CORAL TRIANGLE INITIATIVE
ON CORAL REEFS, FISHERIES AND FOOD SECURITY

PAPUA NEW GUINEA

# WIYALOKI, NATAULE & PANABALA CMMA MARINE RESOURCE MONITORING PROGRAM SURVEY REPORT #: 1

## MONITORING PERIOD: OCTOBER 2012

**June 2013**

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# Survey Report #: 1
# Monitoring Period: October 2012

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# WIYALOKI, NATAULE & PANABALA CMMA MARINE RESOURCE MONITORING PROGRAM

## SURVEY REPORT #: 1
## MONITORING PERIOD: October 2012



**MONITORING REPORT PREPARED FOR WIYALOKI, NATAULE & PANABALA COMMUNITY MANAGED MARINE AREA (CMMA)**

## CHAIRMANS WELCOME

Dear readers, people of Wiyaloki, Engineer Group and other nearby islands inside Samarai-Murua district. I firstly welcome you all to this 1st edition of Wiyaloki, Nataule and Panabala community managed marine (CMMA) marine monitoring program. This monitoring report presents the status of our marine resources where our community conducts surveys utilizing training provided to us by Conservation International (CI). The training is good because it enables us to know what conditions our reefs are in and we are also enable to know the status of our resources. We are grateful for this opportunity provided by Conservation International and we thank their office for providing this support.

1. Monitoring of resources are done in 8 reef areas that are inside our no-take areas (or managed reef areas). There are permanent monitoring transacts placed in each of the 8 identified reef areas inside no-take and 8 reef areas outside the no-take zones. The purpose of having this monitoring is to see the status of our resources whether they are declining or they are recovering.
2. Monitoring is conducted on a voluntary basis by youths as well as members of our community managed marine area (CMMA) management committees. During field monitoring, raw information or data is gathered for target indicator species that we have chosen.
3. Data gathered during the monitoring period is handled by specially trained local monitors from Nuakata and Iabam-Pahilele Islands where they process these data and provide monitoring report for our community. We anticipate that Conservation International will provide the training for local data officers from our community so they can do simple data analysis as those trained members of Nuakata and Iabam-Pahilele CMMA.
4. The purpose for such monitoring report is to inform our community about the changes that are taking place within our reef areas. Thus, whether fish and sea cucumber population is recovering or is not. By doing this kind of monitoring over a long period of time can only give us good information on how we the people of Wiyaloki manage our resources.

I also would like to make you realize that this program does not belong to Conservation International. This program is ours and we must be grateful to have an organization like Conservation International to provide the logistics and funds for such to be executed.

I would urge you all to come and join us in this initiative we are taking as we see that the long term benefits of what we do now will benefit our community as a whole. Let me also say that this program is not for the committee and youths only but is a whole community initiative as a step toward saving and managing what we have today.

Before I leave I would like to take this opportunity to sincerely thank all the participants who have been involved in this 1st monitoring and commend you all for the job well done. I also would like to thank Conservation International for its continue funding and support of this initiative.

## ABOUT THIS REPORT

*This is the first every community based monitoring program conducted by the reef custodians of Wiyaloki, Nataule and Panabala Islands. Those participated in the monitoring program received training from Conservation International in May 2012, and then they were engaged in the July monitoring program for Nuakata and Iabam-Pahilele CMMA for further field experience. Having gone these series of trainings the participants now conducted their first monitoring program in September 2012 which this report summarizes what they observed in their community managed marine area.*

*What is presented as results in this report only provides an indication on the status and distribution of coral reefs, fish and sedentary resources that are of economic and ecological value to the local people and their marine environment. The methods used in the survey are simple and easy and is not too scientific but can be adopted by any local communities who wish to do the same thing for their resources.*

# 1. INTRODUCTION

The marine resources surrounding Wiyaloki, Nataule and Panabala islands is now being studied and monitored after local custodians of these islands were provided training on resource monitoring skills in June 2012. This monitoring report is the first for the locals who live on Wiyaloki, Kwaraiwa and other small islands within the Engineer Group of Islands. This report also highlights survey protocols (methods) by which local members of the monitoring committee have used to gather data for important, selected species indicators as well as the condition of coral reefs. This monitoring is the beginning of a series of monitoring program that will be conducted by these members biannually.

The current report serves as a baseline for the resources in the managed area and does not provide a descriptive characteristics about the general biophysical properties of the reefs located inside the marked no-take areas and on those outside no-take or managed areas. Thus, a full marine resource profile for Wiyaloki, Nataule and Panabala community managed marine areas (CMMA) will later be developed by Conservation International (CI).

# 2. METHODS

## 2.1. Field Data Collection

Biological monitoring methods used during this survey can be found in English et al. (1997). Underwater visual census (UVC) technique was used by the monitoring team to record target marine organisms seen underwater. Scientific data were collected for coral cover morphologies (Table 1), important reef fish indicators (Table 2), and marine invertebrates including sea cucumber, trochus, clam and other invertebrate species. The monitoring program taught and implemented by Wiyaloki CMMA is the same as that implemented by Nuakata and Iabam-Pahilele CMMA. All monitoring protocol and data recording methods have been the same.

Provided in table 1 is coral substrate morphologies and their associated codes which are used during field monitoring.

**Table 1**. Substrate morphology

| **BC** | **Branching Coral** | **SMC** | **Submassive Coral** | **RK** | **Rock substratum** |
|---|---|---|---|---|---|
| **TC** | Table Coral | **DC** | Digitate Coral | **DCR** | Dead Coral Rubble |
| **MC** | Massive Coral | **SC** | Soft Coral | **SG** | Seagrass |
| **FC** | Foliose Coral | **SP** | Sponge | **S** | Sand |
| **EC** | Encrusting coral | **MA** | Macroalgae | **OT** | Other |
| **DDT** | Dead Corals | | | | |

Coral substrate is usually recorded along a 100 meter transact at 0.5m interval. Any substrate of both biotic and abiotic value in that area. Any substrate that lies on each 0.5m mark is often recorded using the code in Table 1.

**Table 2.** List of target monitoring fishes selected by NIPCMMA community members ***(Note. these names have to be changed to names in Wiyaloki vernacular)***

| Code | Wiyaloki vernacular | Common English Name |
|---|---|---|
| **1** | Koyali | Blueline surgeonfish |
| **2** | Kobala | Striated surgeonfish |
| **3** | Ulikwalakwalaoto | Orangespine unicornfish |
| **4** | Kosa | Bullethead parrotfish |
| **5** | Kosa Kalalalawa | Yellowbarred parrotfish |
| **6** | Tamwatamwalali | Barred rabbitfish |
| **7** | Idali | Silver spinefoot (rabbitfish) |
| **8** | Mami | Humphead Maori wrasse |
| **9** | Katumweta | Coral trout |
| **10** | Bwae | Blackspot snapper |
| **11** | Mwakalalalina | Bluespotted hind |
| **12** | Kekwalui | Black tipped grouper |
| **13** | Ulibalila | Big-eye bream |
| **14** | Belawa | Sabre squirrelfish |
| **15** | Kuwetom | Moray eel |

These species list presented above represents three important functional groups of reef fishes seen inside Wiyaloki, Nataule and Panabala Islands. These species are the same as those used by the Nuakata, Iabam and Pahilele CMMA in their monitoring program. Thus, the 3 main groups that is represented by these species include (1). Herbivore fishes, (2). Carnivore fishes and (3). IUCN/aesthetic species which is basically comprise Maori wrasse and moray eel.

List of marine invertebrates further include sea cucumber species classed into major genera (i.e. Actinopygra, Bohadchia, Holothuria, Stichopus, Thelenota and Pearsonothuria); 6 types of clam shells, trochus shells, crown of thorn starfish, and other marine invertebrates.

Monitoring stations selected for long term monitoring around Wiyaloki, Nataule and Panabala marine area is provided in Table 3.

Monitoring stations inside no-take management area

| Designee | Reef Name | Location |
|---|---|---|
| **NT. 01** | Koyogena | Panabala Island |
| **NT. 02** | Yadiyadidina | Panabala Island |
| **NT. 03** | Poupoununa | Wiyaloki Island |
| **NT. 04** | Wiyaloki G | Wiyaloki Island |
| **NT. 05** | Easana-n | Wiyaloki Island |
| **NT. 06** | Sakimalabwana | Nataule Island |
| **NT. 07** | Nataule East | Nataule Island |
| **NT. 08** | Nataule SW | Nataule Island |

Monitoring station outside no-take area

| Designee | Reef Name | Location |
|---|---|---|
| **OT. 01** | Split Rock | Panabala Island |
| **OT. 02** | Kasatavala | Wiyaloki Island |
| **OT. 03** | Matamtaval | Wiyaloki Island |
| **OT. 04** | Bwasomokaba | Wiyaloki Island |
| **OT. 05** | Kamwatali | Nataule Island |
| **OT. 06** | Daikon | Nataule Island |
| **OT. 07** | | Nataule Island |
| **OT. 08** | | Nataule Island |

### 2.2. Data analysis

All data gathered from the field are entered into a Microsoft Excel spreadsheet. These data is then processed using very simple calculations to provide average (or mean), standard deviation (SD) and standard error (SE). The calculated values are then used to construct simple column graphs to provide a visual representation on what each data show. The graphs generated using the fish, coral substrate and invertebrate data are then extracted and put into a report like this report to show you the kind of distribution and abundance of the different target monitoring fish groups, live coral substrate and invertebrates (including sea cucumber, clam, trochus etc)

Live coral cover is expressed as percentage so it describes how much live corals and dead abiotic substrate is found within each monitoring stations. Target reef fish groups is also calculated as average (or mean) to provide us on estimates for each groups within each monitoring stations and the no-take and outside no-take areas. A sample of the fish data and its calculations is given below to give you an idea on how the database looks and how calculations are made.

Figure 1. Sample of fish database created using Microsoft excel spreadsheet

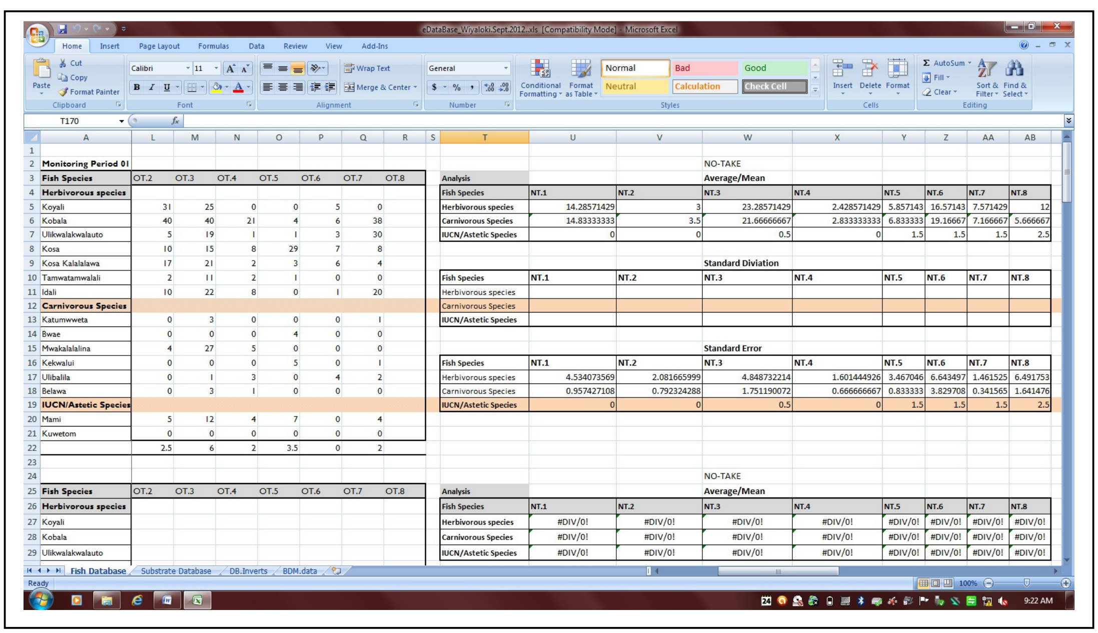


**Table 3.** List of the target monitoring fishes grouped into their common groups (Herbivore/carnivore/IUCN) fish groups

| Herbivore Fishes | Local vernacular |
|---|---|
| **Blueline surgeonfish** | Koyali |
| **Striated surgeonfish** | Kobala |
| **Orangespine surgeonfish** | Ulikwalakwalaoto |
| **Bullethead parrotfish** | Kosa |
| **Yellowbarred parrotfish** | Kosa Kalalalawa |
| **Barred rabbitfish** | Tamwatamwalali |
| **Silverspine foot (rabbitfish)** | Idali |

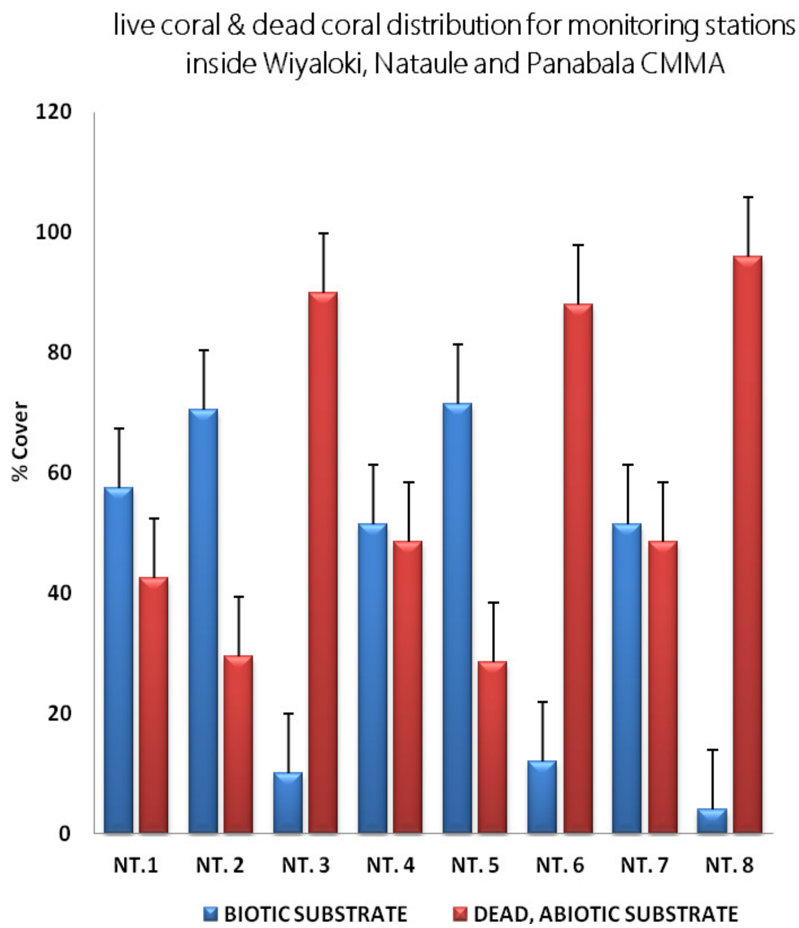
| Carnivore Fishes | Local vernacular |
|---|---|
| **Coral trout** | Katumweta |
| **Blackspot snapper** | Bwae |
| **Bluespotted hind** | Mwakalalalina |
| **Black tipped grouper** | Kekwalui |
| **Black-eye bream** | Ulibalila |
| **Sabre squirrelfish** | Belawa |

| IUCN/aesthetic Fish | Local vernacular |
|---|---|
| **Humphead Maori wrasse** | Mami |
| **Moray eel** | Kuwetom |

Average for each of the three main fish groups is calculated using the representative species for each group. The averages then provide us the information on the population and abundance of each fish groups within the sampled transacts area. The same process is repeated for sites outside no-take or the open fishing areas for the communities from the representative individuals provided which is then used to represent the different fish groups in the no-take (managed area) and for sites outside no-take areas.

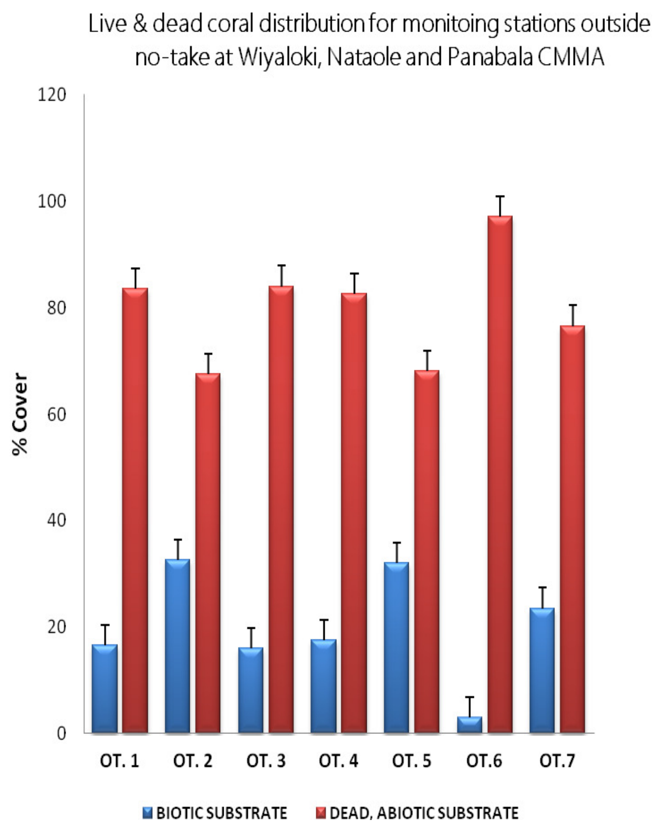
## 3. RESULTS

### 3.1.1 Benthic substrate for reefs inside no-take




The bottom substrate for many of the reefs inside demarcated no-take area showed an average live coral cover of 41.06% and nonliving substrate or abiotic substrate of 58.94%. The live coral cover component was highest for the following individual sites. Easana-n or NT.5 (71.5%), Yadiyadidina i.e. NT.2 (70.5%), Koyogena (NT.1) (57.5%) while Wiyaloki G (NT.4) and Nataule (E) which is NT.7 recorded (51.5%) respectively. All other stations (i.e. Poupoununa (NT3), Sakimalabwans (NT.6) and Nataule SW (NT.8) recorded low live coral cover percentage. When we take a close look at the type of live corals that dominated many of sites inside the no-take areas we found that there were high counts and record for Branching corals (BC). Sites like Yadiyadidina (NT.2) that recorded 70% live coral cover comprised exclusively of branched corals making up 49% of all substrates recorded within the 100m transact line. Sites NT.1 and NT.4 also recorded high percentage of live coral cover with 32% and 41% respectively. Table corals (TC) and foliose corals (FC) were also recorded high in certain areas. Thus, NT.5 recorded 9.5% TC while NT. 7 recorded 12% FC. The only monitoring station that recorded the lowest coral cover was NT.8 with (4%) live coral cover. This station comprised entirely of dead coral rubble (DCR) with 60.5%, rock (RK) and sand (S) both recording 16.5% each.

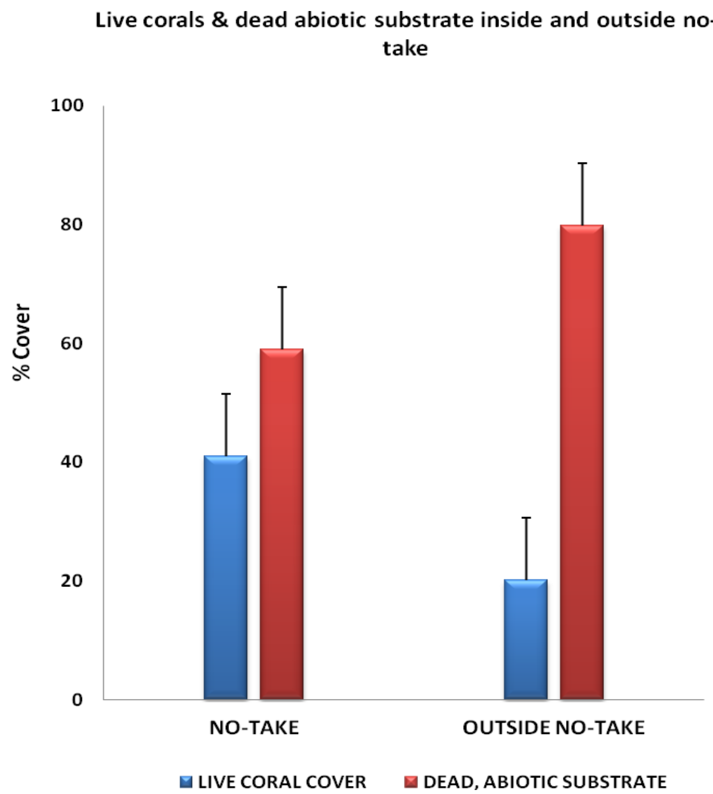
### 3.1.2. Benthic substrates for reefs outside no-take areas




Reefs selected outside no-take showed recorded an average of 20.14% live coral cover for 7 monitoring stations. Many areas where permanent monitoring transacts were established comprised many dead and abiotic substrate hence, making up 79.86% for all 7 sites. Sites with low coral growth include (Kasatavala) OT.2 (32.5%), Kamwatali OT.5 (32%) and OT.7 (23.5%). All other 4 monitoring sites (OT.1, OT.3, OT.4 and OT.8) recorded very low coral cover within each monitoring transacts. For those live coral cover recorded for each sites, the following were the main kind of corals found in each individual sites.

| Sites | Substrate type | Live cover (%) |
|---|---|---|
| **OT.1** | MC (Massive coral) | 6.5 |
| **OT.2** | DC (Digitate coral) | 14 |
| **OT.3** | SMC (Submassive coral) | 5.5 |
| **OT.4** | BC (Branching coral) | 10 |
| **OT.5** | BC (Branching coral) | 4.5 |
| **OT.6** | MC (Massive coral) | 1.5 |
| **OT.7** | FC (Foliose coral) | 8.5 |

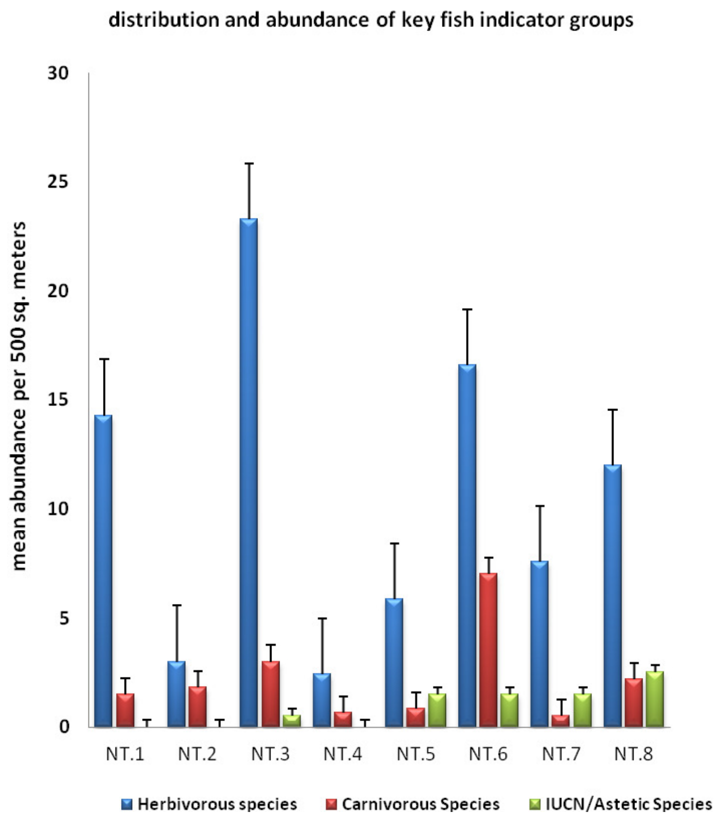
### 3.1.3. Benthic substrates for monitoring stations inside and outside no-take combined




On average 8 monitoring stations inside the no-take areas recorded coral cover percentage of 41.06 while dead coral and abiotic substrates recorded 58.94%. Sites outside no-take recorded low coral cover average of 20.14 for 7 sites inside no-take and dead, abiotic substrates had 79.86%. The averages clearly showed that many of the sites that Wiyaloki, Nataule and Panabala CMMA allocated as no-take are within the fringing reefs of the three islands.

## 3.2 REEF FISH INDICATORS INSIDE & OUTSIDE NO-TAKE AREAS

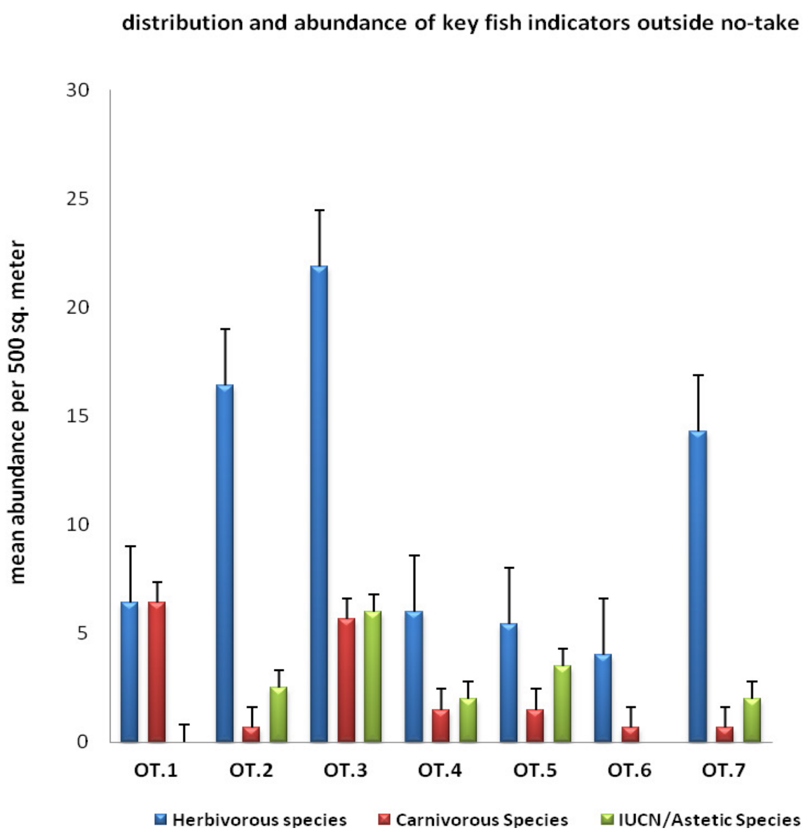
### 3.2.1. Target Reef Fish indicators inside no-take




Results for our target reef fish groups in this first monitoring period showed that Herbivore fish group has an average of 10.63 fishes per 500m$^2$ in the 8 monitoring stations inside our no-take areas. This average was for all 8 stations inside no-take. Some monitoring stations had high individual averages while others had very low averages. Individual site record for each monitoring stations showed that our monitoring station at Poupoununa (NT.3) recorded the highest count of 23.29 herbivore fishes within the sampling area of 500m$^2$. Second to this were (Sakimalabwana) NT.6 with an average record of 16.57 herbivore fishes per 500m$^2$ then (Koyogena) NT.1 with average of 14.29 herbivore fish per 500m$^2$ and Nataule SW (NT.8) with a recorded average of 12 herbivore per 500m$^2$. Monitoring stations like NT.2, NT.4, NT.5 and NT.7 recorded low abundance of herbivore fishes within their 500m$^2$ monitoring areas. The second monitoring fish group was termed 'carnivore' fishes and this group covers fishes like coral trout, red emperor, sweet lips, cods and groupers. The carnivore fishes are those fishes that feed on other fishes while the earlier described herbivore fishes are those that feed on sea grass, algae and other marine plants. Some examples of include rabbit fishes, surgeonfish, parrotfish and unicorn fishes. Our monitoring data presented in the above graph illustrate an overall average of 2.19 carnivores per 500m$^2$ sampling area. This average is very low thus; the only site with a high abundance count within 500m$^2$ monitoring areas was Sakimalabwans (NT.6). This site recorded an average of

7 carnivore fishes per 500m$^2$ while all other 7 monitoring stations recorded very low abundance within respective 500m$^2$ sampling area. The third monitoring group of fishes is those termed IUCN or aesthetic species. Basically these groups include the Humphead Maori Wrasse and the species of moray eel. In this monitoring survey our monitoring team recorded an average of 0.94 species per 500m$^2$ study areas inside 8 no-take stations. The average recorded for each of the study areas was very low. Thus, NT.8 was the only site to record an average of 2.5 species per 500m$^2$ while the other 7 monitoring stations had very low averages for this fish group.

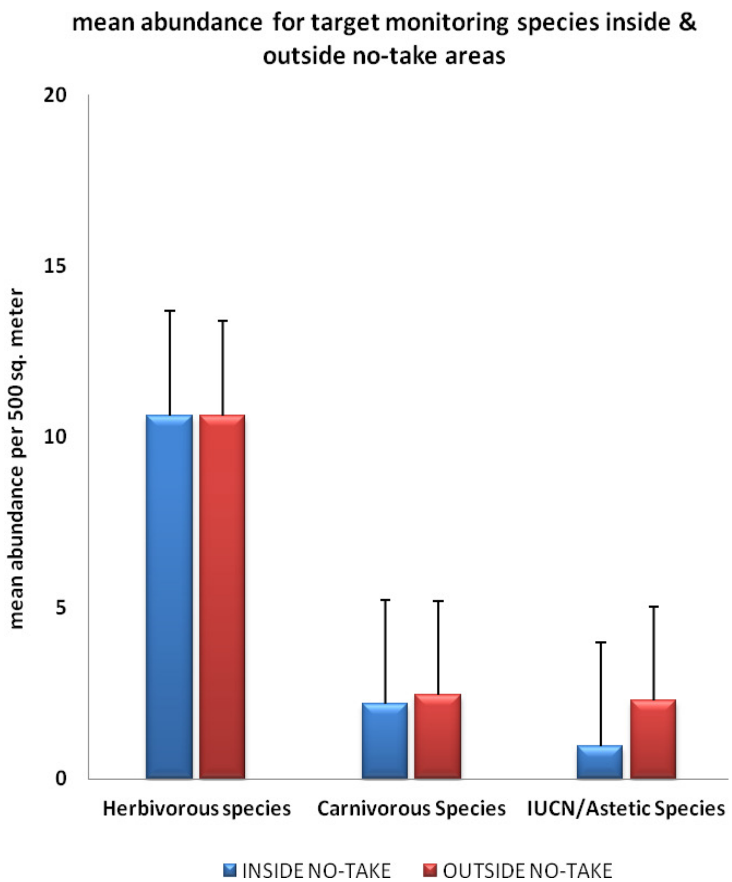
### 3.2.2 Target reef fish monitoring indicators outside no-take




Survey results for sites outside no-take showed an average counts of 10.63 herbivore fishes per 500m$^2$ monitoring transact. As shown in the graph above, the monitoing stations with high abundance of herbivore fishes were (Matamtaval) OT.3 reccording an average of 21.86 herbivore fishes per 500m$^2$ sampling area, followed by (Kasatavala) OT.2 with an average of 16.43 herbivore fishes per 500m$^2$ area and OT.7 with an average count of 14.29 herbivore fishes per 500m$^2$ studied transact. Other monitoring stations including OT.1, OT.4, OT.5 and OT.6 all had very low averages for herbivore fishes. The second monitoring fish group termed the carnivore group recorded an overall average that is almost the same as those recorded for the 8 moitoring stations inside no-take areas. An average of 2.44 carnivore fishes was recorded for the 7 OT stations. Split Rock (OT.1) recorded an average of 6.43 carnivore fishes per 500m$^2$ study area while all other stations recorded much lower averages.

Very similar to the results for sites inside no-take, the average for herbivore fishes outside no-take was 11.4 herbivore/500m$^2$. 4 sites out of the 8 monitoring stations had averages of over 12.0 herbivore/500m$^2$. Sites with very low average include Bwasomokaba (OT.4) with an average of average of 8.8 herbivore/500m$^2$ (see graph above). Reef carnivore fishes and the IUCN/aesthetic fishes both recorded low average of 2.01 carnivore/500m$^2$ and YYY/500m$^2$ respectively.

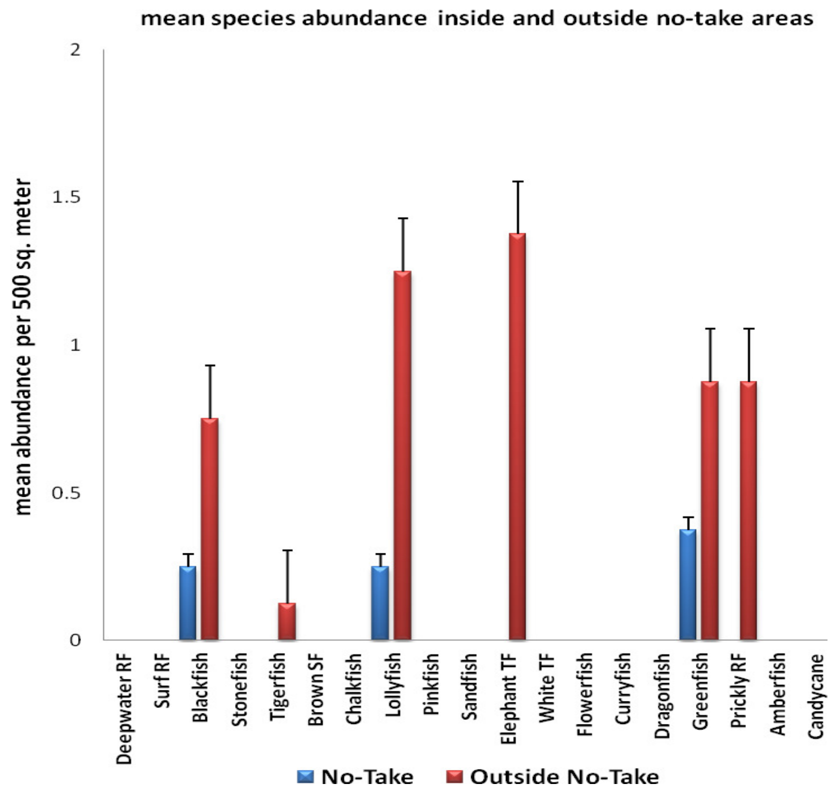
### 3.2.3. Mean abundances for target monitoring fishes inside & outside no-take areas combined




The average for herbivore fishes for all 8 monitoring stations in this monitoring period was 10.63 herbivore per 500 square meter transact area. The same average of 10.63 herbivores per 500 square meter was recorded for the stations outside no-take. A similar average was displayed by carnivore fishes with an average of 2.19 carnivore fishes per 500 square meters. Stations outside no-take also recorded a slightly higher average of 2.44 carnivore fishes per 500 square meter studied area. Also on this graph is the presence of IUCN/aesthetic fishes. Their respective averages were 0.94 fishes per 500 square meter surveyed area for the 8 stations inside no-take and 2.29 fishes per 500 square meter outside no-take areas.

## 3.3 MARINE INVERTEBRATE

### 3.3.1. Sea cucumber




Information gathered for sea cucumber species inside Wiyaloki, Nataule and Panabala CMMA both inside no-take and outside no-take areas show low populaton and abundance for the many species. For those species present within each monitoring transacts, their average values are shown below.

***Monitoring stations inside no-take***

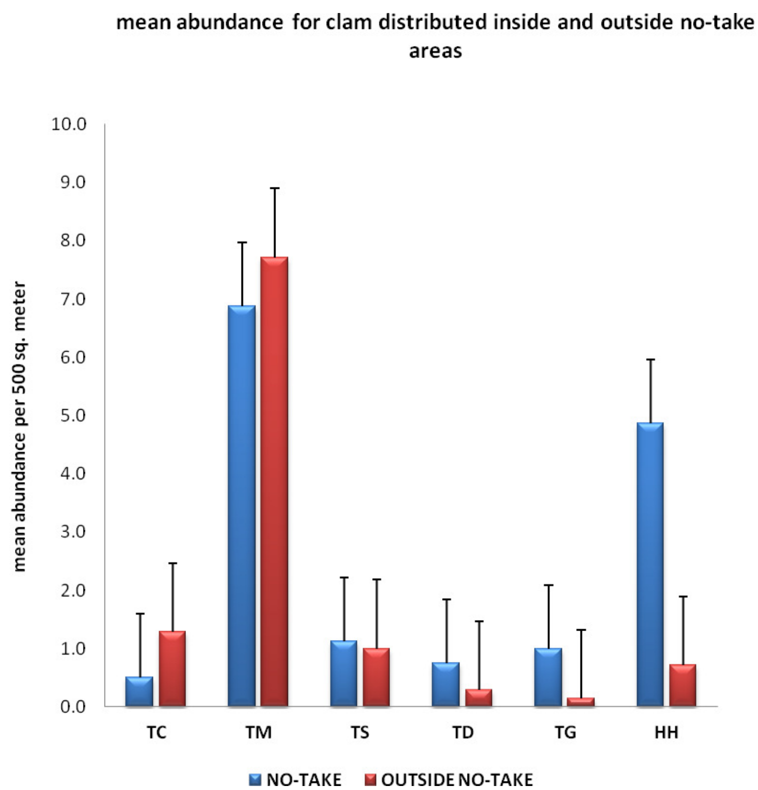
| Species | Blackfish | Lollyfish | Greenfish |
|---|---|---|---|
| | 0.094 | 0.78 | 0.11 |

***Monitoring stations outside of no-take zones***

| Species | Blackfish | Tigerfish | Lollyfish | Elephant trunkfish | Greenfish | Prickly redfish |
|---|---|---|---|---|---|---|
| | 0.11 | 0.02 | 0.25 | 0.42 | 0.12 | 0.11 |

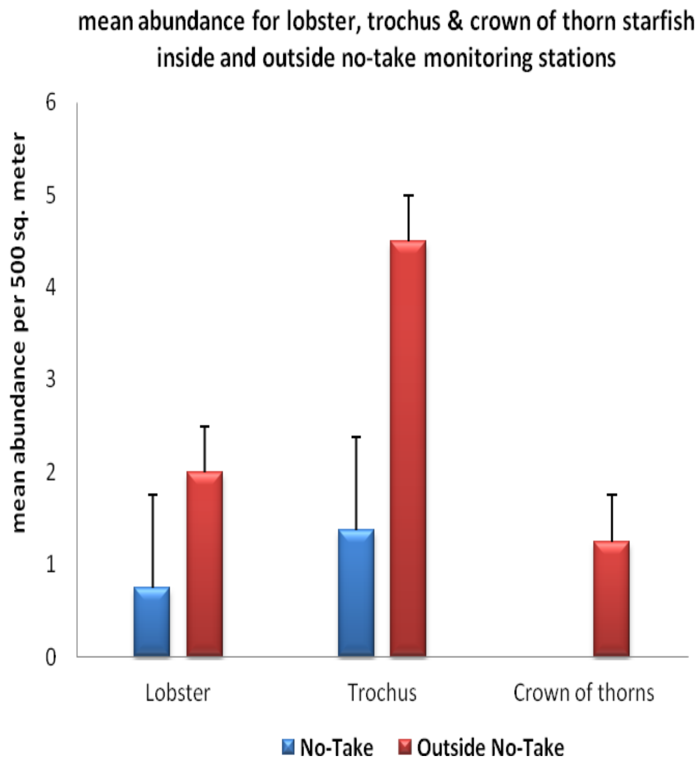
Averages and abundance for sea cucumber species found inside and outside no-take was lowest for all montoring stations inside and outside each studied areas.

### 3.3.2. Giant Clam




The Maxima clam (TM) appeared to be distributed in many reefs located inside and outside the no-take. On average, 8 monitoring stations inside no-take reccorded 6.88 TM/500m$^2$ and sites outside no-take recorded 7.71 TM/500m$^2$. The clam species reccorded in good numbers in the no-take areas was bearpaw clam (HH) with an average of 4.88 HH/500m$^2$. Other clam species were all represented in both the no-take areas as well as in areas outside no-take. All other clam species showed low average population counts (*see above graph*) when

### 3.3.3. Other Marine sedentary resources (Lobster, trochus crown-of-thorn starfish)




This baseline study provides an average count of 0.75 lobster per 500m$^2$ transact for no-take areas and an average of 2.0 lobster per 500m2 for stations outside of no-take areas. Data for trochus population showed a very similar result with average abundance of 1.38 trochus per 500m$^2$ inside no-take and 4.5 trochus per 500m$^2$ for sites outside no-take. Data for crown-of-thorn starfish was observed in the monitoring stations outside no-take with an average count of 1.25 species per 500m$^2$.

# 4. DISCUSSION

## 4.1. Benthic substrate

The management areas for Wiyaloki CMMA marked as no-take has an average live coral cover of 41.06%. The main coral type found in many reef areas inside no-take were those with the branched like structures which we called branched corals or (BC) in our monitoring. Monitoring stations like Yadiyadidina (NT.2) recorded the highest record of BC within 100 transact length. The record for BC alone in this monitoring station amounted 70% while the other 30% comprised other coral types. Koyogena (NT.1) and Wiyaloki G (NT.4)

Other two monitoring stations with high distribution of branched corals was NT.1and NT.4, both recording 32% and 41% respectively. In general, dead coral rubble, sand, hard rocky substrates or abiotic substrates comprised an average of 58.94% for no-take monitoring stations. Monitoring stations outside of the no-take management zone recorded high dead and abiotic substrates with an average 79.86% while live coral cover in those monitoring stations was 20.14%. It was apparent that the most dominating substrate recorded as dead, abiotic materials was dead coral rubble (DCR) with two sites showing very high averages of 64.5% at OT.7 and 57.5% and was at OT.6. Other dead abiotic substrates that were recorded in high numbers in a number of sites include hard rocky substratum (RCK), sand (S) and dead corals (DDC).

It was further noted that many of the live corals were located on the edges of fringing reefs which were either patch reefs and/or island fringing reefs. Other reef flat areas recorded a few colonies of hard boulder corals. These reef flat areas have often been subject to swells and storm surges during the SE Trade Winds therefore, they cannot support the growth of soft and fragile corals.

The high indication of coral rubble shows the dire consequences of SE Trade Winds as it affects a lot of coral growth and distribution. There are high potentials for coral recovery if the frequency of storm and surge is minimized each year. Many barrier reefs often act as coastal defense system and as such the amount of coral growth is often limited to those species that have high resistance. Many of these corals often have solid or strong structures built specifically to withstand any harsh conditions they will face. Corals such as brain corals and others with similar structures are some examples. It is also important that on any reefs that are sheltered often provide perfect habitat for soft corals as well as those with foliose, branching and digitate structures. Corals with table or plate structure and branching corals are often found in areas where there is high water clarity and low to medium current. Growth of corals is often determined by the following factors. If any of these factors is altered in anyway, the coral starts showing signs of stress. In most case, corals turn color from their natural state (either grey, blue etc) to white and this has often been described as 'coral bleaching' (see section 4.1.1.1). Thus, these factors are hereby summarized below.

1) Water that has temperature range of between 18-32 °C
2) Water depth range of 1-12 meters where light penetration is the strongest and require
3) Sunlight of (>50$\mu$E m$^{-2}$ s$^{-1}$).
4) Water that has a calcium carbonate ($CaCO_3$) saturation (i.e. >3.4 $\Omega$-arag)

5) Water with a nutrient content limited to (0.5-3.0μmol $L^{-1}$ ) i.e. low nitrogen & phosphate concentration
6) Water with a salinity of (25-42ppt concentrations = normal for sea water)

#### 4.1.1. General information on coral growth and distribution

***Major Roles of Coral Reef***

There are countless ways in coral reefs provide benefits too. Firstly, reefs provide shelter and habitat to multitude of organisms that dwell in it. Secondly, reefs provide coastal communities with their daily livelihood through fish and marine products utilized as diets for may coastal villages. On country and regional scale, reefs provide important economic benefits to the government. Benefits from dive tourism in the Great Barrier Reef are an example of that. Ecologically, coral reefs maintain ecosystem balance by harmonizing connectivity between many organisms through forming the basis for food chains and many associated scientific linkages.

***Coral reef in a local context***

In a local context, coral reefs are heart and soul to many coastal island communities in Papua New Guinea. Coral reefs enhance livelihood through local cash economy such as fish and other marine product sale. Coral reefs support over 80% of livelihood on a daily basis in many outer lying islands like Brooker, Ware and many other islands in Milne Bay Province. As it is known that reefs provide shelter for marine organisms, having reefs located on fringing reefs (close to your doorstep) mean food security is guaranteed during good season and in bad seasons, especially Southeast Trade Winds.

The potentials for dive fee revenue generation from Dive Industry in Milne Bay Province is a good prospect which is also a return for having vibrant health coral reef systems in the Province. Local economy meaning local reef owing clans and sub clans can generate money by retaining the health of coral reefs through proper dialogue with tourist operators and tourists in order to optimize this opportunity.

Coral reefs also play a greater role in maintaining integrity of coasts and coastlines. Coral reefs serve as barriers from large waves and other severe natural perturbations and provide a safe haven for many low elevation coastal islands.

***Threats to Coral Reefs***

Threats to coral reefs are occurring everyday and are not speculations. Many scientific studies conducted in the Great Barrier Reef and around the world have shown clear indication of coral reef demise. The Caribbean has been severely degraded to a level whereby reversible changes are not possible. Detrimental impacts of climate change through active or pulse disturbances (i.e. cyclones, storms and many natural perturbation) coupled with human's destructive fishing activities have caused irreversible 'phase-shifts' in the natural ecosystem. These threats have been chronic over years that have severely reduced coral reefs natural resilience to stages where reefs are barely dead and/or are transformed from a once hermatypic reef system to a ahermatypic system.

Threats to coral reefs are categorized as 1). Acute (Passive) and 2). Chronic. Acute or passive disturbances are distinct and punctuated. Their occurrences are often unpredicted and infrequent. Clear examples of these disturbances include cyclones, coral bleaching and crown of thorn starfish infestation. These passive disturbances are infrequent and does allow for coral reefs to recover before another passive disturbance strikes. The most catastrophic disturbance is from those described "chronic". Firstly, they are irreversible and often persistent and have long term consequences. Chronic disturbances have been described to have direct determination and/or control over acute disturbances in the essence that they are recurrent and occur at very short space of time which do not allow coral reefs to recover before they set in again. Many of the factors leading to chronic impacts are correlated with human's lack of appreciation of the marine ecosystem through unsustainable resource management strategies. Thus, heavy fishing and/or overfishing practices in the fisheries sector has been one of the many main driver of this vehicle. Increase nutrient deposition and continuous discharge of freshwater with high sediment load provides perfect ingredient for coral demise. Large sediment load shades sunlight penetration and hampers local photosynthetic activities for taking place in marine fauna. Furthermore, large sediment load smothers corals and prevents new coral recruitment process thereby having detrimental impact on shallow fringing reefs. Modern agro-agricultural of monoculture techniques like oil palm plantations often have high use of chemical pesticide and other chemicals containing DDT substances which have catastrophic impacts on marine fauna located close to their disposal. Perhaps the most daunting impact that is far beyond any human direct intervention is climate change. Climate changes impacts have catastrophic impact on the marine organisms through alteration of sea surface temperature (SST), ocean acidification process and excess carbon deposits that reduces water oxygen, driving anoxic environment for organisms to thrive in. Climate change impacts could also be described as the overall driver and catalyst for severe marine ecological catastrophe. Long term chronic impacts have also been responsible for 'phase-shift' for many marine organisms.

## 4.2. Reef Fish

### *4.2.1. Distributions herbivore, carnivore and Humphead Maori Wrasse.*

The reefs surrounding the islands of Wiyaloki, Nataule and Panabala showed more distribution of herbivore fishes than carnivore and IUCN/aesthetic fish species. As shown in the graph of section 3.2.1, monitoring stations inside the no-take and sites outside no-take recorded equal averages for herbivore fishes and an almost similar average for carnivore fishes. The averages for WICMMA in this September monitoring when compared to the December monitoring results for Nuakata Island showed that Nuakata CMMA had 21% more than Wiyaloki in terms of herbivore fishes for the monitoring stations inside no-take areas. Monitoring stations outside no-take also showed Nuakata CMMA the population of herbivore with 6% over what was recorded at Wiyaloki CMMA. The differences of 21% and 6% for monitoring stations inside no-take and outside no-take for Nuakata and Wiyaloki is not much difference. We can conclude that there is almost equal distribution and abundance of herbivore fishes in the respective locations. The only difference noted was fish size classes. Sizes for herbivore fishes recorded at Wiyaloki were greater than those recorded for Nuakata CMMA. A lot of factors could be used to demonstrate such. Human pressure through overfishing could be one of the many reasons. The similar abundance trend is again seen for carnivore fishes and IUCN fish groups. The averages show that there were high averages for the target species at Nuakata than Wiyaloki. On the other hand, most of the individual records in terms of fish sizes showed that many of the monitoring species recorded at Wiyaloki were larger than those that have been recorded at Nuakata CMMA.

It is interesting to see the results generated from Wiyaloki CMMA in the coming monitoring program. There were also many sightings of large size pelagic fishes such as travally, mackerel and other reef fishes sighted outside of the monitoring stations. These sightings indicate that there is plenty in terms of reef fishes for subsistence and artisanal purpose for the people of Wiyaloki CMMA.

**4.3. Sea Cucumber**

Data for sea cucumber for all monitoring stations inside and outside no-take areas show very low density and abundance. Lollyfish appeared to be the most dominant species recorded for many monitoring stations outside no-take area while elephant trunkfish was more abundant in the monitoring stations inside no-take. (Section 3.3.1). The data shown in the graph and tables of section 3.3.1 only indicate what was recorded within the 500m$^2$ transact area for monitoring stations inside and outside no-take. There was also a lot of sea cucumber that were observed outside of each transact areas within different reefs but these sightings were not recorded or accounted as they were not within the defined boundaries of each study area. Examples of species that were found outside no-take include white teatfish, stonefish, brown sandfish and curryfish. Some of these sea cucumber were not recorded inside any monitoring stations but were present on the same reefs where the monitoring stations were located.

The monitoring team also highlighted that there was a lot of new sea cucumber recruitment on many reefs. These new recruitment is an indication of successful fertilization during the breeding season. Successful breeding is dependent on the distance of aggregation between males and females of different species. The closer the sea cucumbers are; the successful is the rate of fertilization that leads to new sea cucumber larvae.

**4.4. Clam Shell**

The population of clam shells recorded inside all monitoring stations generally indicates a low abundance for those species sighted. As shown in section 3.2.2, maxima clam (TM) recorded the highest distribution and abundance with averages of 6.88 TM/500m$^2$ than other species. The bear paw (HH) clam recorded the second high abundance with averages of 4.88 HH/500m$^2$ inside no-take areas and XX for monitoring stations outside no-take.

Although data from monitoring transacts showed low species abundance and distribution, there was a lot of giant clam found in the reefs outside of the monitoring transacts. Thus, there was a clam garden of which clam species like giant clam (TG), southern giant clam (TS) and bear paw clam (HH) were kept and cared for by the local custodians of Wiyaloki Island. Many of these clams have been brought from outer reefs and placed near the island. This is a good initiative as this enhances the success of fertility during spawning period. The closer the clams are, the higher is the chances of fertilization of gametes and a great successful settlement and growth of larvae.

***Lobster***

Results from the monitoring showed that there were very few rock lobsters recorded within each monitoring stations inside and outside no-take areas. An average record of 0.75 lobsters per $500m^2$ for 8 monitoring stations indicates a low presence and abundance. A same result was observed for the monitoring stations outside no-take areas. It is also being noted as since this monitoring period is the first of its kind for the area we cannot establish reasons to tell you why the number of rock lobster was low. This can be provided after a long while when we have continuous monitoring data which can than yield proper explanations for what we observed today.

***Trochus***

Monitoring stations outside no-take recorded a good number of trochus shells. The average record of 4.5 trochus/$500m^2$ for 7 monitoring stations indicate that trochus population within for Wiyaloki, Nataule and Panabala islands are good. The no-take monitoring stations recorded a low average of 1.38 trochus/$500m^2$ monitoring transact. As a baseline data we cannot make any solid conclusions to this as it will require a number of continuous monitoring programs to establish this information.

***Crown-of-thorn (CoT) starfish.***

Crown-of-thorn (CoT) starfish is a natural predator that exists on many reefs. The population of CoT starfish at Wiyaloki is considered low, with an average abundance of 1.25 CoT/$500m^2$ for 7 monitoring stations outside of no-take area. 8 monitoring stations inside no-take had no record for this. CoTs are like many other marine animals that have its natural predators that keep their population low. Triton shell is the main organism that feeds on crown of thorn starfish and by doing so; it regulates its population and keeps it low. Other fishes like triggerfish also feed on them as well. When the populations of these natural predators are high they will regulate the population of CoT. Thus, if their population is low than the population of CoT will increase. Other environmental conditions such as sediments and nutrients from land based flooding have also been reported to give rise to crown-of-thorn population. For our case land based flooding is not a major problem but the continuous harvest of the natural predators can bring about population boom in the number of crown-of-thorn starfish. Crown-of-thorn may only become a concern when their population increases because they feed on live corals and kill off corals. What they leave behind after feeding on corals is a white scar which leads to an eventual death in many coral reefs.

## 5. CONCLUSION

Data gathered during this monitoring period can be described as the baseline data for this CMMA. A series of monitoring program conducted in this area can be use to determine changes and fluctuations in the availability of food

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