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TO: NOAA

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RE: NA06NMF460107
Reporting Period 9/1/2006 to 03/31/08
Title: Invertebrates, communities, and reef health in Airai, the Republic of Palau

The Environment, Inc. in partnership with Ngarabrekork, Inc. has completed the Invertebrate Project. The following has been accomplished:

- A total of 32 field trips were conducted in Airai State
- Data was analyzed and mapped.
- 23 Ngarabrekork Members (and 7 Ngaremeliwei members as assistants) were trained on invertebrate measurement, operation of the "in-water" GPS and quantification of seagrass habitat and invertebrates using the transect method.
- Finding were presented at 7 community meetings including over 250 people with a final presentation to the Airai Planning Commission
- A simple management plan was developed based upon the findings and community discussions
- A Poster Presentation will occur at the Coral Reef Symposium on July 8, 2008

Administration and Financial Reporting

During the months of September through to November 2006, a total of $33,865.00 was received through the Voice Response System. As of March 31, 2008, all funds had been spent to implement this project.

Monthly monitoring of invertebrates

During November 2006 to February 2008 a total of 32 field trips were made. The TEI team and members of Ngarabrekork and Ngarameliwei monitored invertebrates with the two GPS units provided by the Coral Reef Research Foundation (CRRF). The TEI team trained the Ngarabrekork team how to set up and operate the units. The "in-water" GPS units were simple to operate and the Ngarabrekork trainees did not have any problems during the surveys. The tracking data is in agreement with existing maps of the reef in this area. Invertebrates were collected, measured and weighed. Fieldwork indicated that seasons, time of month and day all contribute to the distribution and abundance of invertebrates. Certain women are more skilled and knowledgeable about the reefs than others. Less skilled women were more destructive when prying out embedded clams. The more skilled women extract the clam only, the less skillful break corals in two. This project was community driven, and through this process, three major areas were identified as having habitats rich with a variety of the targeted species including embedded clams, sea urchins and sea cucumbers. These sites included the western fringing reef area called Ongeuidel, the southern fringing reef area called Bkulomelochel, and the eastern fringing reef area called Orakibad to the east coast. The results are presented as the West, South and East sites (Figure 1.)

Habitat Monitoring

Preliminary analysis indicated that invertebrate species overlap habitats and are less restricted to a given habitat as we had thought. Therefore transects were set in habitats that represented several invertebrates rather than just one as was originally proposed. We found that areas with higher densities of invertebrates were usually less accessible areas. Permanent transect sites were established. Three 50-meter transects are set parallel within the three major reef areas selected. The young girls were trained to identify and measure densities and blade lengths of the seagrass species. In addition they learned how to photo-document and quantify invertebrates along the transect lines. The trained members of Ngaremeliwei young men's group helped to train the younger women in the Ngarabrekork group.

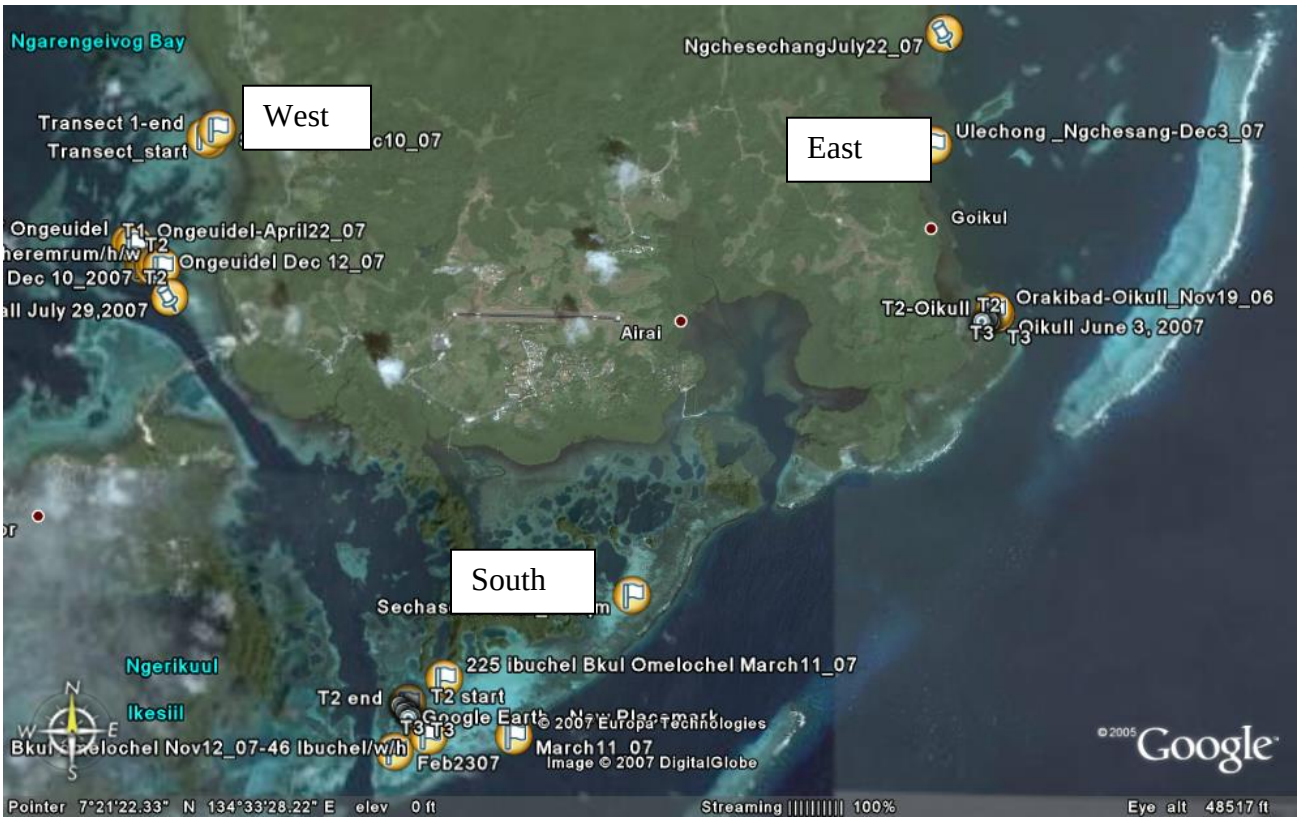


Figure 1. The three main sites were analyzed as the West, South and East Reefs shown above.

Seagrass

The maximum densities for the four seagrass species found were at the northeastern reef of Oikull and southern reef of Bkulomelochel (Figure 2). The highest density of *Enhalus acoroides* (48 /m^2) was recorded at the northeastern reef of Oikull. The highest density of Thalassia *hemprichii* (64/ m^2) was recorded at the southern reef of Bkulomelochel. The highest density of *Cymodacea* sp. (92/m^2) was recorded at Oikull (Figure 3.) The highest density of *Syringodium* sp. (16 m^2) was recorded at Ngechesechang. The Eastern reefs had the highest mean densities for all sea grasses.

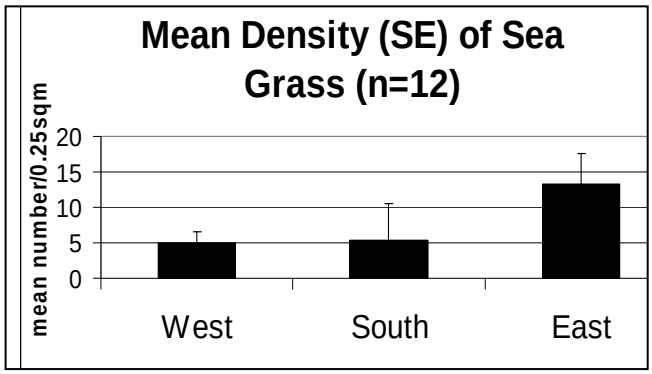


Figure 2.Mean density (standard error) of four seagrass species

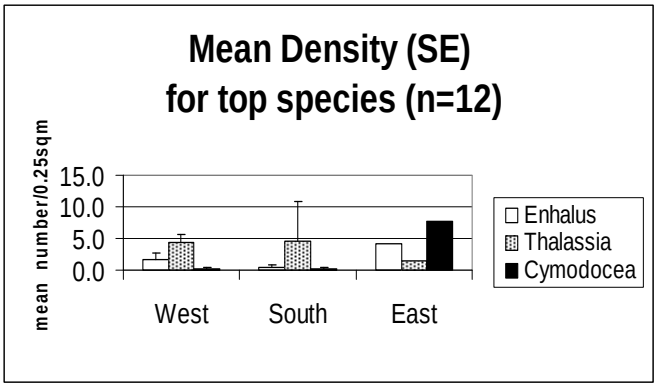


Figure 3. Mean density (standard error) for each of 3 seagrass species counted

Coral

Substrate coverage was quantified at the western reef along 4 transects. The mean coverage was as follows: live coral 54.6% (sd=36.1), dead coral 6.4% (sd=2.8), coral rubble 15.0(sd=7.0) and sand 25.8% (sd=6.2) (Figure 4). An estimated 36% of the live coral was the genus *Porites.* Embedded clam *Tridacna crocea* and *T. maxima* (oruer) densities tended to be higher where the coverage of *Porites* was higher (Table 1).

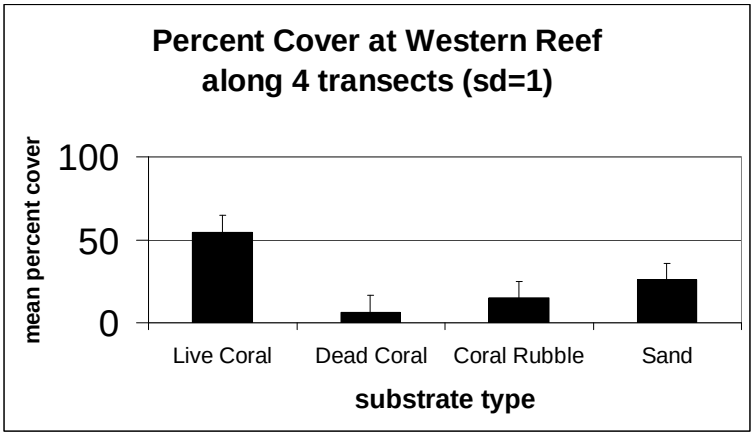


Figure 4. Mean substrate cover at the western reef.

Table 1. Percent Live Cover of *Porites lutea* and the density of *Tridacna crocea* and *T. maxima* on 4 transects along the western reef.

Transect	Percent *Porites lutea*	Density of *T.crocea* & *T. maxima* Density (Number /m^2)
1	23.39%	0.09
2	47.98%	0.12
3	46.75%	0.12
4	25.03%	0.11
Mean	35.7	0.11
sd	0.10	0.02

Tracking Results

The women had tracking GPS units attached to their basins as they harvested along the reefs. In some cases the units malfunctioned and data was lost or not recorded. The following data represents the results of the completed tracks. The mean speed for the women using the mobile GPS unites was 630m/w/h (sd =198, n=24). The average search width was 4 m. Therefore the mean area covered was 2,520 m^2/h or 0.25ha/h. When the women were swimming in either deeper water or high tides, they stopped 9 % of the time on average (sd=6%, n=13) and swam 91% of the time (sd=6%, n=13). When the women were walking they stopped 30 % of the time (sd=11%, n=9) and moved 70 % of the time (sd=11%, n=9. The women stopped to harvest or process invertebrates or rest. The women swam or walked to search or reach an area to search.

Catch Per Unit Effort

Total biomass for all invertebrates collected at all sites showed a significant difference between sites. The non parametric Kruskal-Wallis test was used to test the null hypothesis that the biomass of invertebrates collected per hour (kg/w/h/) and the biomass of invertebrates collected per hour per hectare (kg/w/h/ha) did not differ significantly between sites (West, South, East) for the years 2006 to 2008. The statistic H for was equivalent to 10.14 and 14 respectively which were both greater than the $X^2_{.05[2]}$ value = 5.99. Therefore the null hypothesis is rejected and a significant difference in CPUE and CPUE/ha exists between sites. The CPUE (kg/w/h) was greater at the East site followed by the South and West sites. This may be explained in part a larger population of *Actinopyga miliaris* at the East site and *Tripneustes gratilla* and *Hippopus* at the southern reef. The biomass (kg)/w/h/ hectare was greater along the western reefs. This may be explained in part by the fact that at west site the women focused within a smaller given reef area to harvest the embedded *Tridacna* clams along the west coast and they went directly to this habitat. They were also most familiar with this site as it is their typical collecting areas. The eastern and western reefs had greater densities of the free living *Hippopus hippopus* which was a preferred species and therefore spent more time searching for *H. hippopus* which was already over harvested at the western site.

Table 2. The Catch per Unit Effort (CPUE) in biomass (kg/woman/hour) and the CPUE per hectare (kg/w/h/ha).

Site	West	South	East
kg/w/h	2.1 (sd=2.0, n=10)	2.4 (sd=2.2,n=12	2.8 (sd=2.2, n=6)
kg/w/h/ha	7.3 (sd=13, n=10)	6.9 (sd=9.8, n=12	4.3 (sd=4.9, n=6)

The same test showed a significant difference in the CPUE between sites for *Tridacna crocea* and *Tridacna maxima* counts (H = 42) and weight (H=46), *Hippopus hippopu*s counts (H = 27.6) and weight (H=56) and *Lambis lambis* counts (H =10). The counts of *Holothuria scabra* (molech) were too few to compare sites. The women did not select for *Stichopus variegatus* at the south site or the East site so a comparison between sites was not made.

Tridacna Clams

Tridacna crocea and *Tridacna maxima* are two species of "giant" clams that embed themselves in coral heads and must be pried out with a knife or metal tool. Women have different levels of skill in this extraction process. The western fringing reef of Ongeuidel is complex with 3 reef holes and a convoluted reef margin. The massive *Porites* corals had high densities of the embedded clams, *Tridacna crocea* and *Tridacna maxima*.

The non parametric Kruskal-Wallis test was used to test the null hypothesis that CPUE for counts (ct/w/h) and the biomass (kg/w/h) did not differ significantly between sites (West, South, and East) for the years 2006 to 2008 (Table 3). The statistic H for was equivalent to 42 and 46 respectively which were greater than the $X^2_{.05[2]}$ value = 5.99. Therefore the null hypothesis is rejected and a significant difference in CPUE and CPUE/ha existed between sites. The data suggest that larger yet fewer clams were collected at the eastern reef (Figure. The lowest CPUE of 0.5 was at the more accessible inner western reefs of Ongeuidel. A mean CPUE of 24clams/w/h (one woman collected at a rate of 35 clam/woman/hr) was at the outer and less accessible habitats of western reef of

Ongeuidel. The same CPUE of 24 was calculated at the eastern reef of Orakibad in Oikull, also a less accessible eastern reef.

A key finding was that the women were selective of the size they would harvest. Women harvested clams that were a mean length of 10.2 cm (sd=1.8, n=130) compared to the mean size of clam (7.1cm sd=3.6, n=146) along the transects (Table 3, Figure 5.) The smallest recorded size collected was 6.5 cm. The mean size of *T. crocea* and *T. maxima* along 3 transects at the western reefs was 7.1(sd=3.6, n=102). At the eastern fringing reef of Orakibad in Oikull, the mean clam size was 13.1cm (sd =4.1, n = 7). At the southern fringing reefs the largest mean size of *T. crocea* and *T. maxima* (11.0cm, sd =2, n =52) were collected. At the southern reef of Bkulomelochel, 42% of the clams found along the transect line were less than 6.5 cm in length and not considered harvestable by the women. At the western reef of Ongeuidel, only 11% of the clams measured along the transect line were less than the minimum size of 6.5cm.

Women stated that the undersized clams were left for future collections. These findings suggest that mean clam size may be a good indicator for management of embedded clams on a given reef. T. *crocea* and *T. maxima* would be a good candidate to indicator species of the health of a reef. The size and densities and footprint of harvest as an open cavity in the coral and amount of damage to a coral are all parameters that could be measured. The retail price for *T. crocea* and *T. maxima*

At Yano's Market is $1.90/kg with would take a woman on average 3 hours of gleaning to collect in Airai at the mean rate of 0.62kg/w/h. This current market price does not adequately cover the labor and fuel required to collect *T. crocea* and *T. maxima.* Palauans normally eat fish more regularly than invertebrates. Invertebrates may be eaten once a week or month and considered a supplement to fish.

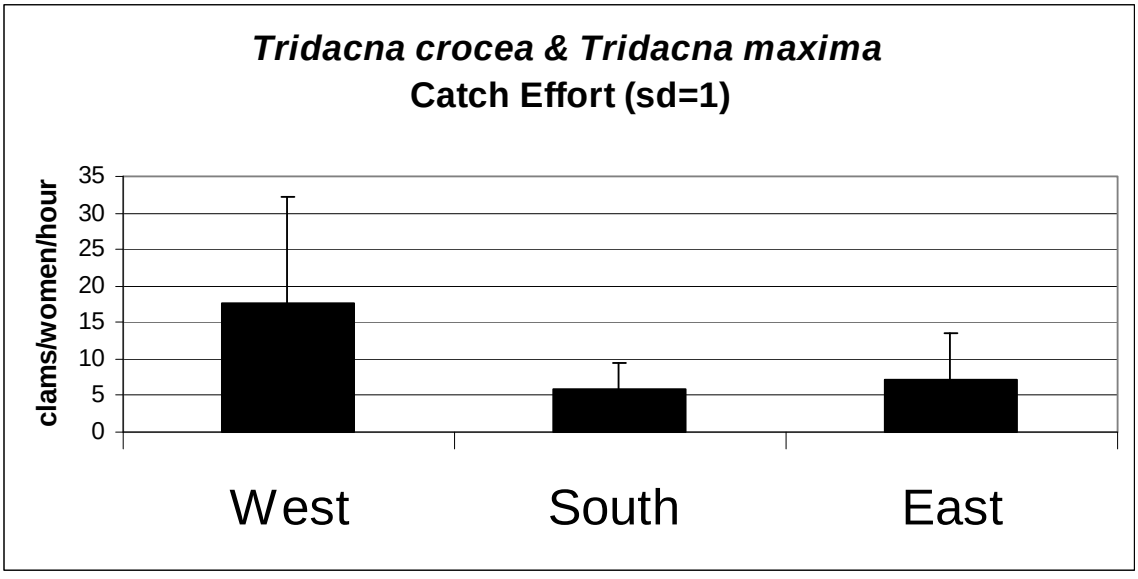


Figure 5. Mean Catch effort (standard deviation) for *T.crocea* and *T. maxima* for the 3 sites.

Table 3. The mean density, size and CPUE *Tridacna crocea* and *Tridacna maxima* For the three sites (sd=1).					
Site	Mean Density	Mean size (cm) Transect	Mean size (cm) Collected	Mean CPUE (ct/w/h)	Mean CPUE (kg/w/h)
West	0.07 (sd=0.08, n=7)	7.1 (sd=3.8, n=113)	9.8 (sd=1.8, n=36)	17.7 (sd=14.4, n=18)	.66 (sd=0.52, n =18)
South	.08 (sd=0.08, n=2)	7.0 (sd=2.7, n=33)	11.0 (sd=2, n=52)	5.8 (sd= 3.7, n =12)	0.63 (sd=0.59, n=10)
East	0.012 n=1		9.3 (sd=1.05,n=42)	7.1 (sd=6.5, n=7)	0.46 (sd=0.31, n=4)
Mean for sites	0.07 (sd=10, n=10)	7.1 (sd=3.6, n=146)	10.2 (sd=1.8, n=130)	11.8 (sd=11.9, n=37)	0.62 (sd=.51,n=32)
H Statistic				42	46

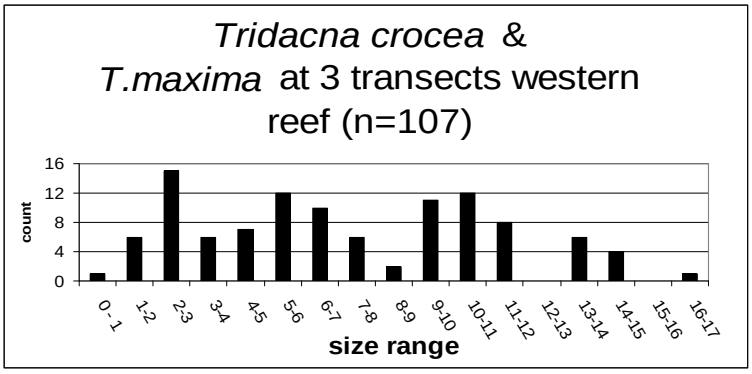


Figure 6. Size distribution of clam shell length for western reef of Ongeuidel.

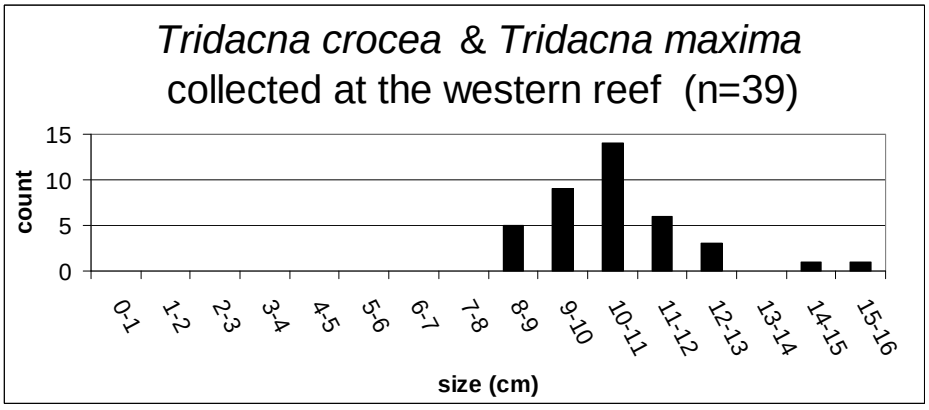


Figure 7. Size distribution of collected *T.crocea* and *T. maxima* at the western site.

Hippopus hippopus

Other free living (not embedded) *Tridacna* species collected but less abundant included *Hippopus hippopus* (duadeb) and *Tridacna squamosa* (melibes). *H. hippopus* was found on all the reefs surveyed. The non parametric Kruskal-Wallis test was used to test the null hypothesis that the CPUE for the number(ct/w/h), biomass (kg/w/h), and size(cm) of *H. hippopus* collected did not differ between sites (West, South, East) for the years 2006 to 2008. The statistic H was 28, 27.6 and 56 respectively for all three parameters which was greater than the statistic H ($X2_{.05[2]}$ value = 5.99) indicating that a significant difference exists for these 3 parameters between sites. The mean density of *H. hippopus* in 2006-2008 (0.011 *H. hippopus* /m^2, sd=0.007, n=5) was greater than the mean density of *H. hippopus* in 2002 (0.002 *H. hippopus* /m^2 (sd=0, n=7).

A few *T. squamosa* were collected at the southern reef of Bkulomelochel with a CPUE of 3.5/woman/hr but the data was insufficient to analyze. Women began to "reseed" the more accessible and over harvested reefs with a portion of the live clams from their catch. One young girl replanted a giant clam, *Hippopus hippopus* at the more accessible and over fished reef without any prompting from us. We propose to set aside protected amore accessible reefs for reseeding as part of our future program.

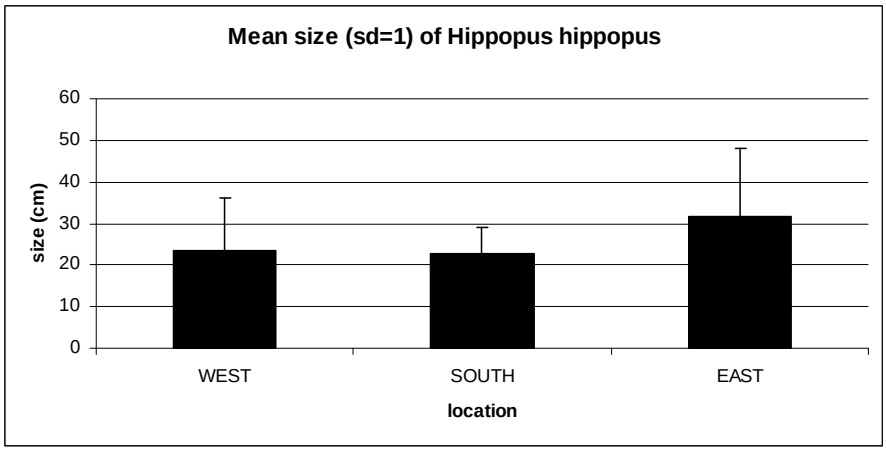


Figure 8. Mean size (cm) for *Hippopus hippopus* at the three site.

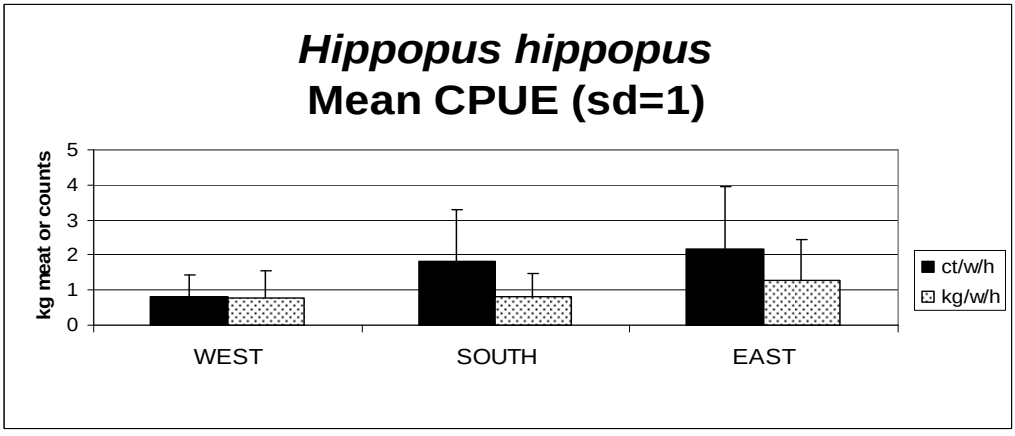


Figure 9. The mean CPUE for biomass (kg of meat only/w/h) and counts (ct/w/h) for three sites.

Table 4. The mean density, size and CPUE of *Hippopus hippopus* for the three sites (sd=1).					
Site	Mean Density of live clam on transect	Mean size of live clam (cm) on transect	Mean size (cm) Collected	Mean CPUE (ct/w/h)	Mean CPUE (kg/w/h)
West	0		23.3 (sd=12.7, n=3)	0.83 (sd=0.59, n =6)	0.76 (sd=0.79, n =6)
South	0.009 (sd=0.008, n= 3)	31.3 (sd=6.2, n=7	22.6 (sd= 6.4, n=43)	1.81 (sd= 1.5, n =17)	0.82 (sd=0.65, n=11
East	0.007 (sd=0.011, n=3)	31.7 (sd= 16.2, n=10)	31.7 (sd= 16.2, n=10)	2.16 (sd=1.86, n=11)	1.29 (sd=1.14, n=9)
Mean	0.005 (sd=.007, n=9)				
H Statistic				30.55	24

Sea Urchins

Tripneustes gratilla, is a one of the most highly prized invertebrates found in specific sites at certain times of the year. This species is not common in the markets as it is difficult to keep fresh. The freshly caught urchins can be eaten on site, as the prized eggs are scooped out of the open test.

The bulk of the catch is brought home and placed in fresh water overnight to be eaten the next day.

The analysis was done on total weight as the eggs are a delicacy which are not separated from the urchin for market. When is season they sell for $2.25/kg. The mean CPUE for *T. gratilla* was 34 *T. gratilla* /w/h (sd=20, n=11). The sites did not differ significantly using a Rank sum test for either CPUE for biomass or CPUE for counts (Table 5). . The mean CPUE = 5.6kg of *T. gratilla* /w/h (sd=1.3, n =11) and the two sites did not significantly differ for weight. The harvest diameter ranged from 4 to 11cm. No urchins were found smaller than 4cm on transects or from the collectors.

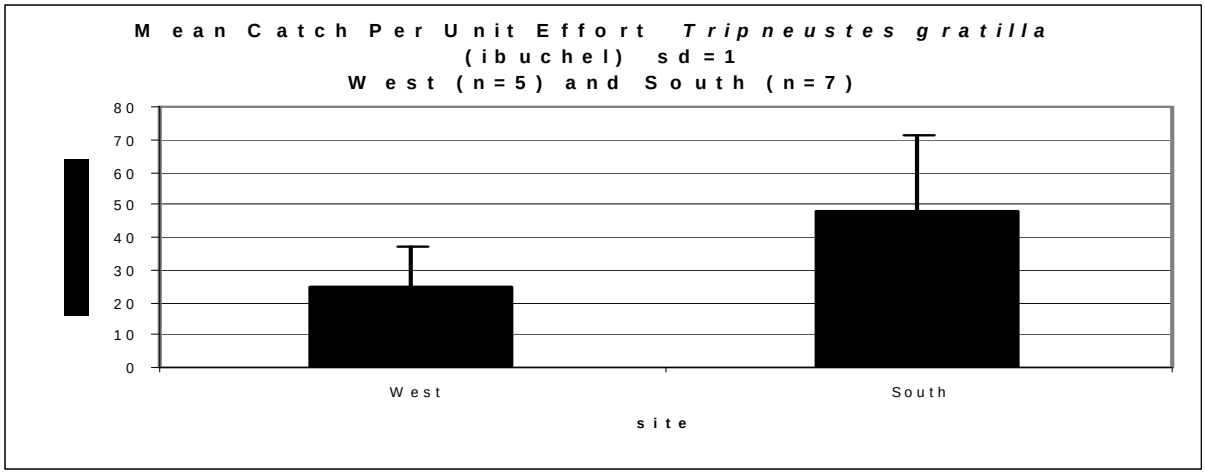
During November, 2006, at the southern outer reef of Bkulomelochel, the total CPUE was 64 urchins/w/h with a mean size of 6.2 cm (sd=0.85, n=95). During March 2007, the largest number of sea urchins were collected at the southern inner reef of Bkulomelochel in March 2007, with a CPUE of 100 *T. gratilla* /woman/h or 32 kg/w/h with a mean size of 6.0 cm (sd= 0.54, n=109). This was the highest collecting rate of all invertebrates during this study. During December 10 2006, women collected along the outer western reef of Ongeuidel with catch rates that ranged from 5 *T. gratilla* /w/h to 42 *T. gratilla* /w/h with a mean size of 7.6 cm (sd = 1.1, n=40). In June 2007, at the outer eastern reef of Orakibad, a few live urchins were collected but mainly empty tests were found along transect line with a mean size of 6.0 cm (sd=0.8, n=24). The density was 0.10 *T. gratilla* /m^2. Quantifying densities along transect lines occurred at different dates at the southern and western sites on dates before and after the large *T. gratilla* recruitment and no urchins were found.

The size distributions of the *T. gratilla* collected during 4 field trip shows the change abundance and size November to June (Figure 11). People stated that it was a good (recruitment) year for urchins with large numbers of urchins at specific sites and moderate numbers at all sites from November until May. During June and July, the numbers declined with only a few found and many empty tests. One woman stated that this is the natural seasonal cycle for sea urchins in Airai. Fisherfolk state that *T. gratilla* fill their cavities with air becoming buoyant and move in large floating masses from reef to reef.

During the summer survey of 2002, only 3 sea urchins were recorded from all sites including similar sites surveyed in 2006-2008. The mean density was 0.005 *T. gratilla*/m^2 (sd=0.004, n=10) in 2002 compared to 0.06 *T. gratilla*/m^2 (sd=0.05, n=3) in 2006-2008. During the three years 2006 to 2008 of this survey November 2006 to March 2007 were the top months to collect *T. gratilla*. Transects were not set during these periods as the women were focused on collecting. Our results show low numbers during the summer months as found in 2003. More research is needed to address the seasonal and annual variability in *T. gratilla.*

During the harvest of *T. gratilla,* women had different opinions on the minimum size to collect. The older women as a whole felt the younger women were collecting urchins that were too small. Women who lived in northern Babeldaob during their childhood stated that the urchins from Airai were small compared to the sea urchins they collected further north. The younger women and several older women from Airai thought that the smaller sizes (less than 5cm in diameter) were large enough to collect. A few older experienced women from Airai thought that all sizes from 4cm and larger were harvestable because this was the season for mature *T. gratilla* to be at these locations. All urchins that were examined had ripe gonads.

The TEI team did have the women return all urchins that were less than 5 cm in diameter. The fact that they each receive a stipend enabled TEI to make this a requirement. No urchins were observed or collected that measured less than 4cm in diameter. Women and men both stated that urchins move in large groups and have observed groups of urchins floating at the water surface. It is believed that the urchins are at either deeper depths and come up to the shallower waters at certain times of the year to breed. One woman stated that the season ends in June and the empty tests found in Oikull was part of their life cycle. Further observations are needed to determine the life history of the sea urchin in Palau. Observations of other fisherfolk on the reefs indicate that men as well as women and children collect urchins in Airai. A highlight of this study was that we observed sea urchins spawning on April 15, 2007 at 4pm in the late afternoon along the inner reef of Bkulomelochel. At least 24 urchins were spawning in the seagrass beds.



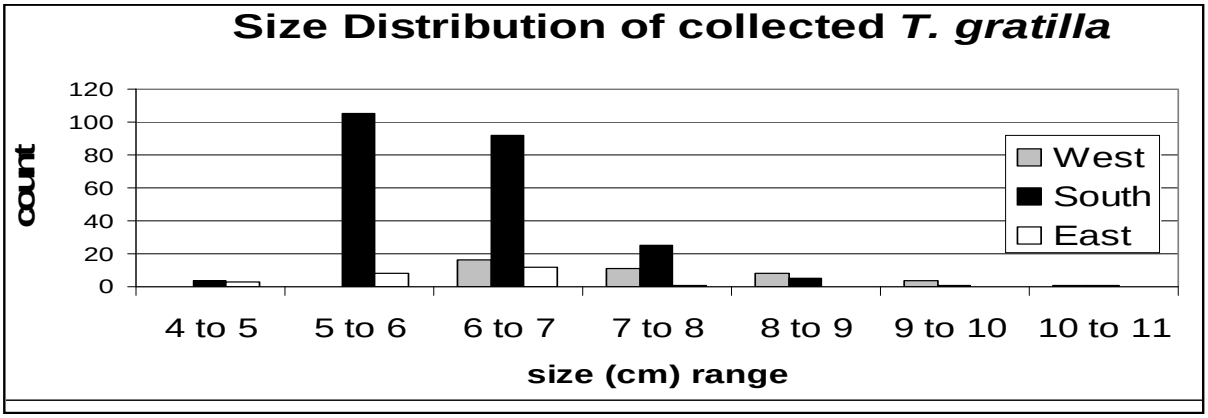


Figure 10a-b. Mean CPUE for the west and south sites and the size distribution of *Tripneustes gratilla* for three sites.

Table 5. The mean density, size and CPUE for *Tripneustes gratilla* for the three sites (sd=1)

Site	Mean size (cm) Collected	Mean CPUE (ct/w/h)	Mean CPUE (kg/w/h)
West	7.6 (sd=1.1, n=40)	24.6 (sd=11.9, n =5)	6.2 (sd=1.2, n =7)
South	6.5 (sd= 1.0, n=233	47.8 (sd= 22.9, n =5)	4.3 (sd=0.9, n=5
East	6.0 (sd= 0.08, n=24 empty test	4.8	5.6 (sd=1.3, n=11)
Rank Sum Test	ns	ns	ns

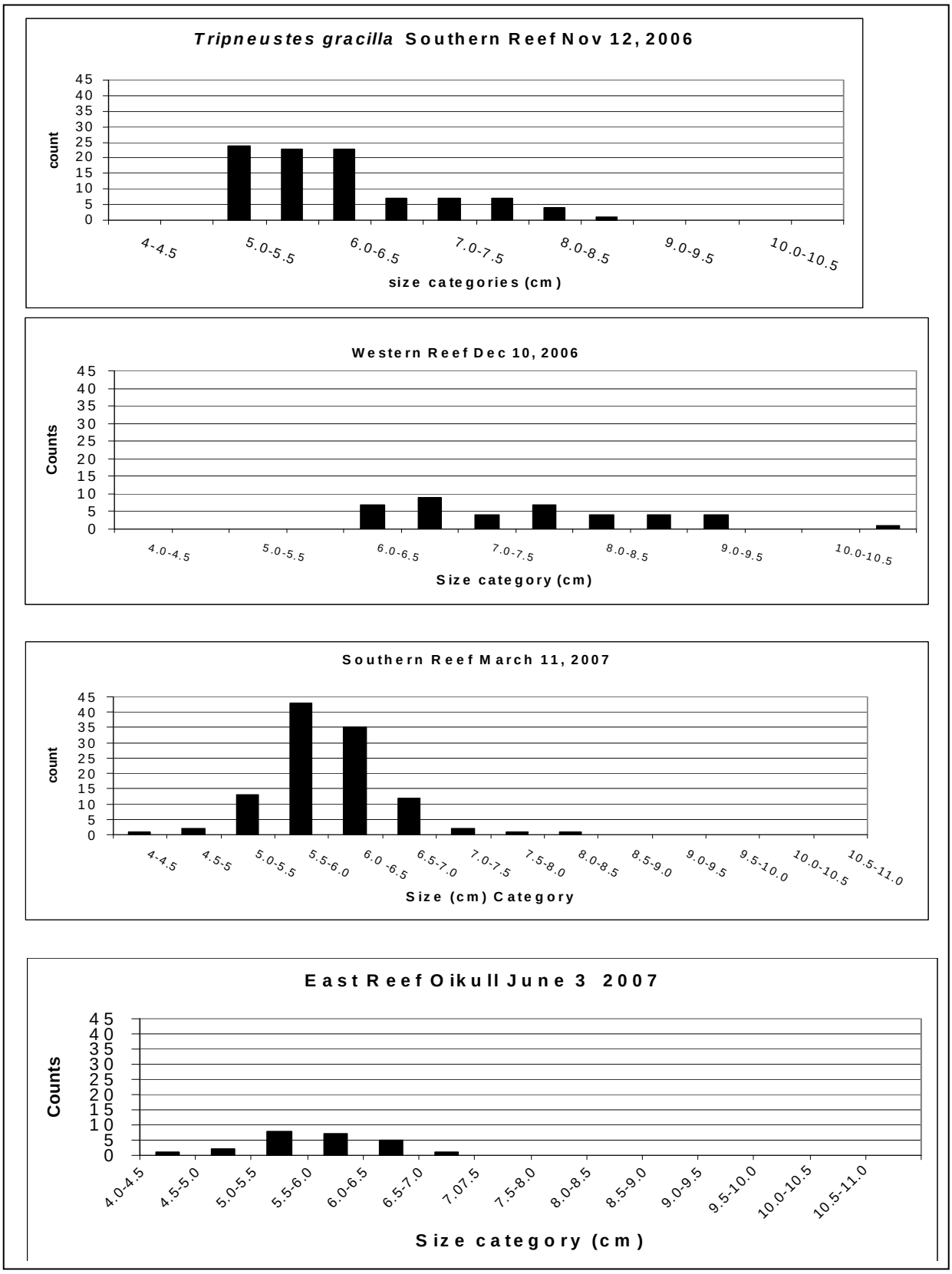


Figure 11. Size distributions of *Tripneustes gratilla* at the West, South and East reef sites on four field days during 2006 to 2007.

Sea Cucumbers

Actinopyga miliaris (cheremrum) were once abundant on the reefs during the day along the western reefs of Ongeuidel. During this survey it was found that this sea cucumber was no longer abundant or easily harvestable during the day. However, at night, at the same site, *A. miliaris* emerged from under the coral heads to feed. Women were collecting at a rate of 16.3 *A. miliaris* /w/h (sd =22.3, n=3). The highest CPUE (42 *A. miliaris* /w/h) was recorded during daylight hours at the eastern reef of Oikull. (No evening trips were taken to Oikull.) The mean size of the *A. miliaris* was 11.5 cm (sd =3.7, n = 96). At the inner north eastern reef of Ngechesechang, the CPUE ranged from 4 to15 *A. miliaris* /w/h or 1.8 to-9.9kg/woman/h. The mean density in this survey (0.07 *A. miliaris* /m^2 (sd=.12, n=10) was similar to the densities in 2003 (0.07 *A. miliaris*/m^2). GPS tracking showed that the women covered an area of 11,000 m^2 to 13,000m^2 (assuming a search swath of 5m) while searching for *A. miliaris*. The Rank Sum Test, a non-parametric test of difference between means showed no significant difference between CPUE (kg/w/h) for the East and West sites (Table 5, Figures 12 and 13).

Women did not collect large numbers of *A. miliaris* because processing takes several hours. The sea cucumbers are place in mesh bags and squashed like grapes for wine to remove the outer rough surface. Once smooth, it is further processed by placing it in meshed sacks to allow the internal organs to seep out. It's the endodermis that is sliced and eaten as food. Women transferred *A. miliaris* from areas with high densities to areas of low densities as part of a traditional way to sustain resources in more accessible areas. The current wholesale price for a half Ziploc bag (@1.3kg) of sliced *A. miliaris* is)$.77/kg with a retail price of $1.50/kg (Evelyn Yano, unpublished 2008). The mean CPUE is 2.7kg/w/h if they gleaned for 3 hrs at this rate it would be equivalent to 8.1 kg or $5.75/day

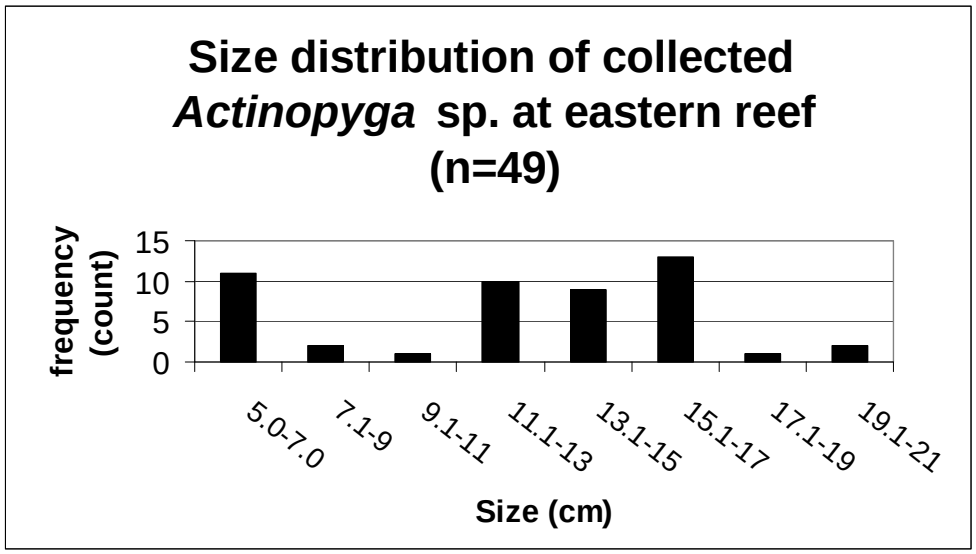


Figure12. The size distribution of collected *Actinopyga* sp. at the eastern reef.

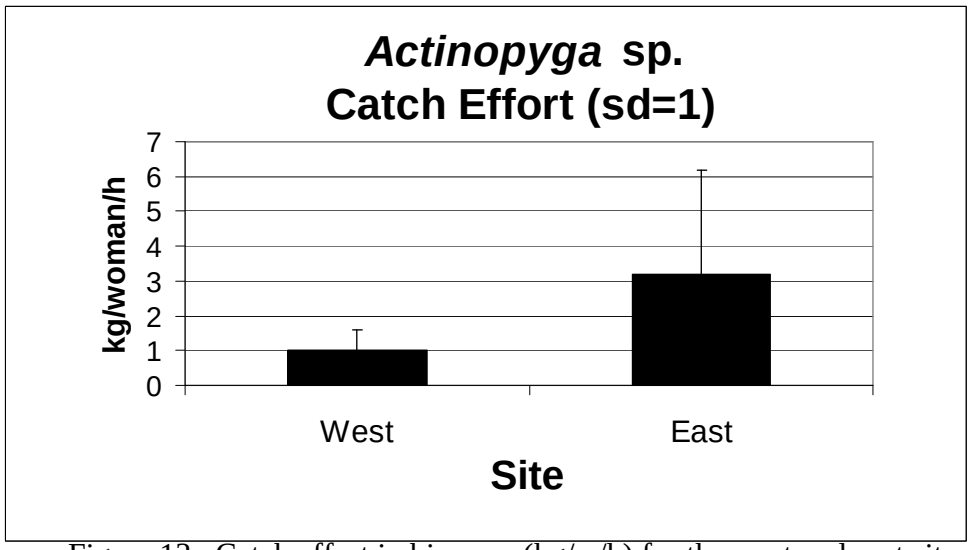


Figure 13. Catch effort in biomass (kg/w/h) for the west and east sites.

Table 5. The mean density, size and CPUE for *Actinopyga miliaris* (cheremrum) for the three sites (sd=1).					
Site	Mean Density (ct/m^2)	Mean size (cm) Transect	Mean size (cm) Collected	Mean CPUE (ct/w/h)	Mean CPUE (kg/w/h)
West	0.006. (sd=.009,n=3)		9.7 (sd=2.2, n=14)	16.3 (sd=22.3, n =3)	1.1 (sd=0.6, n = 3)
South	.003 (sd=.006n=3				
East	.16 (sd=0.14, n=4)	(sd=, n=	12.1 (sd=4.0, n=68)	46.2 (sd=17.8, n = 5)	3.25 (sd=3.0, n=14)
Total mean	.07 (sd=.12,n=10		11.5 (sd=3.7,n=96)	35.0 (sd=23.7,n=8)	2.7 (sd=2.7,n=17
Rank Sum Test				ns	ns

Stichopus variegatus

Stichopus variegatus (ngimes) is the most common sea cucumber collected by the women. This sea cucumber can be sliced in one or more parts and regenerates. Women traditionally slice it in half and throw half back to repopulate the reefs. The guts are removed and eaten. During 2006-2008, the average size of *S. variegatus* collected by the women was 17.9 (sd =5, n=170). The women collected very few at the more accessible inner western reefs (CPUE = 1.5/w/h) compared to the outer less accessible habitats (CPUE= 67/woman/h or 5kg/woman/h). The author and the women used to collect basketfuls of ngimes in an hour a couple decades ago in this same accessible area. During December 2006, one woman collected and cut *S. variegatus* into sections of 2 and 3 and disbursed all back without gut removal in order to replenish the reef area. This was traditionally practiced by the women to replenish depleted areas (Figures 14 and 15).

During 2002, *Stichopus* measured along 13 transects of Airai's fringing reefs had a mean size of 14.7cm (sd= 2.3, n=1,388) with highest densities were found along the inner southeast transects near Bkulomelochel (Figure 16). In the 2002, higher densities of *S. variegatus* were collected along the southern fringing reefs than either the eastern or western (Table 6.) The mean sizes of S. variegatus decreased in mean size from west to south to east (Table 7 and Figure 15) during both the 2002 and 2006-2008 studies. During 2006-2008, the women preferred to collect *S. variegatus* along the western reefs than the southern or eastern reefs. They stated that the *S. variegatus* "tasted better" along the western reefs. At the southern reefs they preferred to collect clams and sea urchins. At the eastern reefs they preferred to collect clams and *Actinopyga miliaris*. The current price for processed *S. variegatus* is an estimated $2.25/1kg. The number of ngimes to produce one half bag would be at least 50 *S. variegatus* or one hour of work.

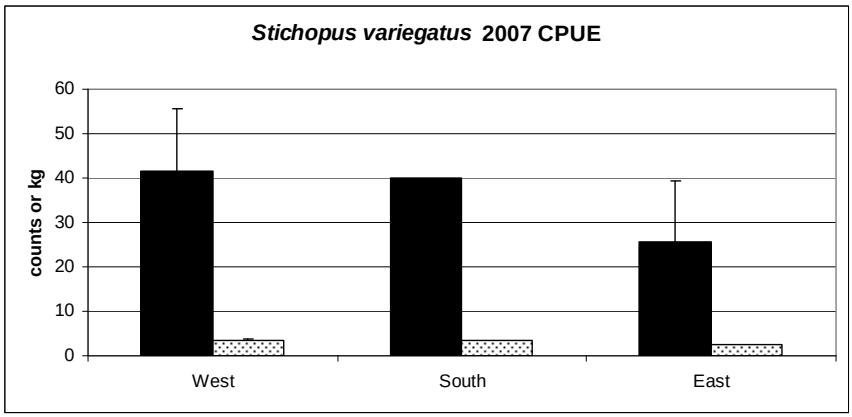


Figure 14. Mean CPUE for Biomass (kg/w/h) and Counts (ct/w/h) with standard deviation for the four sites.

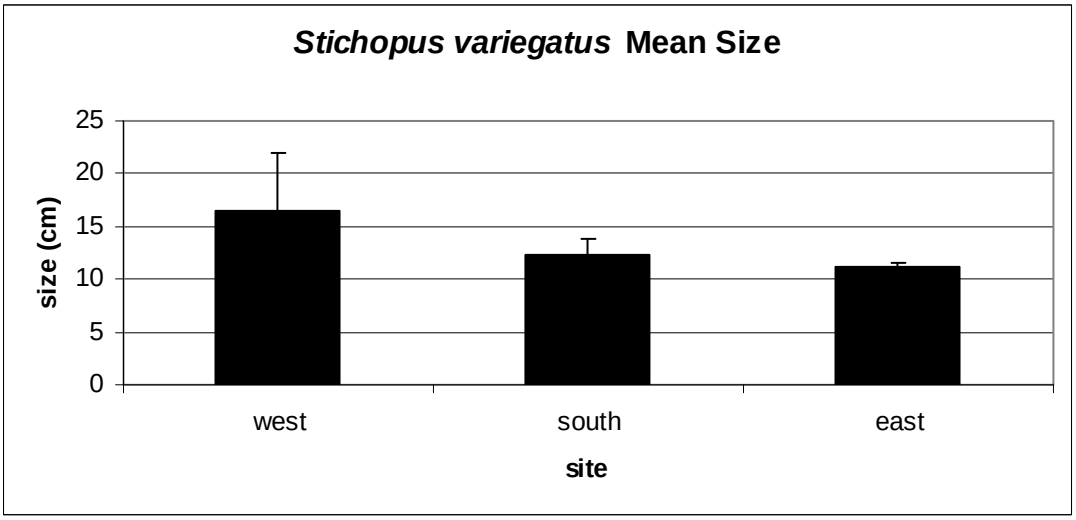


Figure 15. Means length (cm) (sd=1) for *S.variegatus* at 3 sties in 2007.

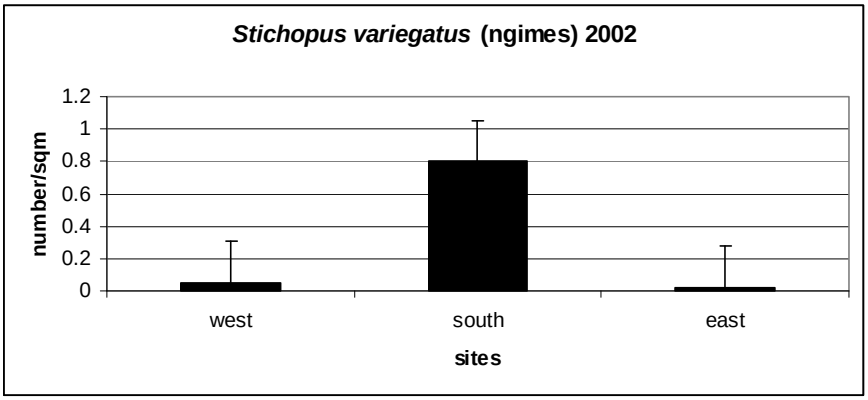


Figure 16. Mean density of *S. variegatus* during a 2002 survey.

Table 6 *Stichopus variegatus* density (ct/m^2) the deviation of the means or standard error (SE) and number of samples (n)		
	2006-2008 Density(ct/m^2)	2002 Density(ct/m^2)
West	0.01 (SE=.01,n=2)	0.05 (SE=.07,n=6)
South	0.94 (SE=0.93, n=3	0.80 (SE=0.76, n=3
East	0.01 (SE=0.003, n=2)	0.02 (SE=0.003, n=2)
Mean	0.41 (SE=0.73, n=7)	0.24(SE=0.48, n=11

Table 7. Mean lengths of *Stichopus variegatus* during 2002 summer survey.			
	West	South	East
	22	11	11.5
	22	14	10.9
	19	12	
	8		
	14		
	14		
mean	16.5	12.3	11.2
SE	5.5	1.5	0.4
n	6	3	2

Holothuria scabra (molech)

Holothuria scabra was not common. The mean Catch effort was 3.8 *H. scabra*/w/h (sd=4.2, n=4) and 1.4 kg/w/h (sd=1.2,n=4). The density was 0.004 *H. scabra*/m^2 using the transect and tracking data to estimate area. The numbers collected were too small to compare sites The numbers were also small during the 2002 study.

The Spider Shell

Lambis lambis (sang) is of cultural significance as a shell that was disbursed by the gods of Airai and is symbolic of its history and cultural richness. Once of great abundance throughout Airai, it is now uncommon. The mean size of measured shells was 12.4cm (sd=2.3, n=13) ranging from 7 to 18 cm. The mean weight was 0.3kg. The mean CPUE was 0.8 *L. lambis* /w/h, sd=1.2, n=22).The CPUE for counts was higher at the southern reefs (1.4 *L. lambis* /w/h, sd=0.9, n=8) than the eastern (1.2 *Lambis*/w/h, sd=0.7, n=4) or western reefs (0.6ct/w/h, sd=0.3, n=4) (Figure 17). The non parametric Kruskal-Wallis test was used to test the null hypothesis that the CPUE for numbers (ct/w/h) and biomass (kg/w/h) and sizes (cm) of *L. lambis* collected did not differ between sites (West, South, East) for the years 2006 to 2008. The statistic H was 10 for CPUE for numbers (ct/w/h) which was greater than the statistic H ($X^2_{.05[2]}$ value = 5.99) indicating a difference between sites for the numbers ct/w/h. The sample sizes for CPUE biomass (kg/w/h) and sizes (cm) were too few to compare sites. The mean densities of *L. lambis* during this study (0.004 sang/m^2, sd=0.003, n=3) was similar to the mean density in 2002 (0.005/m^2, sd=0.004, n=10).

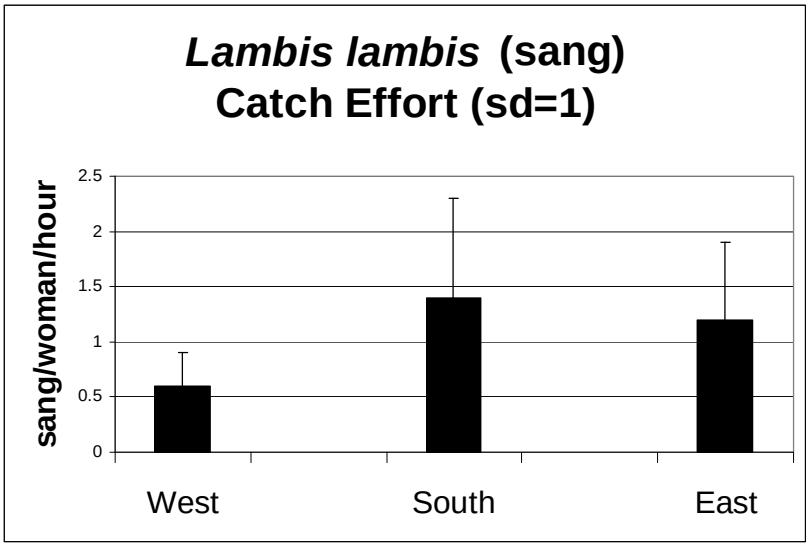


Figure 17. the mean CPUE for counts for the 3 sites.

Participation

A total of 23 Ngarabrekork Members (and 7 Ngaremeliwei members as assistants) have been trained and participated in the collection of invertebrates and operation of the "in-water" GPS and data collection. Their ages range from 13 to 61 years of age. Most members of Ngarabrekork work or attend school during the week and can only participate on weekends and holidays. We have focused our studies on weekends during the day although we have made several night trips to investigate nocturnally active invertebrates. Several members are full time fishers who are available on most survey dates and are available within an hour's notice. The participants have been very enthusiastic

about the program. Members are providing information about their observations outside our monthly survey dates.

Community meetings and recommendations.

Seven community meetings were held with a total of over 250 people attending. The main recommendations from these meetings were as follows:

- Stop dredging the inner reef
- Protect important areas in each village
- Conduct further studies
- Restrict boating in important areas
- Support conservation officers
- Develop clam and fish farms
- Investigate sources of pollution
- Develop sustainably
- Get more communities involved

Proposed Plan

During discussions a proposed plan was developed and presented to the Airai Planning Commission during the final community presentation. The main components of this plan are as follows:

- Initiate an Airai State Conservation Program
- Develop a Resource Management Plan
- Draft Legislation to protect reefs & key resources
- Include protected areas for each Village
- Develop a "hands on" Learning Program in Airai
- Train and Finance the Conservation Officers

Summary

Our results indicate that Airai's reef habitats are healthy especially less accessible reefs that are less impacted by land based pollution and overfishing. Women have local knowledge that is passed down through their families. They have a keen understanding of the reef habitats and seasons that need to be considered when assessing relative populations and standing stocks of invertebrates. Harvests methods that include size limits and limits on total harvest amounts exist in traditional collections of invertebrates. Transfer of organisms from areas rich in a specific species to areas depleted of a resource is traditional practice that also occurred during this project for clams and sea cucumbers. The dynamics of reef resources is complex, surveying resources must account for seasonal, lunar and diurnal cycles of invertebrates and life history patterns for breeding and feeding sites. Gleaning activities is not just about collecting food, it's about good exercise, laughter and

solving problems and listening as a group. Sustainable gleaning activities provides for both physical and mental well-being. A healthy reef provides for a healthy community. This study has begun to provide incite regarding the ecology of several species that can be built upon for future projects of this nature.

Findings from this project were as follows:

- Baseline data was collected at 3 major sites in Airai.
- Temporal & spatial variation was documented for key invertebrates.
- Women were selective on sizes & numbers collected.
- Skilled collectors are less destructive.
- Over harvesting & sediment are concerns in populated areas.
- Communities enjoyed learning by doing.
- A draft Management Plan will be developed with the community.
- Information was shared and more is needed.

Acknowledgements

We would like to acknowledge the following entities for their support of our efforts.

The National Oceanographic Atmospheric Administration-Habitat Conservation Program provided the necessary funding and technical support. The members of Ngarabrekork and Ngarameliwei implemented this project with the help of their partners at Airai State Government, the Palau Conservation Society, the Palau International Coral Reef Center, the Palau Automated Land and Resource Information System, the Coral Reef Research Foundation, and the Bureau of Marine Resources, Ministry of Resources and Development, The Republic of Palau.