very few animals present in the New Concrete Blocks, but due to the short establishment time, high sedimentation of the area and depth this is to be expected. Following the success of the Fishnet and to increase the structural complexity of this area, we threaded a series of ropes around the structures in a matrix style similar to that of the Fishnet. Following this we transplanted approximately 30 sponges onto the Concrete Blocks using wire and zip ties. The transplants were found in areas close by and were chosen only if they were not attached to the substrate and did not have animals living in them.

Maintenance and future suggestions

Some of the structures are severely rusting and other parts have polluted the area, for example the ink leaking printer. For future projects I suggest that the thorough cleaning

of all structures be mandatory, making sure that when cleaning on land the excess does not enter the ocean through an alternative route or equally pollute terrestrial ecosystems. The material used to make new structures should be carefully thought out. Much of the seven structures are severely rusting. Although this will not last forever it is adding unwanted Iron Oxide into Lembeh Straight effectively increasing the level of eutrophication[1] and decreasing the resistance of ecosystems in the straight. Although this may seem a minimal amount compared to pollution pumped elsewhere into the straight, it is definitely not the aim of the project and sets a bad example for others trying to do similar reef restoration, not to mention it looks bad to those tourists who know what they are looking at.
The shape of the structures should also be more carefully considered. A computer is not a good hiding place for animals. The smooth surface of the plastic and glass is also not a good settling surface for new coral spats and is also difficult for sponge and algae to grip onto. If the initial structure is to be of a non complex nature that is fine but a material that is more settle friendly should be used. Terracotta plates have been found to be the most effective artificial material for the settling of coral.
I advise that future artificial reef structures should be thoroughly cleaned, made with abrasive, settling friendly materials and be spatially complex.

Fish Houses

Description

There are 23 fish house structures that are scattered over a large area from within the Dome Biorock Northwards to the Mandarin Fish Dive Site. They are situated in approximately 7 to 15 meters depth and for the sake of the project I divided them into two groups; deep (below 12m) and shallow (above 12m). They were first installed in April- June 2003, and so have had six years to establish before my study. Each structure is made out of several long rectangular prisms stacked on top of each other so that they look like a chimney with gaps in the sides. Some of the structures are falling over while others appear very sturdy. There is evidence of some coral settling despite the high sediment cover over most of the structures. Some corals have established themselves and are growing healthily.

Species Composition

The fish houses appear to be the most successful of all the artificial reef structures in Lembeh Resort House Reef. They have the second highest population of animals (The wreck being the highest had many schooling fish), the highest family abundance and the second highest species abundance. The large area in which this structure encompasses must be taken into account for comparative reasons, however only those animals actually associated with a structure were included in the species composition, not those

[1] Eutrophication- a process where excess nutrients are received by a water body which increases the plant growth and subsequently decreases the dissolved oxygen in the water there fore decreasing the ability of an ecosystem to resist change.

found in between. The deep and shallow structures showed a very similar population and species abundance, however they showed a very different species composition. As previous volunteers have found that coral transplants do not survive well on the fish houses, few corals were transplanted here throughout my study. However sponge transplants appeared to be much more successful in surviving and attracting fish life. It was uncanny to see that within minutes of transplanting a large fragmented barrel sponge, more than ten fish including butterfly, damsel, and wrasse approached this area within minutes where previously there was only two gobies.

Maintenance and future suggestions

The fish houses are quite well established. Some of the structures do appear to be falling over and could use some restructuring or reinforcing with ropes. Although this would only be necessary for two or three structures. As we found that sponge transplants were so successful here, I favored sponge transplantation to coral transplantation on all structures except the Biorock (built to enhance coral growth) and the wreck (too deep and best left alone for schooling fish). I recommend more sponge transplants on all the fish houses while focus should be on developing one fish house at a time.

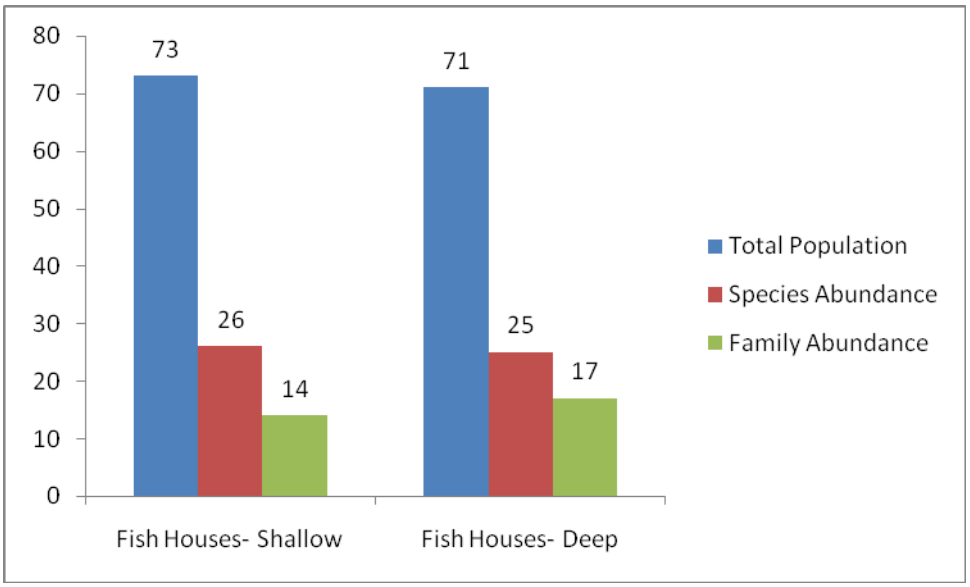

Figure 3; Histogram of the total population, species abundance and family abundance of the fish houses both shallow and deep located at Lembeh Resort House Reef, Lembeh Island, Sulawesi, Indonesia.

Overview and Reflection

The basis of all effective conservation activities is through education. The Lembeh Resort House Reef Project is a great starting point to bring about awareness of the environmental issues Lembeh Straight and the greater region faces. These include pollution (untreated sewerage, runoff, rubbish), overfishing, dynamite fishing, and sedementation. It is important that Lembeh Resort lead by example.

The runoff issue in Lembeh Resort is a serious one. There is high sedimentation on the House Reef on any given day, however after rain it is quite extreme. Coral reefs are fragile ecosystems. There is only so much resistance an ecosystem can posess before it will break. On several occasions it looked like there had been a milk leakage infront of the resort. The majority of the runoff was from an open construction site and the excavation of a new rubbish tip up the mountain. The best and most effective way of reducing runoff is by use of natural filters. Planting native grasses and shrubs close to the creek and over the open dirt sites is the best option. Temporarily even a tarp would do. Also if it can be prevented construction should be completed before the wet season starts.

The education center proposed for Pintu Cota Kechil is a great way to increase local awareness of environmental issues. I understand that funding is an issue but the sooner this project gets started the better.

Acknowledgements

My time at Lembeh Resort was an amazing one. I would like to thank all the staff and guests who made my six weeks there feel like a home away from home.

I would especially like to thank the Critters@Lembeh management team Kerri and Hergen for a smooth ride and lots of good pasta. Danny Charlton for generously providing me the oportunity to study and stay at Lembeh Resort. My helpful project assistants Vita, Refo and Andi for doing boring stuff when they didn't want to. All the dive team for showing me critters that I didn't know existed. And last but not least my mentor and friend Dimpy Jacobs for being a good person and a great marine biologist.

Thankyou all for the memories of a life time. I will be back.

Resources

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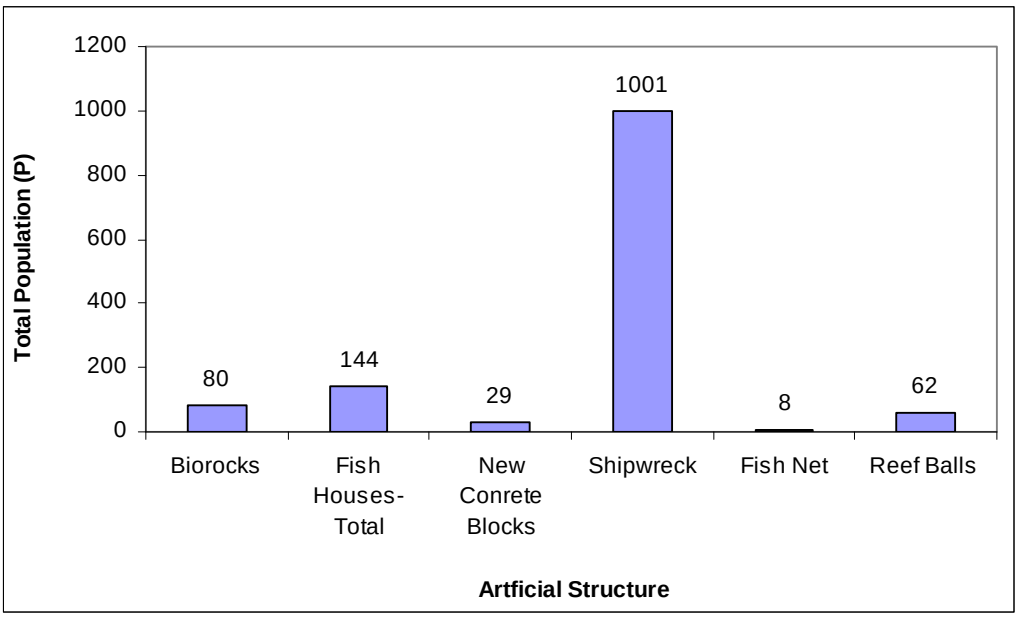
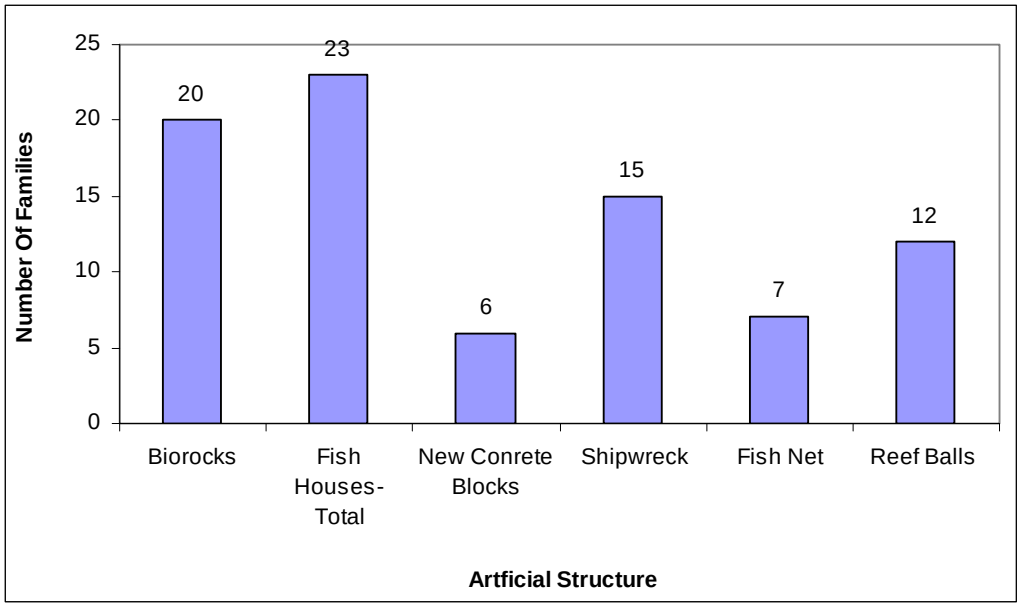
Appendix




Number Of Families
25
20
15
10
5
0
20
23
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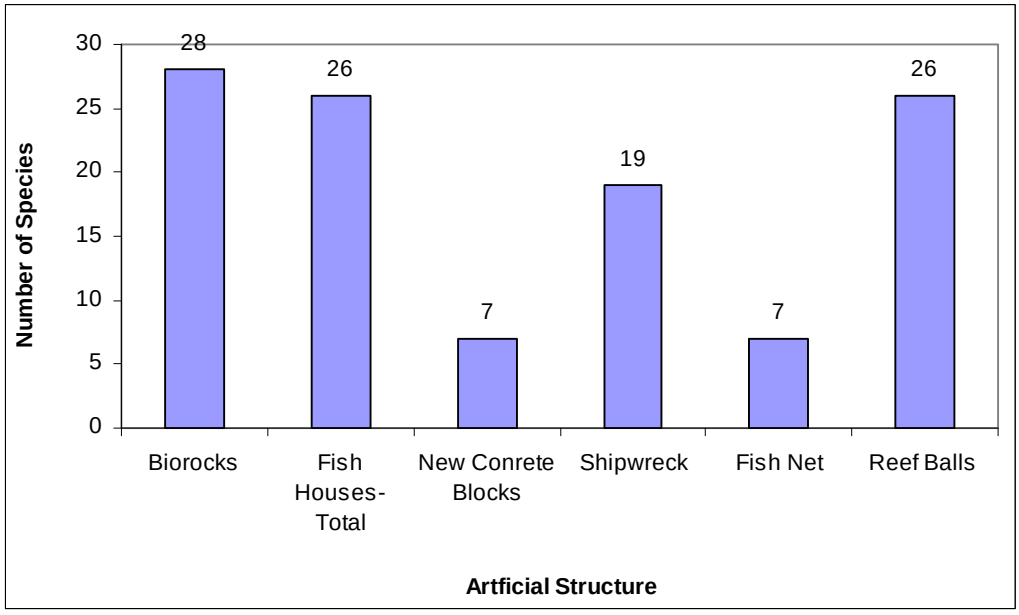
15
7
12
Biorocks
Fish Houses-Total
New Conrete Blocks
Shipwreck
Fish Net
Reef Balls
Artficial Structure


Number of Species
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20
15
10
5
0
28
26
7
19
7
26
Biorocks
Fish Houses-Total
New Conrete Blocks
Shipwreck
Fish Net
Reef Balls
Artficial Structure