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Abundance of commercially important species of invertebrates in the Maravaghi Community-Based Marine Protected Area in Ngella, July 2004

Report prepared for:

Foundation of the Peoples of the South Pacific International (FSPI)

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May, 2005

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SUMMARY

After completing the Sisili and Taburu Marine Protected Areas (MPAs) baseline survey between 23rd to 26th July, 2004, the same survey team (comprising personnel from the Foundation of the South Pacific Peoples International (FSPI), Department of Fisheries and Marine Resources (DFMR), The Nature Conservancy (TNC) and the International Waters Programme (IWP)), proceeded on and completed the Maravaghi MPA baseline survey from 27th to 29th. Like the baseline survey at Sisili and Taburu MPAs, activities undertaken by the survey team for the Maravaghi MPA baseline included: (a) a baseline survey on commercially important marine invertebrates of the MPA (b) training of selected community representatives on species identification (invertebrate species) and survey methodologies and (c) education and awareness activities within the Maravaghi community.

Basically, the survey of commercially important marine invertebrates involved the use of transects. Invertebrates were surveyed in two habitats, the shallow and deep habitats. The shallow habitat constituted the reef terrace of depth 1 – 4m whereas the deep habitat comprised the slope below the terrace of depth 14 – 30m. Surveys in the shallow habitat were done using 2m x 50m transects and in the deep habitat 5m x 50m transects. Six transects were laid in the shallow and five in the deep at each study site. Data were collected on the numbers and sizes of important marine invertebrates.

Results obtained showed that the abundance of important marine invertebrates in the study area is low compared to what is reported in other parts of the Solomon Islands and the South Pacific region. Sea cucumber abundance is extremely low both in the shallow and deep habitats. Only 3 of the known commercial sea cucumber species in the Solomon Islands were recorded during this survey. In the shallow habitat, sea cucumber is only found at the Maravaghi MPA with a mean density of 0.33 per transect ($100m^2$) or equivalent to 33 per hectare whereas in the deep habitat only at the two reference areas Luhunago and Taihola reefs both with a mean density of 0.20 per transect ($250cm^2$) or equivalent to 8 per hectares respectively.

In the shallow habitat, giant clam abundance is also low as well. Giant clam abundance ranged from 0.50 – 2.50 per transect ($100\ m^2$) or equivalent to 50 – 250 per hectare. *Tridacna maxima* was the most abundant clam species with densities ranging from 0 – 1.67 per transect or equivalent to 0 – 167 per hectare. *Tridacna crocea* was present with mean densities of 0.33 – 0.67 per transect or equivalent to 33 – 67 per hectare while *T. derasa* and *T. squamosa* were recorded with densities of

0 – 0.17 and 0 - 0.33 per transect or equivalent to 0 – 17 and 0 – 33 per hectare respectively. The largest species *T. gigas* and the horse shoe clam *Hippopus hippopus* were not seen in sampled transects.

Trochus (*Trochus niloticus*) was only recorded at both the Maravaghi MPA and Luhunago reference areas with similar mean densities of 0 – 0.17 per transect or equivalent to 0 – 17 per hectare. Blacklip pearl oyster (*Pinctada margaritifera*) was only recorded at Taihola reef with a mean density of 0.17 per transect or equivalent to 17 per hectare. The two shell-money species Ke'e (*Beguina semiorbiculata*) and Kurila (*Atrina vexillum*) were encountered in low numbers and densities as well.

In general, the coral reef condition of the study area is in a healthy condition. No crown of thorn starfish (*Acanthaster planci*) was recorded in sampled transects. Species like greensnail (*Turbo marmoratus*) and the crown of thorn starfish predator trumpet triton shell (*Charonia tritonis*) were also not recorded in sampled transects.

A number of conclusions were made to highlight these and other results found during this baseline survey.

This baseline study is designed to compare "before" and "after" declaration data for the Maravaghi MPA and the two reference areas of Luhunago and Taihola reefs. It is hoped that changes detected within the MPA over time would determine whether the MPA has been successful in enhancing or maintaining stocks of exploited commercial invertebrates or not.

1.0 INTRODUCTION

Through the Solomon Islands Locally Managed Marine Areas (SILMMA) network, the government, FSPI, TNC, IWP, WWF (World Wide Fund for nature) and other non-government organizations (NGOs) are working closely with many local communities in Solomon Islands to promote and improve management and sustainable use of coastal marine resources. Three of those communities are Marau in Guadalcanal Province, Ngella in the Central Islands Province and Langalanga in Malaita Province. Management measures being promoted at these sites include MPA establishment, ban on destructive fishing methods and resource enhancement trials.

To date, two community-based and managed MPAs have now been established in Marau (Ramohia, 2004) by the Marapa and Simeruka communities and another two have now been established in Ngella by the Leitongo communities (Ramohia et. al., 2005). It is expected that many more will be established through this network in other parts of Solomon Islands in future.

After completing the Leitongo baseline survey from 23rd to 26th July, 2004, the SILMMA team comprising personnel from FSPI, DFMR, TNC and IWP proceeded on to Maravaghi community and undertook a baseline survey on key commercially important marine invertebrate species of their proposed MPA from 27th to 29th.

Specific activities undertaken during this baseline survey include:

a) field data collection
b) species identification training for community representatives
c) survey methodology training for community representatives and
d) education and awareness raising

This report presents the results of the baseline survey carried out for the Maravaghi community-based MPA.

2.0 METHOD

2.1 Study Sites

The study sites for this baseline survey consisted of the Maravaghi MPA and two reference reef areas of Luhunago and Taihola reefs (Figure 1). These study sites are located in the vicinity of Maravaghi resort. The MPA is established and owned by the Maravaghi community which also included the owners and staff of the resort and they themselves were responsible its demarcation. Detail information on the study sites and their exact coordinates are given Tables 1a and 1b.

2.2 Survey Procedures

The survey procedures and sampling methods used in this baseline study is adopted from the Arnavon Marine Conservation Area (AMCA) study (Lincoln-Smith and Bell, 1996). These procedures and sampling methods were also described in Ramohia (2004) and Ramohia *et al.*, (2005). As explained also in previous baseline studies (Ramohia, 2004 and Ramohia *et. al.*, 2005) the sampling methods were selected for the following reasons:

(i) The methods are suitable and relevant for monitoring the monitoring program i.e. monitoring of important commercial marine invertebrates.

(ii) The methods are simple and therefore are easy to learn quickly.

(iii) Because the methods are simple and therefore easy to learn quickly, the training component of the monitoring program can be successfully implemented within a short period of time.

A summary of the survey procedures and methods are given below.

2.2.1 *Invertebrates in the Shallow Habitat*

Surveys in the shallow habitat were done at depths between 1 – 4 m. Invertebrates surveyed included giant clams, Trochus (*Trochus niloticus*), pearl oysters (of Genus *Pinctada* & *Pteria*) and several species of sea cucumbers including lollyfish (*Holothuria atra*), surf redfish (*Actinopyga mauritiana*), orangefish (*Pearsonothuria graffei*) and greenfish (*Stichopus chloronotus*). Indicator species such as Crown of thorn star fish (*Acanthaster planci*), false trochus (*Tectus pyramis*) and Tritons (*Charonia tritonis*) were also recorded.

Sampling was done using 50 m long by 2 m wide transects. Six transects were laid haphazardly over the terrace at each site. Two teams of divers were involved in sampling. Table 2 gives the list of invertebrate species surveyed.

2.2.2 *Invertebrates in the Deep Habitat*

Surveys in the deep habitat were done at depths ranging from 14 – 30 m. The deep habitat included the slope below the terrace. In this habitat, only sea cucumbers were surveyed. However, the larger species of giant clams and pearl oysters were also recorded when encountered in transects.

Sampling was done using 50 m long by 5 m wide transects. Five transects were laid approximately parallel to the reef crest and over soft substratum or rubble (hard or rocky bottoms were avoided). Only one team of SCUBA divers was involved in sampling. Table 2 gives the list of invertebrate species surveyed.

3.0 TRAINING

Four community representatives were trained during this baseline study (Table 3). They were trained in the identification of target or key invertebrate species (based on common English and

local dialect names) and sampling methods. Training on the sampling methodology also included a land based demonstration and a field practical session in laying transects and data recording. A brief outline of the survey rationale was also given to the trainees.

4.0 DATA ANALYSIS

As in previous MPA baseline studies (Ramohia, 2004 and Ramohia *et al.,* 2005), no statistical analysis was performed on the data collected during the survey. The data has however, been interpreted graphically as follows.

Mean and standard errors (±SE) for species and composite variable were calculated for the MPA and the reference areas. Graphs were then constructed for the MPA and reference areas for each species and composite variable. These graphs allow for easy comparison between the MPAs and reference areas.

5.0 RESULTS

5.1 General

Only 3 species of sea cucumbers, 8 species of bivalves (giant clams and oyster shells) and the two gastropod species *Trochus niloticus* and *Tectus pyramis* were encountered at the three sites sampled during this baseline survey (Table 4). Many species like the gold lip pearl oyster (*Pinctada maxima*), greensnail (*Turbo marmoratus*), the giant clams *Tridacna gigas* and *Hippopus hippopus* and the coral predator crown of thorn (*Acanthaster planci*) were not observed at the study sites.

Abundance of important species of invertebrates vary greatly between the two habitats surveyed (shallow and deep) and the sites sampled (Maravaghi MPA and two reference areas). For example, the shallow habitat recorded more species than the deep (Table 4) while Maravaghi MPA recorded not only the highest number of invertebrate species (Fig. 2) but also the highest overall number of invertebrates (Fig. 5) and giant clams in this habitat (Fig. 4).

Although the shallow habitats recorded more invertebrates than the deep habitats, overall, the abundance of sea cucumbers in both habitats and the sites surveyed were very low. Not only that the number of sea cucumber species recorded in transects low, the total number of individual

found is also very low. As stated above, only 3 species comprising 3 individuals were recorded in this habitat.

The rest of this Section provides more detail on the key marine invertebrate species.

5.2 Invertebrates in the Shallow Habitat

Results for twelve species and composite variables from the shallow habitat are shown in Figures 2 to 13. The mean number of species of commercially important invertebrates ranged from 1.17 (±0.31) at Taihola reference area to 2.17 (±0.79) at the Maravaghi MPA (Fig. 2). Luhunago reference site recorded 1.83 (±0.48) (Fig. 2).

Sea cucumber was only recorded at the Maravaghi MPA with a mean number of 0.33 (±0.21) (Fig. 3). The two reference areas did not record any sea cucumbers. Only two species of sea cucumbers comprising 2 individuals were recorded in the shallow habitat. These were the tigerfish (*Bohadschia marmoratus*) and amberfish (*Thelenota anax*).

Maravaghi MPA recorded the highest mean number of giant clams per transect with 2.67 (±0.95) compared to Luhunago reef with 2.00 (±0.73) and Taihola reef 0.5 (±0.34) (Fig. 4). *Tridacna maxima* was the most abundant species with 18 individuals recorded in sampled transects.

The mean number of all commercially important invertebrates ranged from 1.33 (±0.33) at Taihola reef to 3.67 (±1.43) at the Maravaghi MPA (Fig. 5). Luhunago reef recorded the second highest with 2.83 (±1.14).

Tridacna crocea was more abundant at Luhunago reef than both Maravaghi MPA and Taihola reef with a mean number of 0.67 (±0.33) (Fig. 6). Maravaghi MPA and Taihola reef recorded 0.50 (±0.50) and 0.33 (±0.21) respectively. *T. maxima* was the most abundant of the clam species (Fig. 7). However, the species was only recorded at the Maravaghi MPA and Luhunago reef with mean numbers of 1.67 (±0.56) and 1.33 (±0.56) respectively (Fig. 7). *T. derasa* was recorded both at the Maravaghi MPA and Taihola reef with the same mean number of 0.17 (±0.17) respectively (Fig. 8). *T. squamosa* was only observed at the Maravaghi MPA with a mean number of 0.33 (±0.33) (Fig. 9). *T. gigas* and *Hippopus hippopus* were not recorded at the study sites.

Trochus niloticus was recorded only at the Maravaghi MPA and Luhunago reef with the same mean number of 0.17 (±0.17) respectively (Fig. 10) while the false trochus *Tectus pyramis* was encountered at all three sites with a mean number 0.50 (±0.34) at the Maravaghi MPA and Luhunago reef respectively and 0.33 (±0.21) at Taihola reef (Fig. 11). The blacklip pearl oyster (*Pinctada margaritifera*) was recorded only at Taihola reef with a mean density of 0.17 (±0.17) (Fig. 12).

Only two species of sea cucumber were recorded in sampled transects. These were tigerfish (*Bohadschia argus*) and amberfish (*Thelenota anax*). Both species were seen only at the Maravaghi MPA each with a mean number of 0.17 (±0.17) respectively (Fig. 13 & 14).

Greensnail (*Turbo marmoratus*) and the crown of thorn starfish (*Acanthaster planci*) were not seen in sampled transects.

5.2.1 *Size Frequency Distribution*

Comparison of size frequency distribution among the MPA site and the Reference sites is limited by the relatively very small sample sizes. The number of individuals measured in the shallow habitat were very small (n > 50), making it difficult to detect (statistically) any change in exploited invertebrates across times and spatial scales (Lincoln-Smith and Bell, 1996). However, the average size of giant clams and *Trochus niloticus* found in the shallow habitat are given in Table 5.

5.3 Invertebrates in the Deep Habitat

Results for five species and composite variables from the deep habitat are given in Figures 15 – 19. The mean number of commercially important species in the deep habitat ranged from zero at the Maravaghi MPA to 0.40 (±0.24) at Taihola reef (Fig. 15).

The mean number of all sea cucumbers ranged from zero at Maravaghi MPA to 0.20 (±0.20) at both Luhunago and Taihola reefs (Fig. 16). Only two species of commercial sea cucumbers comprising 2 individuals were recorded in sampled transects in this habitat. These were white teatfish (*Holothuria fuscogilva*) and tigerfish (*Bohadschia argus*). White teatfish was only recorded at Taihola reef with a mean density of 0.20 (±0.20) (Fig. 17) and tigerfish at Luhunago reef with a mean density of 0.20 (±0.20) (Fig. 18).

The brown lip pearl oyster (*Pteria penguin*) was encountered only at the Taihola reef with a mean number of 0.40 (±0.40).

5.3.1 *Size Frequency Distribution*

Comparison of size frequency distribution among the MPA site and the Reference sites is also limited by the very small sample sizes. Like in the shallow habitat, the number of individuals measured in the deep habitat were very small (n > 50), making it difficult to detect (statistically) any change in exploited invertebrates across times and spatial scales (Lincoln-Smith and Bell, 1996). Overall, there was insufficient numbers of invertebrates in this habitat to include in the size frequency table.

6.0 DISCUSSION

As discussed in earlier reports (Ramohia, 2004 and Ramohia *et. al.,* 2005), the invertebrates listed in Table 2 are those known to be utilized as food resources (e.g. giant clams and beche-de-mer) or have other commercial value (e.g. trochus and pearl oysters) or have traditional, cultural and custom values (*Beguina semiorbiculata* and *Atrina vexillum*) and indicators of coral reef health (e.g. trumpet triton and crown of thorn starfish). The above reports also highlighted that dependency on marine invertebrates like sea cucumbers, Trochus and giant clams is likely to increase further in future. With the high dependency on these marine invertebrates, coastal communities in Solomon Islands are faced with the challenge of implementing appropriate management intervention to curb uncontrolled and unsustainable exploitation of these resources.

The result of this baseline study does not reflect well of the study area. Mean numbers of important invertebrate species in both the shallow and deep habitats for the Maravaghi MPA and the two reference areas of Luhunago and Taihola reefs are very low. In the shallow habitat the mean number of species ranged from 1.17 to 2.17 per transect whereas in the deep habitat, the mean numbers ranged from zero to 0.40. These results are even lower than those obtained for Leitongo (Ramohia et. al., 2005) and Marau (Ramohia, 2004).

Holland (1994) reported 22 and Ramofafia (2004) a possible 32 species of sea cucumbers being harvested in Solomon Islands respectively. However, only 3 of these species i.e. tigerfish (*B. argus*), white teatfish (*H. fuscogilva*) and amberfish (*T. anax*) were recorded in the sampled transects during this baseline study. Of these 3 species, 1 occurred only in the deep habitat, 1 only

in shallow and 2 in both shallow and deep habitats (Table 4). The two species found in the shallow habitat comprised only 2 individuals while the 2 species recorded in the deep habitat also comprised 2 individuals.

Mean densities of individual sea cucumber species in both the shallow and deep habitats is low. Of the 2 species recorded in the shallow habitat, amberfish was recorded with mean densities of 17 per hectare while tigerfish 20 per hectare. In the deep habitat, both white teatfish and tigerfish were recorded with a mean density of 8 per hectare. Many studies like Preston (1993), Lincoln-Smith and Bell (1996), Creese and Friedman (1995), Ramohia (2004) and Ramohia *et. al.*, (2005) have reported density figures for many of the sea cucumber species harvested in the South Pacific region and Solomon Islands. Although the above results may be similar to what is found in some of these studies, the results of this study may not be accurate enough to allow for a meaningful comparison with studies like Preston (1993) or Lincoln-Smith (1996) considering the fact that only a small number of sites with small numbers of transects were sampled per study site during this study. Thus the presence of one specimen in the five transects sampled in the deep habitat will be equivalent to a mean density of 8 per hectare while in the shallow, the presence of one specimen in the six transects sampled will be equivalent to a mean density of 17 per hectare. The results of this baseline should be taken with caution especially if one is to use them for comparison with results of work done elsewhere. These results however, would be useful for comparison with results from future assessment surveys undertaken of the MPA (Maravaghi) and the two reference areas to ascertain if any change in densities of sea cucumbers has occurred.

The fact that very low numbers of sea cucumber is recorded during this study for both the shallow and deep habitats is a big concern. Whether this is due to heavy exploitation or not is not clear, considering the fact that no historical harvest data is available for the sites surveyed.

Not all six species of giant clams known from Solomon Islands were recorded during this study. However, overall the Maravaghi MPA recorded the highest mean number of giant clams with 2.67 per transect, Luhunago reef 2.00 and Taihola reef 0.50. This would be equivalent to 267, 200 and 50 clams per hectare at the three sites respectively. Of the six, only *T. derasa, T. squamosa, T. maxima* and *T. crocea* were found. These species were recorded with varying mean numbers. *T. maxima* was the most common species of giant clam recorded among all three study sites with mean numbers of zero per transect at Taihola reef to 1.67 at the Maravaghi MPA. This would be

equivalent to 0 – 167 per hectare. Compared to Munro (1993), Ramohia *et. al.,* (2005), Lincoln-Smith and Bell (1996) and Creese and Friedman (1995), this is low. Munro (1993) reported well over 1,000 individuals per hectare in French Polynesia, Creese and Friedman (1995) 1,400 per hectare for the Indispensable Reef, Lincoln-Smith and Bell (1996) up to 194 for the AMCA region and Ramohia *et. al.,* (2005) up to 183 per hectare.

Tridacna crocea on the other hand was recorded with 50, 67 and 33 per hectare respectively. Compared to mean densities reported in other studies, this is low. For example, Munro (1993) reported densities well over 3,000 individuals per hectare in French Polynesia. *T. derasa* was recorded with mean densities of 17 per hectare at the Maravaghi MPA and Taihola reference area. *T. squamosa* was recorded only at the Maravaghi MPA with mean densities of 33 per hectare. This is very low compared to Creese and Friedman (1995) who reported higher densities of up to 500 per hectare at the Indispensable Reef. *T. gigas* and *Hippopus hippopus* were not recorded at all in this study. Larger species of giant clams like the *T. gigas* is vulnerable to over-exploitation but whether the result obtained here is related to over-exploitation or not is not clear as there were no historical harvest data available for this species for the area.

Trochus niloticus was encountered in sampled transects only at the Maravaghi MPA and Luhunago reference area with a mean density of 17 hectare respectively. This is very low compared to Nash, 1993 and Nash *et. al., 1995*. In contrast, the false trochus *Tectus pyramis* was recorded at all three study sites with mean densities ranging from 33 – 50 per hectare. Blacklip pearl oyster (*Pinctada margaritifera*) on the other hand was present only at Taihola reference area with a mean density of 17 per hectare. Whilst gold lip (*P. maxima*) was not encountered during the survey, Brown lip (*Pteria penquin*) was recorded only at Taihola reference area with a mean density of up 40 per hectare.

The shell maoney species ke'e (*Beguina semiorbiculata*) was found with very low mean densities. Kurila (*Atrina vexillum*) on the other hand, was not encountered at all at any of the study sites.

The main expectation of this baseline study is to be able to detect change in realistic increase in abundance and size of commercially important invertebrates over time and at spatial scales. This is because: (1) low abundances were found prior to MPA declaration and (2) similar levels of variabilities in the MPA and reference areas.

A major concern would be that sample sizes for length frequency analysis may not be large enough to provide an appropriate test for the study sites. Unlike the "before" and "after" or Beyond BACI procedures (Underwood, 1993) whereby a relationship is established before human impact, the relationship between the MPA and reference areas in this case is established in the presence of human fishing activity. The impact of removal of fishing from the MPA will be assessed through the "before" and "after" sampling regime. Two assumptions are therefore important: (1) no fishing in the MPA and the level of fishing in the reference areas remain unchanged and (2) the conditions within the MPA would be suitable to support an increase in number and size of invertebrates than occur there now in the absence of exploitation.

7.0 CONCLUSION

This baseline study has established the following:

(1) The abundance of important (commercial & subsistence) invertebrate species in the Maravaghi study area (MPAs & Reference Areas) is very low, even lower than what was found for the Leitongo MPAs (Ramohia *et. al.*, 2005), Indispensable reef (Creese and Friedman, 1995), Marau MPAs (Ramohia, 2004), the AMCA (Lincoln-Smith and Bell, 1996 and Lincoln-Smith *et. al*., 2000) and the south Pacific region (Munro, 1993). The establishment of an MPA by resource owners of Maravaghi for the conservation and enhancement of marine resources is a step in the right direction.

(2) Sea cucumber species, Trochus and some species of giant clams like *T. derasa* and *T. squamosa*) are probably heavily exploited in the study area resulting in the very low abundance of these species. The fact that *T. gigas* was never recorded during the survey is a great concern. This may be the result of over-exploitation.

(3) Maravaghi MPA recorded more invertebrate species than either of the two reference areas Luhunago and Taihola reefs. The decision to establish this MPA is a good one.

(4) For the MPA to be successful, the Maravaghi and surrounding communities must have respect for their MPA. Not only that, partner support for this community initiative will also be necessary to ensure community commitment and interest in the long term.

(5) No coral damage from crown of thorn starfish *Acanthaster planci* infestation was observed in the study area. Although dynamite fishing used to be practiced in the area and coral harvesting for the Aquarium Trade and lime production is taking place in the area, coral destruction associated with these activities is minimal.

8.0 RECOMMENDATION

MPAs serve many purposes (Ramohia, 2004) and can be used by coastal communities as a marine resource management tool. The establishment of the Maravaghi MPA is an important step towards the management and protection of marine resources in Ngella. As such, it will be of paramount importance that the people of Maravaghi community respect this MPA. At the same time, the support from other stakeholders such FSPI, Department of Fisheries and Marine Resources for this community initiative is crucial.

In light of the importance of this community MPA and the results of this baseline survey, the following are recommended.

(a) The community must be assisted through annual surveys of their MPA so that additional sets of data are made available for comparison of numbers (and sizes) of invertebrates before and after declaration thus determining the success or effectiveness of the MPA. Through such surveys, community interest will be maintained. The participation of more members of the Solomon Islands Locally Managed Marine Area (SILMMA) partners in this FSPI coordinated initiative in future is desirable and recommended.

(b) In future, although not absolutely necessary at this stage, the possibility of monitoring other marine resources and habitats such as Fish, Corals and Seagrass must also be considered.

(c) It is important that the result of this baseline survey and future surveys must be taken back and shared with the Maravaghi community.

9.0 ACKNOWLEDGEMENT

This baseline survey has been successful as a result of the contributions of many organizations and individuals. The South Pacific Regional Environmental Program (SPREP) funds this study through

the Coral Gardens Project, coordinated by FSPI and the Department of Fisheries and Marine Resources.

The Solomon Islands FSPI and SILMMA coordinator Mr. Silverio Wale is commented for his tireless effort in ensuring FSPI program activities are properly coordinated.

The Chiefs, village elders, community members and the owners of the Maravaghi resort are very supportive of this study and without their support the baseline study would not have been possible.

The willingness and enthusiasm shown by the community representatives to learn and take part in training and the actual baseline survey, especially data collection in the shallow habitat, is acknowledged. They include Joseph Keba, Harry Pandapanda, Simon Suba and Isaiah Kapini.

The contribution of those who assisted in data collection in the deep habitat is commented. They include Peter Rex Lausu'u of Department of Fisheries, Hugo Tafea (ECANSI), Ferral Lasi (TNC) and Patrick Mesia (IWP).

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Table 1a: A general description of the sampling sites

SHALLOW AND DEEP HABITATS

Locality	Site	Site Description
Maravaghi MPA	S1/D1	Sheltered reef terrace and slope in front of Maravaghi Resort.
Luhunago Island	S2/D2	Reef terrace and slope in front of a small village on southern end of island.
Taihola Reef	S3/D3	Reef terrace and slope opposite to the Maravaghi Resort and south of Niumala village.

Table 1b: Latitude and longitude for each sampling site, measured using a Global Positioning System (GPS)

LOCALITY	SITE	LAT. (South)	Long. (East)
Maravaghi MPA	S1	08° 57.06'	160°03.48'
Luhunago Reef	S2	08° 57.71'	160°02.95'
Taihola Reef	S3	09° 01.36'	160°07.60'
Maravaghi MPA	D1	09° 00.08'	160°06.10'
Luhunago Reef slope	D2	08° 57.73'	160°02.95'
Taihola Reef slope	D3	08° 57.55'	160°03.63'

Table 2: Invertebrate species studied during this baseline survey.

TAXA	COMMON NAME	SPECIES
Sea cucumbers	Deepwater redfish	*Actinopyga echinites*
Sea cucumbers	Stonefish	*Actinopyga lecanora*
Sea cucumbers	Surf redfish	*Actinopyga mauritiana*
Sea cucumbers	Blackfish	*Actinopyga miliaris*
Sea cucumbers	Tiger/Leopardfish	*Bohadschia argus*
Sea cucumbers	Chalkfish/false Teatfish	*Bohadschia similes*
Sea cucumbers	Brown sandfish	*Bohadschia vitiensis*
Sea cucumbers	Lollyfish	*Holothuria atra*
Sea cucumbers	Snakefish	*Holothuria coluber*
Sea cucumbers	Pinkfish	*Holothuria edulis*
Sea cucumbers	White Teatfish	*Holothuria fuscogilva*
Sea cucumbers	Elephant's trunkfish	*Holothuria fuscopunctata*
Sea cucumbers	Black Teatfish	*Holothuria nobilis*
Sea cucumbers	Sandfish	*Holothuria scabra*
Sea cucumbers	Orange/flowerfish	*Pearsonothuria graeffei*
Sea cucumbers	Greenfish	*Stichopus chloronotus*
Sea cucumbers	Dragonfish (Peanutfish)	*Stichopus horrens*
Sea cucumbers	Curryfish	*Stichopus hermanni*
Sea cucumbers	Brown curryfish	*Stichopus vastus*
Sea cucumbers	Prickly redfish	*Thelenota ananas*
Sea cucumbers	Amberfish	*Thelenota anax*
Sea cucumbers	Lemonfish	*Thelenota rubralineatus*
Pearl Oysters	Gold lip pearl oyster	*Pinctada maxima*
Pearl Oysters	Blacklip pearl oyster	*Pinctada margaritifera*
Pearl Oysters	Brown pearl oyster	*Pteria penquin*
Giant clams	Giant clam	*Tridacna gigas*
Giant clams	Smooth giant clam	*Tridacna derasa*
Giant clams	Fluted giant clam	*Tridacna squamosa*
Giant clams	Rugose giant clam	*Tridacna maxima*
Giant clams	Burrowing giant clam	*Tridacna crocea*
Giant clams	Horseshoe clam	*Hippopus hippopus*
Snails	Trochus	*Trochus niloticus*
Snails	False Trochus	*Pyramis tectus*
Snails	False Trochus	*Trochus maculates*
Snails	Greensnail	*Turbo marmoratus*
Snails	Triton*	*Charonia tritonis*
Starfish	Crown of Thorns*	*Acanthaster planci*

* Indicator species coral reef health

Table 3: List of community representatives who were trained in the survey methodologies during this baseline survey

Name	Community (Village)
Joseph Keba	VDW - Ngella communities
Harry Pandapanda	Sisili MPA – Leitongo
Simon Suba	Taburu MPA – Leitongo
Isaiah Kapini	Maravaghi MPA – Maravaghi Resort

Table 4: Invertebrate species composition and distribution for the two habitats surveyed.

SHALLOW HABITAT	DEEP HABITAT	SHALLOW AND DEEP HABITAT
Sea Cucumbers		
Thelenota anax (Amberfish)	*Holothuria fuscogilva* (white teatfish)	*Bohadschia argus* (tigerfish)
Bivalves		
Tridacna crocea	*Pteria penguin (brownlip)*	-
Tridacna maxima	-	-
Tridacna squamosa	-	-
Tridacna derasa	-	-
Pinctada margaritifera (blacklip)	-	-
Beguina semiorbiculata (Ke'e)	-	-
Atrina vexillum (Kurila)	-	
Gastropods		
Tectus pyramis (False trochus)	-	-
Trochus niloticus	-	-

Table 5: Number and average sizes of some invertebrate species recorded in the shallow habitat during this baseline study. (Note: only 2 sea cucumbers and 2 pearl oysters were recorded in the deep habitat).

Shallow Habitat **Species**	**Average size (cm)**	**Numbers found (n)**	**Range (cm)**
Tridacna derasa	31	2	27.0 – 35.0
T. squamosa	29.5	2	28.0 - 31.0
T. maxima	15.1	18	4.0 – 24.0
T. crocea	8.3	9	6.0 – 11.0
Trochus niloticus	9.7	2	8.3 – 11.0

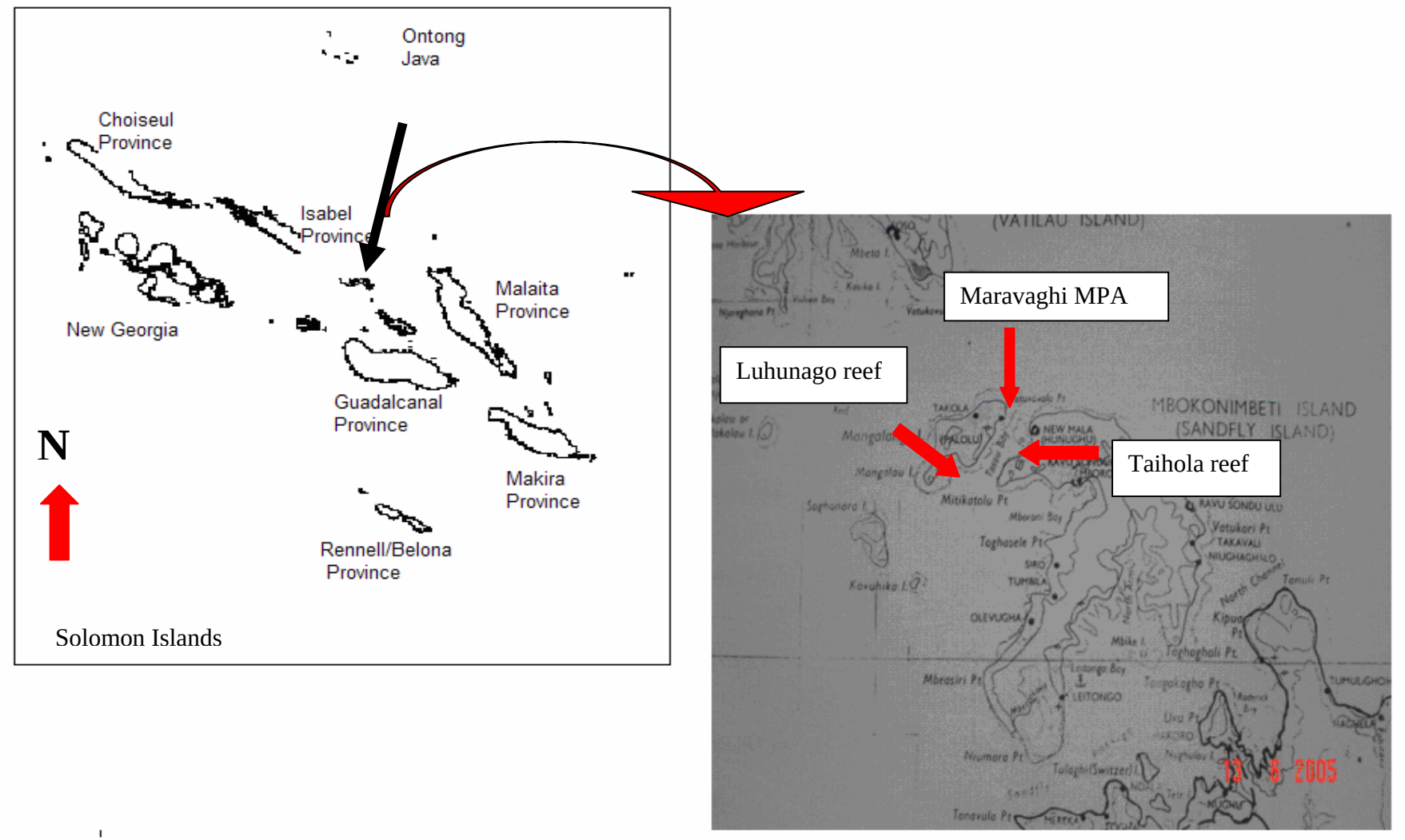

Figure 1: Map of Solomon Islands and Florida group showing the approximate locations of the Maravaghi study sites

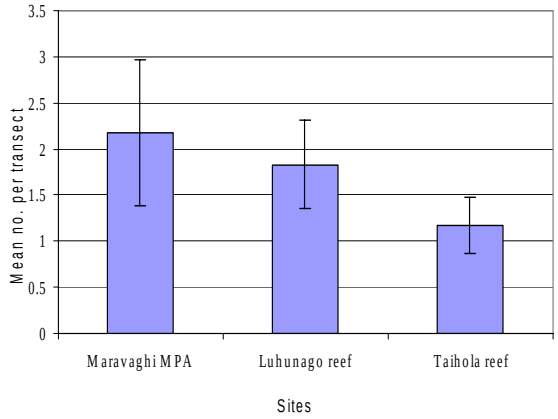

Figure 2: Mean number (±SE, n=6) of species for the Maravaghi MPA and the two reference areas of Luhunago and Taihola in the shallow habitat.

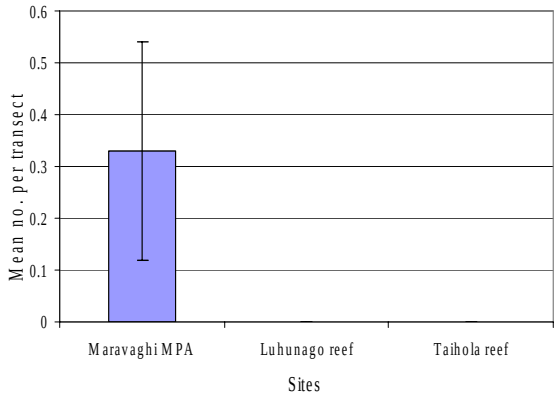

Figure 3: Mean number (±SE, n=6) of sea cucumbers for the Maravaghi MPA and the two reference areas of Luhunago and Taihola in the shallow habitat.

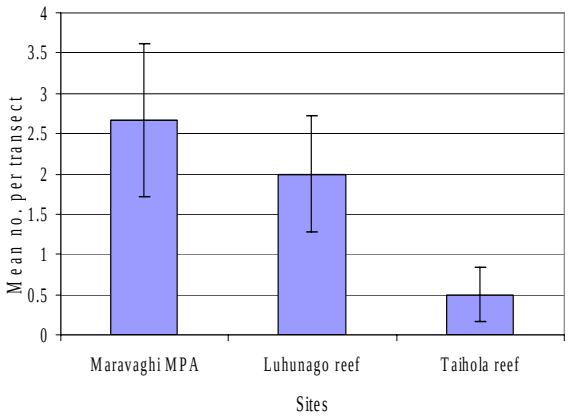

Figure 4: Mean number (±SE, n=6) of giant clams for the Maravaghi MPA and the two reference areas of Luhunago and Taihola in the shallow habitat.

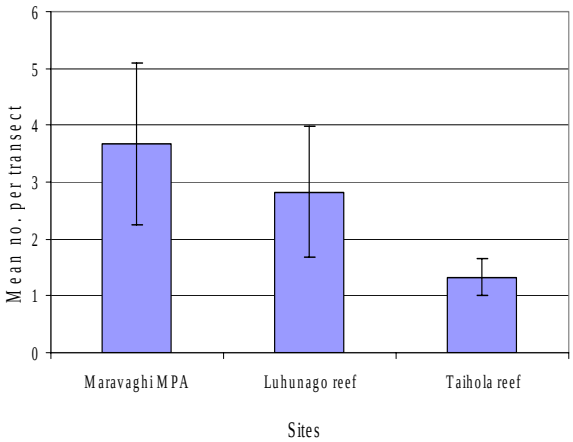

Figure 5: Mean number (±SE, n=6) of all invertebrates for the Maravaghi MPA and the two reference areas of Luhunago and Taihola in the shallow habitat.

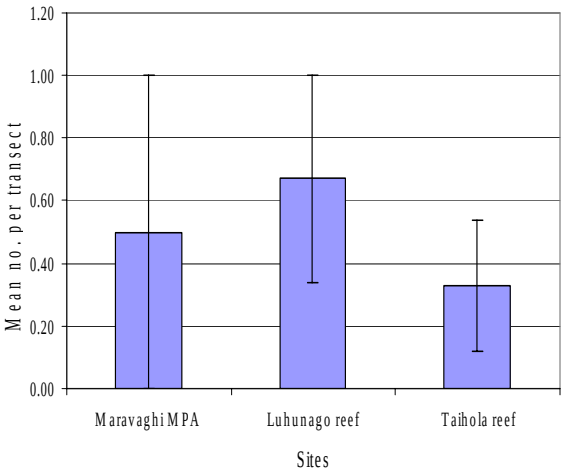

Figure 6: Mean number (±SE, n=6) of *T. crocea* for the Maravaghi MPA and the two reference areas of Luhunago and Taihola in the shallow habitat.

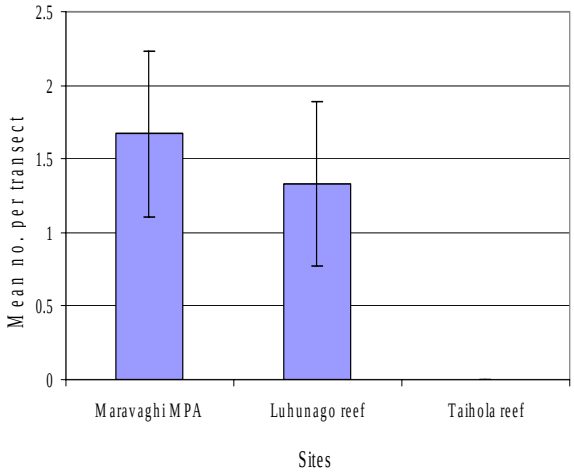

Figure 7: Mean number (±SE, n=6) of *T. maxima* for the Maravaghi MPA and the two reference areas of Luhunago and Taihola in the shallow habitat.

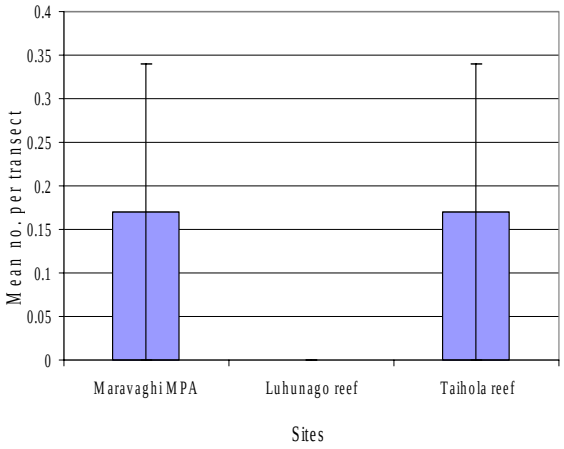

Figure 8: Mean number (±SE, n=6) of *T. derasa* for the Maravaghi MPA and the two reference areas of Luhunago and Taihola in the shallow habitat.

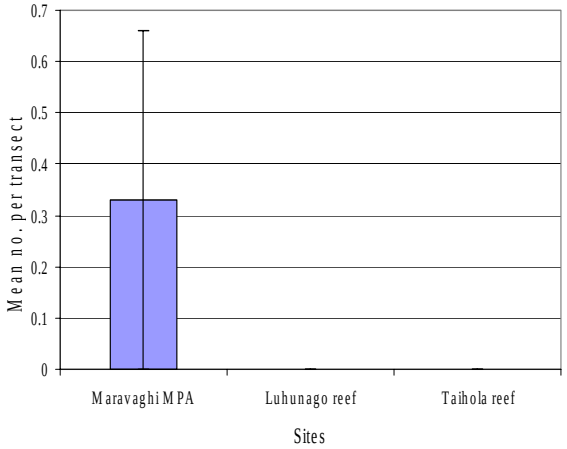

Figure 9: Mean number (±SE, n=6) of *T. squamosa* for the Maravaghi MPA and the two reference areas of Luhunago and Taihola in the shallow habitat.

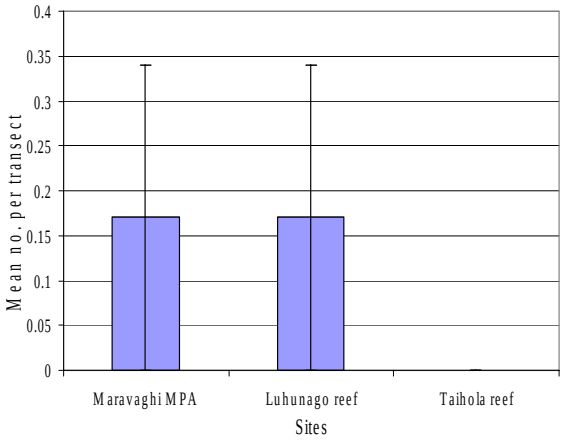

Figure 10: Mean number (±SE, n=6) of *Trochus niloticus* for the Maravaghi MPA and the two reference areas of Luhunago and Taihola in the shallow habitat.

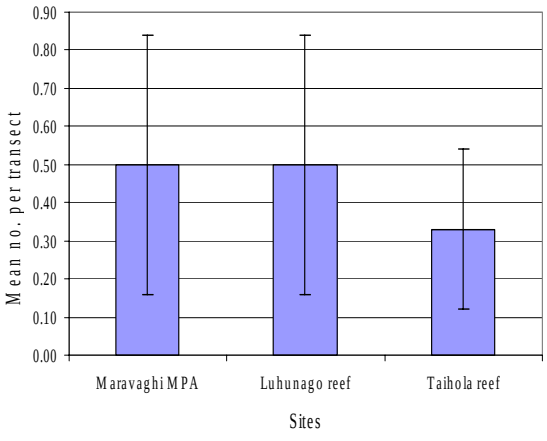

Figure 11: Mean number (±SE, n=6) of *Tectus pyramis* for the Maravaghi MPA and the two reference areas of Luhunago and Taihola in the shallow habitat.

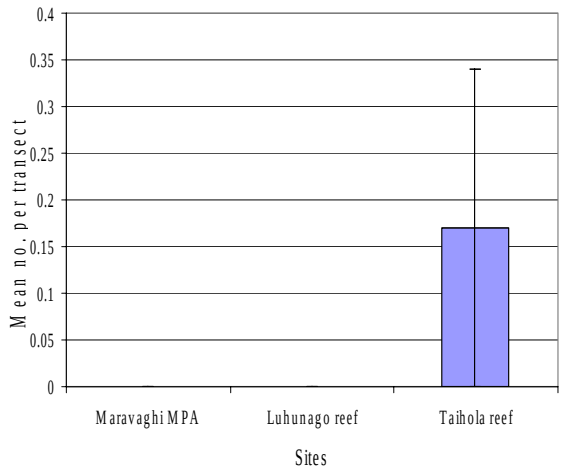

Figure 12: Mean number (±SE, n=6) of *P. margaritifera* for the Maravaghi MPA and the two reference areas of Luhunago and Taihola in the shallow habitat.

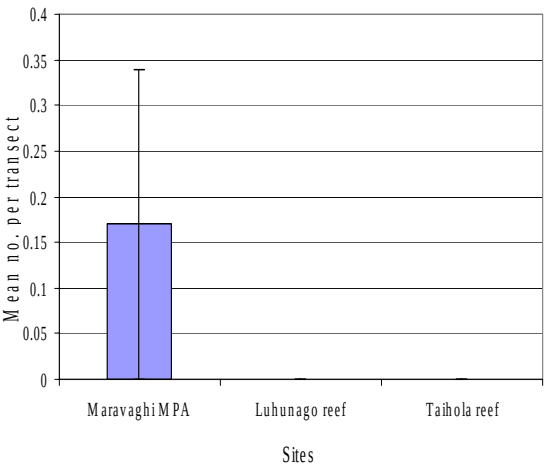

Figure 13: Mean number (±SE, n=6) of *B. argus* for the Maravaghi MPA and the two reference areas of Luhunago and Taihola in the shallow habitat.

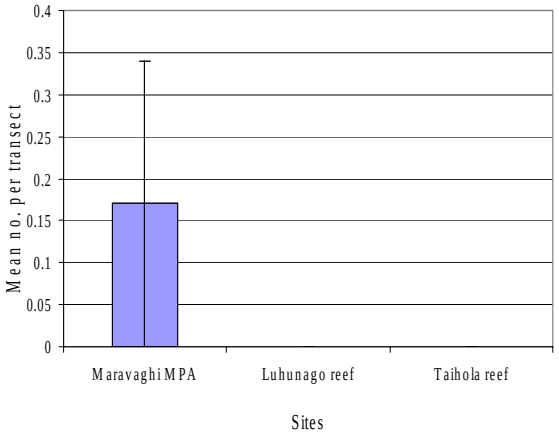

Figure 14: Mean number (±SE, n=6) of *T. anax* for the Maravaghi MPA and the two reference areas of Luhunago and Taihola in the shallow habitat.

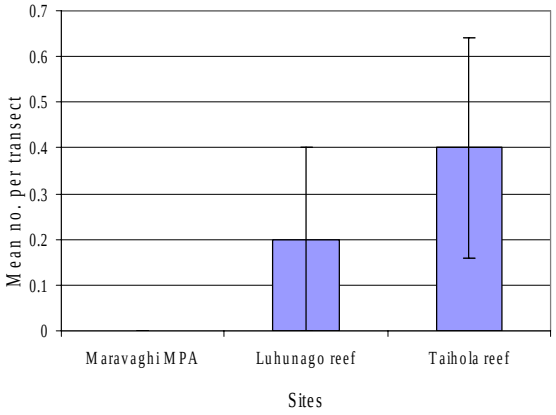

Figure 15: Mean number (±SE, n=5) of species for the Maravaghi MPA and the two reference areas of Luhunago and Taihola in the deep habitat

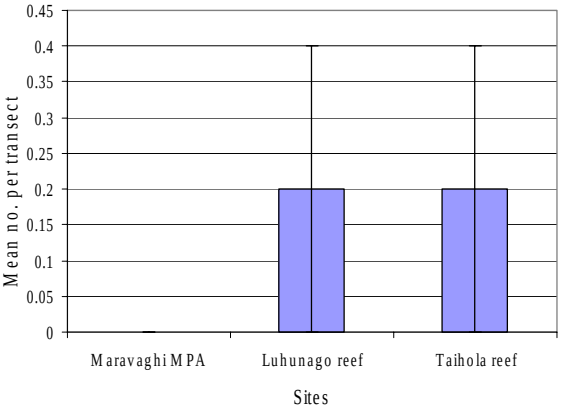

Figure 16: Mean number (±SE, n=5) of sea cucumber for theMaravaghi MPA and the two reference areas of Luhunago and Taihola in the deep habitat.

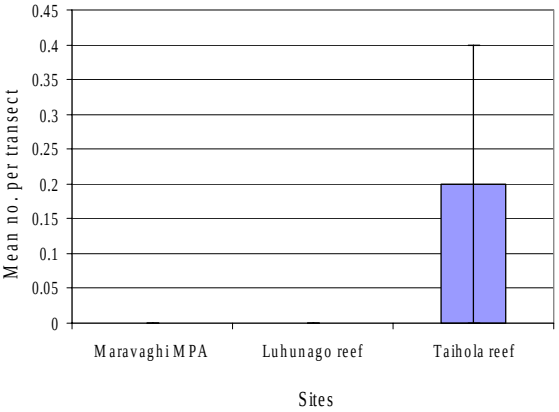

Figure 17: Mean number (±SE, n=5) of *H. fuscogilva* for the Maravaghi MPA and the two reference areas of Luhunago and Taihola in the deep habitat

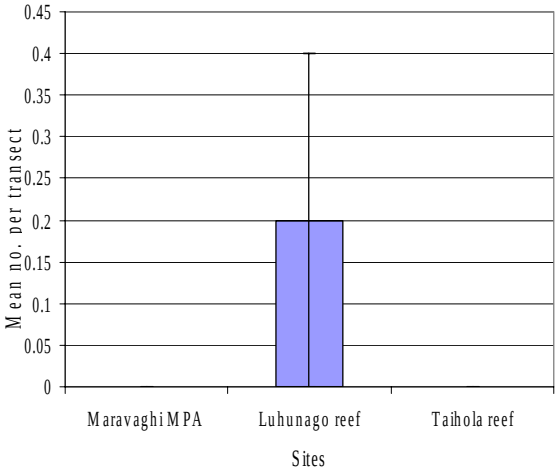

Figure 18: Mean number (±SE, n=5) of *B. argus* for the Maravaghi MPA and the two reference areas of Luhunago and Taihola in the deep habitat

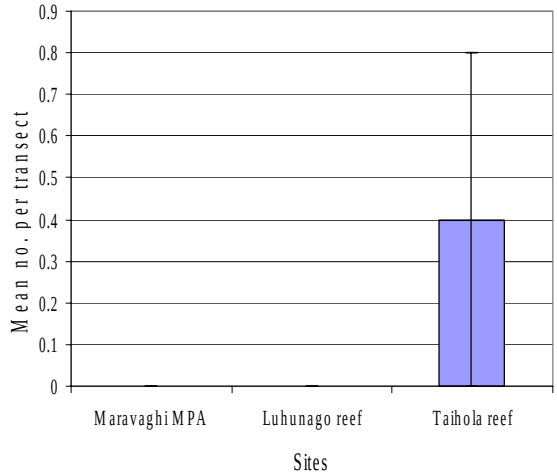

Figure 19: Mean number (±SE, n=5) of *Pteria penguin* for the Maravaghi MPA and the two reference areas of Luhunago and Taihola in the deep habitat