REPORT

On

BASELINE DATA FROM PERMANENT MONITORING SITES

And

COMMUNITY BASED MONITORING TRIALS

ALEIPATA DISTRICT

A Report to the Aleipata Marine Protected Area District Committee and the Samoa Marine Biodiversity Protection and Management Project

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EXECUTIVE SUMMARY

Baseline monitoring was carried out in two complementary programs : establishment of Permanent Monitoring Sites conducted by the Project Team, and trials of a Community Based Monitoring Program undertaken with village volunteers who will monitor their respective No-Take areas on a more frequent basis. The former program was expected to give rigorous data on the effectiveness of the MPA design, while the second Community Based Program was designed to give regular semi-quantitative feedback to District communities on the progress of changes that could be attributed to MPA management measures. The Community Based Monitoring program was also designed to improve community involvement and awareness of the MPA project and its function.

Permanent Baseline Monitoring Program

Permanent Baseline Monitoring sites were established in June 2002 to statistically test the effectiveness of the Aleipata MPA Management Plan. Environmental indicators for coral, fish, and clams, formed the focus for the selection of sites and the collection of relevant data. Four sites were chosen from a list of No-Take areas that have been proposed in the Plan. An additional four Comparative sites were included in the permanent baseline study to account for natural changes in similar habitats to the No-Take areas. The majority of No-Take – Comparative site pairs (6 sites) were located in outer lagoon habitats, with two sites located in a shallow reef top habitat.

Parameters that were surveyed included : coral cover and a coral damage index; fish density and biomass for 18 families; and densities of 8 indicator macro invertebrates, including giant clams, plus 2 disturbance indicators (coral predators : crown of thorns starfish *Acanthaster planci,* and *Drupella* spp gastropods). Methods used to collect statistically valid data were specific to each particular parameter, and are commonly used in coral reef science. Coral cover was estimated from replicated transects, whilst coral damage, coral disturbance, fish density, fish size (biomass), and macro invertebrate density were estimated from replicated belt transects of varying dimensions.

Mean percent coral cover was estimated using a 3-point intercept method along 5 by 50m replicate transect lines at each site. Three of the four No-Take and Comparative site pairs (Aau Magoto – I Timu, Lalomanu – Tuiolemu, Papasina – Itu Papasina) had similar live coral cover and similar coefficients of variation, and one pair (Sagafoe – Mutu) had very different coral cover and CV values. Coral cover ranged from means of 29.9% to 65.1%.

A coral damage index using 3 forms of 'damage' (broken branches, overturned colonies, and split colonies) was calculated to estimate the frequency of damage in No-Take and Comparative sites. All moderate to large colonies (>10cm diameter) were recorded among colonies with either tabulate, branching, digitate, or corymbose growth forms. These included both *Acropora* spp and non-*Acropora* species. Most site pairs demonstrated similar damage frequencies relative to each other, and all sites had generally high damage indices : 15.6% of all colonies at Aau Magoto cf 13% at I Timu; 23.3% at Lalomanu cf 25.4% at Tuiolemu; 82.7% at Papasina cf 66.1% at Itu

Papasina. In contrast, there were 42.4% damaged colonies at Sagafoe cf 21.8% at Mutu. Overall, damage was most pronounced in *Acropora* spp, and usually the level of damage within this genus was similar across all growth forms, except for the Sagafoe – Mutu sites, where very different genera dominated each site. Damage was probably a result of both natural events such as storm events, and human activities.

Coral health and disturbance data suggest that the symptoms of a recent bleaching event appeared to be receding at the time of the survey (June 2002). *Acropora* spp were predominantly affected by the bleaching and most appeared to be recovering. Coral disease was very rare in colonies, and feeding scars from crown of thorns starfish and *Drupella* gastropods were not common in the permanent monitoring sites. The incidence and location of coral disease and coral predation was consistent with the conclusions drawn from the broad scale surveys conducted by the project team earlier in 2002.

Fish abundance and biomass were predictably variable among sites but there was a consistent pattern of dominance by damsel fish, surgeon fish, and parrot fish. Most sites were located in the outer lagoon habitat, where it was observed in the broad scale surveys to be a juvenile nursery for surgeon and parrot fish, in particular. The permanent baseline data strongly reflect this general conclusion. Of importance is the observation of the complete absence or extreme rarity of certain fish families (as well as sharks and rays), particularly predator groups. Fish density and biomass showed similar trends among sites but with generally heterogeneous abundance and biomass data.

Macro invertebrates were surveyed at most sites, and in particular, giant clams were recorded as a performance indicator for the conservation of endangered species in the Management Plan. Both giant clams and trochus have very low population densities and were absent from the majority of sites. Anemones were also very low in occurrence and abundance. Four of the most common holothurian species were sparsely distributed and those present were the less desirable species in terms of human consumption. Corallivorous crown of thorns starfish and *Drupella* gastropods were abundant in outer lagoon habitats especially along the southern coast and the northern part of the eastern lagoon joining the offshore islands of Namua and Fanuatapu.

Community Based Monitoring Program

The Community Based Monitoring trials were extremely useful for assessment of the degree of commitment that will be required by the Project Team to complete this activity at all villages. It also was useful in refining the methods, techniques, and aims of this most important activity. It was estimated that a minimum of two to three days would be necessary to complete basic training and monitoring activities in each village. The trials also highlighted the necessity of restricting the number of volunteers from each village at any particular training and monitoring session as the range of water competence of individuals was quite large. Future community monitoring activities will have to take into account the expected turnover and availability of competent people to participate in the activities.

Several changes to the data sheet formats and changes to specific features within the sheets were recommended from the trails. This included the rearrangement of data categories for recording information, and the introduction of more relevant category codes for certain organisms and indicators. For example, a fish category is recommended that is smaller than the originally used smallest size category. Also, the use of a zero present category is recommended to ensure that a definite decision is made on all potential observations, and that a unwritten record on the data sheet is not recorded as a true (not present) observation.

Clarification of some indicators was also a recommendation, as the equivalent Samoan word in some cases tends to aggregate distinctly different indicators. For example, certain Samoan words for marine algae and holothurians tend to combine a number of specifically different forms.

The resultant data summary formats were tested with the Project Team and after a number of good positive suggestions and alterations, the final formats are thought to be very good for feedback to villages. It is expected that the awareness-raising aspect of the activity, including the additional personal observations and experiences of volunteers, will be important components of this activity. It is recommended that volunteers write personal observations on the data sheets, and that de-briefing with a project officer be a regular part of community-based monitoring activities because of the potential of raising awareness, and detecting other unpredictable processes that will occur from time to time.

1. PERMANENT BASELINE MONITORING PROGRAM

1.1. INTRODUCTION

The World Conservation Union (IUCN) and the Government of Samoa are working in partnership with the District Safata in a five year project aimed at assisting these communities to conserve and sustainably use their marine resources through the establishment of a multi-purpose marine protected area in each district. Eleven villages in the Aleipata District (Tiavea, Samusu, Amaile, Utufaalalafa, Saleaaumua, Mutiatele, Lotopue, Satitoa, Ulutogia, Vailoa, Lalomanu) are participating in this initiative. This report contains the results of detailed assessments of fish and benthic components of specific sites that will be adopted as permanent long term reference sites

Table 1. Revised Environmental Impact Indicators. ** refers to a provisional indicator which has yet to be confirmed.

Original Indicator	*Revised Indicator*	*Mode of Verification*
Continued recovery in coral reefs (increase in live coral cover approximately 2% per year)	Continued recovery in coral reefs: (a) Increase in live coral cover of 20% over a 10 year period; No significant decrease in coral cover at end-of-project; (b) At least 50% decrease in Damaged Coral in No-Take Zones at end-of-project.	Not measured during life of project (a) Permanent sites with estimates of % cover ; (b) Permanent sites with estimates of the proportion of damaged to undamaged colonies.
No decrease in current area of mangroves	No decrease in current area of mangroves at end-of-project	Change in area inside marked mangrove trees at perimeter of current mangrove areas.
Statistically significant and important increase in the productivity of target fish species after 5 years	Statistically significant increases in the size and abundance of target fish species by end-of-project	Size (length) and abundance (number) of selected target fish species. Measured inside and outside No-Take Zones.
No decrease in the populations of threatened species (e.g. turtles, seabirds)	No decrease in the populations of threatened species: (a) No decrease in number of turtle nests over a 20 year period (in Aleipata MPA only); (b) Increase in numbers of giant clams in suitable No-Take areas.**	(a) Not measurable in project period; (b) Permanent sites with estimates of the density of giant clams.

Performance indicators were identified in the original Project Brief (IUCN 1996) and have been reviewed by the Supervision Mission members (Table 1). Some of the indicators have been modified to reflect the current conditions of the District and the current project timelines. The reason for the variation to the original project brief indicators is because some environmental indicators could not be realistically measured during the life of the project. For example, changes in live coral cover are most likely only statistically measured after about 10 years, using standard field assessment tools.

By the end of the project, the No Take zones would have had an implemented management plan for only 2-3 years, and changes in live coral cover would not be distinguishable from natural variability and survey error over this time period. It was therefore agreed that while changes in live coral cover could remain a long-term goal, the indicator would be measured by two proxys at the end of the project : (a) no significant decrease in coral cover; and (b) a minimum of 50 percent decrease in the damaged coral index inside no-take zones.

For similar reasons, measurable changes in the number of turtles and giant clams would not be detected by the end of the project, as it takes a minimum of 20 years for turtle nest counts to show significant differences. In addition, the MPA has insufficient parental stock of giant clams to ensure their short term recovery. It was therefore agreed that while turtle nest counts and giant clam populations would remain a long-term (20 year) impact indicator, the project would initiate the collection of long term data on turtles and giant clams.

The first supervision mission recommended that the area of mangrove be measured simply by marking mangrove trees with painted numbers at approximately 100 m intervals. The communities could then easily monitor changes in areas, especially if they were involved in the original marking of the boundaries. Table 1 shows the revised environmental indicators.

The Permanent Baseline assessment incorporates changes to the indicators and provides detailed information that will be used to assess the performance of the Marine Protected Area managed by the Aleipata District representatives.

1.2. METHODS

Permanent baseline sites were established in June 2002 at 8 sites located throughout the Aleipata District. The sites were chosen for their representativeness and for the management zone they represent in the Draft Management Plan for the MPA. Sites were categorised into pairs, one as a No-Take site and one as a site in an equivalent habitat nearby that was a general use zone which could be used as a comparison to the protected site. A description of the sites is presented in the results and discussion section.

Replicate transects were established within sites to give an estimate of the mean of the various population parameters and the variability of these estimates. The coefficient of variation (CV) was used to compare the degree of variation between sites. A low

CV value (approaching zero) indicates highly homogeneous sample estimates (transect means) whereas a high value (approaching 1) indicates relatively heterogeneous estimates. Heterogeneous estimates can cause problems with univariate statistical analyses of temporal changes, but these problems can be reduced by data transformations prior to analyses.

Coral Cover

Coral percent cover was measured along transects by the 3-point sample method. This technique is a rapid and efficient way to obtain estimates of the percent cover of major benthic types and substrata, including live coral. Tape measures are used as independent transect samples. Here, 5 x 50m transects are laid out on the substrate. At every 2m interval along each transect (starting at 2m) the benthos is recorded underneath the measuring tape at each of these 2m interval points. In addition, a further 2 points perpendicular to each of these interval points and at a distance of 1m either side, are also used to record additional benthos underneath those points. This results in 25 intervals per 50m transect, and a total of 75 point samples of the benthos per transect. A figure illustrating the 3-point sample design is presented in the 'Biodiversity Assessment and Monitoring Manual' (Fisk 2003). The categories and codes that are used to describe the benthos are predominantly the same that are used for the GCRMN Line Intercept Transect method (English et al 1997) and all are described in detail in the Monitoring Manual (Fisk 2003).

The coefficient of variation (CV) is a measure of the variability of a sample and is calculated by dividing the standard deviation by the mean. Site pairs that have similar mean cover and similar CV values can be expected to be similar to each other.

Coral Damage

Damage to corals is an indicator of fishing or gleaning activity due to the presence of shallow lagoon habitats and to the nature of the harvest methods. Harvest methods include walking over coral to set nets and to get to fishing locations. Coral breakage also occurs from deliberate disturbance to coral to chase out fish and to collect animals hiding inside coral lumps, as well as from anchor damage. In order to gauge the effectiveness of No-Take areas, a baseline assessment of the current level of coral damage that is a result of both natural events and (probably) human activity is required. In the absence of significant natural disturbances, the removal of human activities should result in a decrease in the incidence of coral damage.

The Coral Damage Index is calculated by measuring the percentage of broken or damaged coral colonies (eg, from destructive fishing practices, anchor damage, or following a major storm) to the total number of colonies present. Colonies that were present with greater than 50% of the colony within the belt dimensions were included in the assessment. Five replicate belt transects of 50m length each and 2m wide (1m each side of the transect) were used to estimate the proportion of damaged coral.

As the aim of the study is to assess coral damage, only colony forms that are most susceptible to damage were recorded. These include branching, foliose, tabular, corymbose, digitate and submassive growth forms. A distinction between *Acropora* spp and non-*Acropora* forms was also made in this study.

Colonies larger than a minimum size of 10 cm maximum diameter were recorded in this survey because they are generally more susceptible to damage than smaller colonies. Also, survey time was saved in the field by not recording the numerous smaller colonies.

Information on the health of each coral colony was added along with the growth form data. Coral Health is of general interest but is not specifically required for the monitoring of Performance Indicators. However, the information can be easily recorded in addition to and at the same time as the damage index, therefore this information was included in the survey. Seven Coral Health indices were recorded using the same sampling method as the coral damage data, that is, along 5 replicate 50m x 2m wide belts. The coral health indices were (along with their codes) :

- **DIS** (diseased),
- **BL** (bleached),
- **COTS** (with feeding scars from Crown of Thorns starfish),
- **DRU** (with feeding scars from *Drupella* spp gastropods),
- **ALG** (overgrown by Algae),
- **ASC** (overgrown by encrusting Ascidians),
- **SPO** (overgrown by encrusting Sponges).

Fish Abundance and Biomass

At each site, 5 transects 3 m wide and 50m long, were used to estimate fish density and biomass of target fish families. An area 3m above the belt transect in the immediate water column was also included as part of the sample. This means that the total area surveyed at each site was 5 x 50m x 3m, or 750 m^2 per site. The belt width was spread equally on either side of the tape,ie, at 1.5m either side of the tape.

Table 2. Log abundance categories used in estimates of abundance of numerically dominant fish species. The two highest categories use the minimum value for the range and not the median (see text below).

LOG 4 ABUNDANCE CATEGORY	NUMBER OF FISH	MEDIAN NUMBER
1	1	1
2	2 – 4	3
3	5 – 16	10
4	17 – 64	40
5	65 – 256	160
6	257 – 1024	640
7	1025 – 4096	1025 (minimum)
8	4096 – 16384	4097 (minimum)

Estimations of fish abundance were carried out by using abundance categories (Table 2 shows the categories and the median values for each). Note that for the two highest abundance categories, the minimum abundance number is used (as recommended in English et al, 1997). The sizes of fish were estimated using a number of standard size classes which are given in Table 3. Note that the largest size category was defined as fish greater than 80 cm length (and the median value was nominated as 80 cm as well).

The fish families recorded in the surveys are those that are amenable to visual census techniques and are not the cryptic and hiding ones. Visual fish census surveys have to take into account the behavioral differences among different fish species and families. In general, large highly mobile species/families were counted first when the tape was first laid out,ie, the assistant follows behind the fish census person laying the tape on the substrate during the first swim survey of the tapes. A subsequent swim back along the tape (after all transects have been surveyed for the first survey) was used to estimate medium size mobile fish and small site-attached fish.

Table 3. Standard categories used to estimate size of fish based on the usual descriptive method used by Samoan fishermen.

SIZE CATEGORY	SIZE MEASUREMENT (cm)	MEDIAN SIZE (cm)
1	1 – 20 (Finger tip to wrist)	10
2	1 – 50 (Finger tip to elbow)	25
3	1 – 80 (Finger tip to shoulder)	40
4	1 - >80 (Finger tip to > shoulder)	80

Fish Families included in surveys were the target groups that are most in demand for food or those fish families that are readily assessed by this method and which are indicators of general reef health. Certain families such as snappers and groupers, serve as good indicators of fishing pressure. Presumably these fishes have been targeted historically in Samoa along with parrotfish and surgeonfish. All are highly mobile and are assessed first at the same time as the tapes are being laid out. In addition, certain families of fish that are wide ranging and will move away from areas when divers are present are included in the initial first pass of the transects. Note that the term ‘fish family’ is used here to include the Elasmobranch families of sharks and rays.

The fish families recorded for this project were as follows :

First Swim along transects :

Emperor (Lethrinidae)
Grouper (Serranidae)
Mackerel (Scombridae)
Parrot fish (Scaridae)
Rabbit fish (Siganidae)
Sharks (Carcharhinidae)
Snapper (Lutjanidae)
Surgeon fish & Unicorn fish (Acanthuridae)

Sweetlips (Haemulidae)
Trevally (Carangidae)

Second Return Swim back along transects :

Angel fish (Pomacanthidae)
Butterfly fish (Chaetodontidae)
Damsel fish (Pomacentridae)
Goat fish (Mullidae)
Mullets (Mugilidae)
Rays (Dasyatidae & others)
Trigger fish (Balistidae)
Wrass (Labridae)

The compilation and summary of data to calculate fish biomass requires a number of steps and procedures that have to be carried out prior to any analyses. This cannot be done with these lumped data as each fish species has an individual set of 'conversion factors' for calculating biomass from length estimates. Consequently, mean fish lengths are used here as an index of biomass. The length categories adopted from the standard way local fishermen describe the sizes of fish.

To convert the density of fish in the survey belt transects to a standard density per hectare, the total number of fish recorded at each site in 5 x 50m x 3m transects (= $750m^2$), is multiplied by 13.33. This will give an estimate of fish density per hectare (= $10,000m^2$).

Macro Invertebrates

Macro invertebrates were surveyed the same time as other indicators were assessed. Density of macro invertebrates were assessed using the same belt transect dimensions used for the coral damage index, ie, 5 x 50m x 2m belt transects. Macro invertebrates of interest included : giant clams (*faisua*), trochus shells (*aliao*), crown of thorns starfish *Acanthaster planci* (*alamea*), *Drupella* spp corallivore gastropods, anemones, sea urchins (*Echinothrix* spp (*vaga*), and *Echinometra mathaei* (*tuitui*)), holothurians (*Bohadschia argus* (*fugafuga*), *Stichopus chloronotus* (*maisu*), *Holothuria atra* (*loli*), and *Thelenota anas* (*sea*)).

1.3. RESULTS & DISCUSSION

The data collected from all permanent baseline sites is presented in tabular form below. Discussion is generally restricted to the similarity or otherwise of the data in relation to the comparative pairs of No-Take and Comparative sites.

A general description of each site is also included to help understand the reason behind the selection of sites. Descriptive information is also given so that future investigators can be confident in returning to the same sites. Figure 1 shows the position of the permanent monitoring sites within the District.

Site Descriptions

Pair 1. (A) Papasina (No-Take) and (B) Itu Papasina (Comparative)

1A. Papasina (No-Take)

Description

This site is located on the inner crest habitat landward (south) of the crest and slope of a major fringing reef that is present along the northern coastline of Aleipata (Figure 4). The fringing reef is characterised by a relatively narrow extension of the reef habitat without the presence of a lagoon. The back-crest habitat is characterised by the presence of table coral, *Acropora hyacinthus*. The site is opposite the first headland east of the village of Tiavea. This headland is known as Papsina which has an old Samoan myth associated with the features of the headland. Significant storm damage to corals was a feature of the site. High waves from a close passing cyclone in late 2001 were possibly the cause of the damage.

Site Significance

The site is in a highly productive and relatively diverse area that is associated with the shallow slopes where caves and indentations are situated. The shoreline and fringing reef associated with the headland is included in the No-Take zone in the Management Plan. The position of the site relative to the headland is easily recognizable and the boundaries relatively easily defined.

Location of Transects

Transects commence opposite the most northerly section of the headland and continue to the east more or less parallel to the crest at a depth of 2-5m and at 5-7m landward (south) of the crest. Transects sequentially follow each other in a single line and are parallel to the crest that runs into the bay known as Alaufau.

Bearings

GPS Position (Start of Transect #1) : 13^0 5852^1 S, 171^0 2749^1 W.

1B. Itu Papasina (Comparative)

Description

This site is located on a broken crest habitat on the opposite side of Alaufau bay from Papasina (Figure 4). As with the Papasina site, there is no lagoon present, and in contrast, there is less development of the crest habitat at this side of the bay. The back-crest habitat is characterised by the presence of table coral, *Acropora hyacinthus*. Transects vary from 2-5m depth. Significant storm damage to corals was a feature of the site. High waves from a cyclone passing close to Upolu in late 2001 were probably the cause of the damage.

Site Significance

Despite relatively less development of the crest habitat, other features are similar to the No-Take site of Papasina, making it a good comparison site. The site is probably exposed to waves from fewer directions compared to Papasina.

Location of Transects

Transects commence at a point towards the inner edge of the fringing reef on the eastern side of Alaufau bay. Transects sequentially follow each other in a direction from south to north, ending close to the more exposed fringing reef at the eastern headland known as Leuluniu.

Bearings

GPS Position (Start of Transect #1) : 13^0 5857^1 S, 171^0 2730^1 W.

<u>Pair 2. (A) Sagafoe (No-Take) and (B) Mutu (Comparative)</u>

2A. Sagafoe (No-Take)

Description

This site is situated in the outer lagoon opposite Amailie Fish Reserve and between two avas (Ava o To'aigau to the south, and Ava i Tofaga to the north, Figure 5). It is a shallow habitat dominated by large clumps of branching *Acropora*. The habitat is regularly flushed with water from waves that overtop the crest, and the area also experiences tidal flow parallel to the crest and towards the avas.

Site Significance

The habitat has relatively low coral diversity but high juvenile fish abundance and diversity, due to the protective branching coral habitat. The site has been incorporated into the Amailie Fish reserve, making it a significant No-Take area in an area that is accessible from the shore in most tide and sea conditions. The presence of high juvenile fish abundance indicates that the area could be a major nursery for juvenile fish.

Location of Transects

Transects commence adjacent to the northern side of Ava i To'aigau, and continue towards the north in a more or less straight line sequentially following each other. Transect 5 finishes close to the southern side of Ava o Tofaga.

Bearings

GPS Position (Start of Transect #1) : 13^0 5957^1 S, 171^0 2570^1 W.

2B. Mutu (Comparative)

Description

This site is situated in the outer lagoon north of Ava Sinasina and transects pass the small ava called Mutu (Figure 5). It is a shallow habitat dominated by large clumps of branching *Acropora* and extensive areas of *Pocillopora damicornis*. The habitat is flushed with water from waves that overtop the crest, and the area also experiences tidal flow parallel to the crest and towards the major avas at either end of the transect lines. A feature of the habitat is the presence of high macro algae abundance on a predominantly rubble substrate.

Site Significance

This site is situated as close as possible to the relatively unique habitat of the Sagafoe site. Despite being a typical shallow outer lagoon site, it differs from the No-Take Sagafoe site in terms of coral species dominance and the presence of high macro algae abundance. The site is relatively more offshore compared to Sagafoe as well, though it is easily accessible under most conditions.

Location of Transects

Transects commence just north of Ava Sinasina and continue in a more or less straight line one sequentially following each other towards the north, finishing close to and north of Ava Mutu.

Bearings

GPS Position (Start of Transect #1) : 14^0 0017^1 S, 171^0 2494^1 W.

<u>Pair #3 : (A) Aau Magoto (No-Take) and (B) I Timu (Comparative)</u>

3A. Aau Magoto (No-Take)

Description

Aau Magoto is a well defined area of predominantly outer lagoon habitat situated on the south to south-west side of Fanuatapu Island (Figure 2). It consists of a series of channels, a sand / rubble outer lagoon, and some reef flat habitat. The area has good water flow due to its proximity to Ava Vainuu, and at times of high ocean swell, it also experiences high water turbulence. This area is the most distant section of the lagoon from adjacent coastal villages (apart from the offshore islands of Nu'utele and Nu'ula).

Site Significance

The site was identified from the broad scale surveys as an area of exceptional diversity for both coral and fish. The area has a local name which may indicate it has recognizable features and is potentially important to local villagers. Aau Magoto was defined in the MPA Management Plan as a significant area of diversity and importance as fish habitat, and includes a significant fish aggregation area.

Location of Transects

The five permanent baseline transects are located along the northern edge of the largest channel, commencing at the outer point closest to Ava Vainuu and extending in a series of lines towards the north north-west direction. The transect lines sequentially follow each other at an average depth of 1.5 m.

Bearings

No GPS fixes were taken but the site can be relocated easily as it is a very distinctive area. See aerial map with the approximate transect positions shown (Figure 1).

3B. I Timu (Comparative)

Description

I Timu is an outer lagoon area located to the south west of Ava Vainuu (Figure 2). The area is predominantly a sandy – rubble habitat with mainly clumps of branching *Acropora* spp and *Porites* spp. There are larger composite patch reefs of predominantly massive *Porites* spp in the area as well. The site experiences relatively good water flow due to the flushing of tidal water in and out of Ava Vainuu nearby, but it also experiences high turbulence in periods of high swells. The habitat was generally defined in the broad based surveys as of moderate to low diversity.

Site Significance

The name for this site (I Timu) was adopted by the project as no local name is associated with this precise area. The name refers to a small ava that is located nearby in the exposed outer reef edge. It was chosen as a comparative site to Aau Magoto because of its position and similar exposure to the physical conditions experienced at Aau Magoto.

Location of Transects

The five permanent transects commenced to the western side of the relatively shallower outer lagoon area comprised of rubble and solid substrata. The transects extend in a series of lines towards the north - north-west. The transect lines sequentially follow each other at an average depth of 2 m.

Bearings

A GPS fix was taken in the vicinity of transect #5, which was located at the most extreme eastern part of the survey area and closest to Ava Vainuu.

GPS Position (Transect #5) : 14^0 0006^1 S, 171^0 2459^1 W.

<u>Pair 4. (A) Lalomanu (No-Take) and (B) Tuiolemu (Comparative)</u>

4A. Lalomanu (No-Take)

Description

Lalomanu is an outer lagoon site situated to the west of Ava Masaulu and to the east of Ava Tele (Figure 3). The transects are located in the outer lagoon habitat within 3-5m north of the shallow outer flat rubble zone. The habitat receives regular pulses of oceanic water from large waves that spill over the crest and on to the extensive outer reef flat rubble habitat. There is also a relatively strong east-west flow of water due to tidal movements and the presence of major avas at either extremities of the site.

Site Significance

This site incorporates outer lagoon habitat situated between major avas and includes habitat affected by ava water flow. The transects are opposite a major tourist beach destination and was recorded in the Management Plan as an important tourist site as it is an area with patches of high coral cover and fish diversity, and high (juvenile) fish abundance surrounding the ava entrances. It is also a habitat with a scattered population of the important commercial and food holothurian species (*Holothuria whitmaei**). (* Formerly *H.nobilis*)

Location of Transects

The transects start at the eastern side of the outer lagoon area, which is comprised of smooth consolidated platform, rubble and large coral lumps. The transects extend in a series of lines from the east to the west, more or less parallel to the crest. The transect lines sequentially each other at an average depth of 2m.

Bearings

A GPS fix was taken at the start of transect #1, which was located at the most extreme eastern part of the survey area and closest to Ava Masaulu.

GPS Position (Start of Transect #1) : 14^{0} 0277^{1} S, 171^{0} 2679^{1} W.

4B. Tuiolemu (Comparative)

Description

Tuiolemu is an outer lagoon site situated to the west of Ava Masaulu and to the east of Ava Tele (Figure 3). The transects for this site were placed on the outer lagoon habitat within 3-5m north of the shallow outer flat rubble zone. The habitat receives regular pulses of oceanic water from large waves that spill over the crest and on to the extensive outer reef flat rubble habitat. There is also a relatively strong east - west flow of water inside the lagoon due to tidal movements and the presence of a relatively unbroken crest to the west as far as the western boundary of the Aleipata District at Saleapaga. A small ava (Ava Talimea) is present close to the start of the transects.

Site Significance

This site incorporates outer lagoon habitat situated opposite a small clearing and car park on shore. The site is adjacent to mid lagoon habitat that is relatively deep for this section of the coast (2-3 m depth). Because of the lack of avas on the adjacent crest, it is a relatively enclosed lagoon. However, regular flushing of oceanic water occurs due to overtopping of the crest by large waves and at high tides. The resultant regular increase in water volume in the lagoon causes a net flow of water westwards and parallel to the crest. For this reason, the site is a reasonable comparative site for the Lalomanu No-Take site, even though it is relatively more enclosed. The habitat was recorded in the broad based surveys as an area of exceptionally high coral and fish diversity with high juvenile fish abundance.

Location of Transects

The transects start at the eastern end of the outer lagoon area comprised of smooth consolidated platform, rubble and large coral lumps. The transects extend from the east to the west, and are more of less parallel to the crest. The transect lines sequentially follow each other at an average depth of 2m.

Bearings

The start of transect #1 is located in the outer lagoon opposite a position approximately 50m to the east of the car park / track to the beach.

GPS Position (Start of Transect #1, opposite position on shore) : 14^{0} 0244^{1} S, 171^{0} 2057^{1} W.

Coral Cover

Table 4 shows the percent cover of combined live coral (LC) cover of individual coral growth forms, as well as cover of other benthic components. The mean percent cover of each of the benthic components is presented along with the standard deviation (SD). Mean percent live coral cover is the performance indicator of primary interest in this study. A measure of the similarity or otherwise of the comparative site with its "No-Take" site can be done by comparing the pooled live coral cover of both sites. Three of the No-Take – Comparative site pairs have similar total percent cover to each other (within 6-7% difference in cover), and one pair (Sagafoe – Mutu) has quite different live coral cover (35% difference). In most cases, the cover of *Acropora* spp is a high proportion of the total live coral cover at most sites. This coral genus is highly susceptible to damaging activities and generally grows fast. In terms of live coral cover, two site pairs are very similar with respect to *Acropora* spp cover (Lalomanu – Tuiolemu, 7% difference; and Papasina – Itu Papasina, 2% difference), and two pairs are less similar (Magoto – I Timu, 12% difference; and Sagafoe – Mutu, 26% difference).

In Table 4, the Coefficient of Variation (CV) for each site is presented under the standard deviation (SD) row. In all but the last site pair (Sagafoe – Mutu) the CV's are very similar to each other indicating that the cover estimate is relatively accurate and that the sites are similar in terms of percent live coral cover variability.

Table 4. Summary of percent cover data for the Aleipata permanent baseline sites.

KEY TO COLUMN HEADING CODES USED IN TABLE : LC = Total Live Coral **, ACB** = *Acropora* branching**, ACC** = *Acropora* corymbose**, ACD** = *Acropora* digitate**, ACT** = *Acropora* table**, CA** = Coralline algae**, CB** = Non-***Acropora*** Coral branching**, CE** = Non-*Acropora* Coral encrusting**, CF** = Coral foliose**, CM** = Coral massive**, CME** = *Millepora* spp**, CS** = Non-*Acropora* Coral submassive**, DC** = Dead coral**, HA** = *Halimeda* spp macro algae**, MA** = Other macro algae**, OT** = Other macro invertebrates**, PLA** = Platform**, R** = Rubble**, S** = Sand**, SC** = Soft coral**, SR** = Sand and rubble**, TA** = Turf algae. **KEY TO OTHER TERMS : COMP.** = Comparative site; **Mean** %C = Mean percent cover; **SD** = Standard deviation, **CV** = Coefficient of variation; **TR** = Transect number.

	TR	LC	ACB	ACC	ACD	ACT	CA	CB	CE	CF	CM	CME	CS	DC	HA	MA	OT	PLA	R	S	SC	SR	TA
1A. PAPASINA	**1**	58.7	0.0	0.0	1.3	56.0	34.7	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	6.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(NO TAKE)	**2**	49.3	1.3	2.7	2.7	29.3	49.3	0.0	10.7	0.0	2.7	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3	24.0	0.0	0.0	9.3	5.3	61.3	0.0	9.3	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	13.3
	4	57.3	1.3	1.3	0.0	41.3	37.3	0.0	12.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	4.0
	5	57.3	1.3	4.0	1.3	38.7	41.3	0.0	12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3
MEAN %C. =		**49.3**	**0.8**	**1.6**	**2.9**	**34.1**	**44.8**	**0.0**	**8.8**	**0.0**	**0.8**	**0.3**	**0.0**	**0.3**	**0.0**	**1.6**	**0.0**	**0.0**	**0.0**	**0.0**	**0.3**	**0.0**	**3.7**
SD =		**14.6**	**0.7**	**1.7**	**3.7**	**18.7**	**10.8**	**0.0**	**5.0**	**0.0**	**1.2**	**0.6**	**0.0**	**0.6**	**0.0**	**2.9**	**0.0**	**0.0**	**0.0**	**0.0**	**0.6**	**0.0**	**5.6**
CV =		**0.30**																					
1B. ITU PAPASINA	**1**	62.7	6.7	0.0	1.3	49.3	26.7	0.0	0.0	0.0	2.7	0.0	2.7	4.0	0.0	1.3	0.0	0.0	2.7	2.7	0.0	0.0	0.0
(COMP.)	**2**	41.3	0.0	2.7	0.0	22.7	53.3	0.0	14.7	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.3
	3	38.7	2.7	1.3	0.0	33.3	61.3	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4	32.0	0.0	0.0	0.0	29.3	68.0	0.0	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	5	41.3	0.0	0.0	0.0	40.0	58.7	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MEAN %C. =		**43.2**	**1.9**	**0.8**	**0.3**	**34.9**	**53.6**	**0.0**	**3.7**	**0.0**	**0.8**	**0.0**	**0.8**	**0.8**	**0.0**	**0.3**	**0.0**	**0.0**	**0.5**	**0.5**	**0.0**	**0.0**	**1.1**
SD =		**11.5**	**2.9**	**1.2**	**0.6**	**10.2**	**16.0**	**0.0**	**6.2**	**0.0**	**1.2**	**0.0**	**1.2**	**1.8**	**0.0**	**0.6**	**0.0**	**0.0**	**1.2**	**1.2**	**0.0**	**0.0**	**2.4**
CV =		**0.27**																					
2A. SAGAFOE	**1**	85.3	81.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7	0.0	1.3	2.7	0.0	0.0	0.0	1.3	6.7	2.7	0.0	1.3	0.0
(NO TAKE)	**2**	69.3	36.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0	32.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.3	2.7	0.0	13.3	1.3
	3	69.3	52.0	0.0	0.0	0.0	1.3	17.3	0.0	0.0	0.0	0.0	0.0	1.3	2.7	0.0	0.0	0.0	17.3	2.7	0.0	5.3	0.0
	4	72.0	69.3	0.0	0.0	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.3	2.7	0.0	0.0	0.0
	5	29.3	24.0	0.0	0.0	0.0	0.0	2.7	0.0	0.0	2.7	0.0	0.0	0.0	0.0	0.0	0.0	1.3	48.0	1.3	0.0	18.7	1.3
MEAN %C. =		**65.1**	**52.5**	**0.0**	**0.0**	**0.5**	**0.3**	**4.3**	**0.0**	**0.0**	**7.5**	**0.0**	**0.3**	**0.8**	**0.5**	**0.0**	**0.0**	**0.5**	**22.1**	**2.4**	**0.0**	**7.7**	**0.5**
SD =		**21.0**	**23.4**	**0.0**	**0.0**	**1.2**	**0.6**	**7.4**	**0.0**	**0.0**	**13.8**	**0.0**	**0.6**	**1.2**	**1.2**	**0.0**	**0.0**	**0.7**	**16.0**	**0.6**	**0.0**	**8.0**	**0.7**

	TR	LC	ACB	ACC	ACD	ACT	CA	CB	CE	CF	CM	CME	CS	DC	HA	MA	OT	PLA	R	S	SC	SR	TA
CV =		**0.32**																					
2B. MUTU	**1**	60.0	57.3	0.0	0.0	0.0	2.7	2.7	0.0	0.0	0.0	0.0	0.0	1.3	1.3	0.0	0.0	0.0	8.0	9.3	1.3	4.0	12.0
(COMP.)	**2**	34.7	34.7	0.0	0.0	0.0	28.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.3	0.0	0.0	4.0	4.0	0.0	8.0	4.0
	3	34.7	34.7	0.0	0.0	0.0	28.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.7	0.0	0.0	8.0	5.3	0.0	14.7	2.7
	4	8.0	8.0	0.0	0.0	0.0	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	57.3	0.0	0.0	9.3	5.3	0.0	16.0	1.3
	5	16.0	0.0	0.0	0.0	0.0	10.7	0.0	1.3	0.0	1.3	1.3	12.0	0.0	4.0	42.7	0.0	0.0	13.3	4.0	0.0	2.7	6.7
MEAN %C. =		**30.7**	**26.9**	**0.0**	**0.0**	**0.0**	**14.4**	**0.5**	**0.3**	**0.0**	**0.3**	**0.3**	**2.4**	**0.3**	**1.1**	**24.8**	**0.0**	**0.0**	**8.5**	**5.6**	**0.3**	**9.1**	**5.3**
SD =		**20.1**	**23.1**	**0.0**	**0.0**	**0.0**	**12.8**	**1.2**	**0.6**	**0.0**	**0.6**	**0.6**	**5.4**	**0.6**	**1.7**	**24.4**	**0.0**	**0.0**	**3.3**	**2.2**	**0.6**	**6.1**	**4.2**
CV =		**0.66**																					
3A. AAU MAGOTO	**1**	20.0	6.7	0.0	1.3	5.3	8.0	1.3	1.3	1.3	1.3	0.0	1.3	1.3	0.0	0.0	0.0	0.0	38.7	32.0	0.0	0.0	0.0
(NO TAKE)	**2**	29.3	2.7	0.0	0.0	17.3	5.3	4.0	4.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	64.0	0.0	0.0	0.0	1.3
	3	22.7	0.0	0.0	2.7	17.3	10.7	0.0	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37.3	5.3	1.3	21.3	1.3
	4	21.3	1.3	0.0	0.0	14.7	16.0	1.3	1.3	1.3	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	52.0	4.0	0.0	2.7	4.0
	5	57.3	4.0	0.0	2.7	29.3	5.3	0.0	0.0	0.0	20.0	0.0	1.3	1.3	0.0	4.0	0.0	0.0	29.3	2.7	0.0	0.0	0.0
MEAN %C. =		**30.1**	**2.9**	**0.0**	**1.3**	**16.8**	**9.1**	**1.3**	**1.9**	**0.8**	**4.3**	**0.0**	**0.8**	**0.5**	**0.0**	**0.8**	**0.0**	**0.0**	**44.3**	**8.8**	**0.3**	**4.8**	**1.3**
SD =		**15.6**	**2.6**	**0.0**	**1.3**	**8.6**	**4.5**	**1.6**	**1.5**	**0.7**	**8.8**	**0.0**	**0.7**	**0.7**	**0.0**	**1.8**	**0.0**	**0.0**	**13.7**	**13.1**	**0.6**	**9.3**	**1.6**
CV =		**0.52**																					
3B. I TIMU	**1**	41.3	0.0	0.0	0.0	4.0	5.3	16.0	0.0	1.3	8.0	2.7	9.3	0.0	0.0	1.3	0.0	0.0	40.0	6.7	1.3	4.0	0.0
(COMP.)	**2**	25.3	14.7	0.0	0.0	0.0	0.0	2.7	4.0	0.0	1.3	1.3	1.3	0.0	0.0	0.0	0.0	0.0	14.7	45.3	1.3	12.0	1.3
	3	26.7	12.0	0.0	0.0	0.0	0.0	9.3	0.0	0.0	4.0	0.0	1.3	0.0	0.0	1.3	1.3	0.0	2.7	34.7	0.0	32.0	1.3
	4	12.0	9.3	0.0	1.3	0.0	2.7	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.7	24.0	0.0	37.3	5.3
	5	14.7	5.3	0.0	0.0	0.0	8.0	1.3	0.0	0.0	4.0	1.3	2.7	0.0	0.0	0.0	0.0	0.0	8.0	45.3	0.0	24.0	0.0
MEAN %C. =		**24.0**	**8.3**	**0.0**	**0.3**	**0.8**	**3.2**	**6.1**	**0.8**	**0.3**	**3.5**	**1.1**	**2.9**	**0.0**	**0.0**	**0.5**	**0.3**	**0.0**	**16.8**	**31.2**	**0.5**	**21.9**	**1.6**
SD =		**11.6**	**5.8**	**0.0**	**0.6**	**1.8**	**3.5**	**6.4**	**1.8**	**0.6**	**3.1**	**1.1**	**3.7**	**0.0**	**0.0**	**0.7**	**0.6**	**0.0**	**14.3**	**16.3**	**0.7**	**13.8**	**2.2**
CV =		**0.48**																					
4A. LALOMANU	**1**	56.0	34.7	0.0	1.3	9.3	0.0	0.0	0.0	0.0	5.3	0.0	5.3	5.3	0.0	0.0	0.0	0.0	38.7	0.0	0.0	0.0	0.0
(NO TAKE)	**2**	22.7	6.7	0.0	1.3	4.0	8.0	0.0	1.3	1.3	1.3	6.7	0.0	0.0	6.7	0.0	0.0	0.0	50.7	0.0	0.0	9.3	2.7
	3	30.7	12.0	1.3	0.0	9.3	1.3	4.0	4.0	0.0	0.0	0.0	0.0	0.0	1.3	1.3	0.0	0.0	29.3	12.0	0.0	22.7	1.3
	4	30.7	6.7	0.0	1.3	8.0	0.0	1.3	2.7	0.0	10.7	0.0	0.0	1.3	0.0	0.0	1.3	0.0	17.3	6.7	0.0	41.3	1.3
	5	46.7	34.7	1.3	0.0	4.0	4.0	1.3	2.7	1.3	1.3	0.0	0.0	2.7	0.0	0.0	0.0	2.7	24.0	5.3	0.0	12.0	2.7
MEAN %C. =		**37.3**	**18.9**	**0.5**	**0.8**	**6.9**	**2.7**	**1.3**	**2.1**	**0.5**	**3.7**	**1.3**	**1.1**	**1.9**	**1.6**	**0.3**	**0.3**	**0.5**	**32.0**	**4.8**	**0.0**	**17.1**	**1.6**
SD =		**13.6**	**14.5**	**0.7**	**0.7**	**2.7**	**3.4**	**1.6**	**1.5**	**0.7**	**4.4**	**3.0**	**2.4**	**2.2**	**2.9**	**0.6**	**0.6**	**1.2**	**13.0**	**5.0**	**0.0**	**15.8**	**1.1**

	TR	LC	ACB	ACC	ACD	ACT	CA	CB	CE	CF	CM	CME	CS	DC	HA	MA	OT	PLA	R	S	SC	SR	TA
CV =		**0.36**																					
4B. TUIOLEMU	**1**	29.3	5.3	4.0	0.0	16.0	0.0	0.0	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.7	1.3	0.0	10.7	8.0
(COMP.)	**2**	29.3	5.3	1.3	0.0	9.3	1.3	1.3	0.0	0.0	0.0	10.7	1.3	2.7	0.0	0.0	0.0	0.0	36.0	4.0	1.3	24.0	1.3
	3	40.0	17.3	0.0	0.0	8.0	1.3	0.0	0.0	0.0	8.0	0.0	6.7	0.0	0.0	0.0	0.0	26.7	2.7	16.0	0.0	13.3	0.0
	4	12.0	2.7	0.0	0.0	4.0	0.0	0.0	1.3	0.0	1.3	0.0	2.7	5.3	0.0	0.0	0.0	33.3	1.3	14.7	0.0	32.0	1.3
	5	38.7	13.3	2.7	2.7	10.7	0.0	0.0	0.0	0.0	8.0	0.0	1.3	1.3	0.0	0.0	0.0	34.7	8.0	5.3	0.0	10.7	1.3
MEAN %C. =		**29.9**	**8.8**	**1.6**	**0.5**	**9.6**	**0.5**	**0.3**	**0.3**	**0.0**	**4.3**	**2.1**	**2.4**	**1.9**	**0.0**	**0.0**	**0.0**	**18.9**	**19.7**	**8.3**	**0.3**	**18.1**	**2.4**
SD =		**11.2**	**6.2**	**1.7**	**1.2**	**4.4**	**0.7**	**0.6**	**0.6**	**0.0**	**3.7**	**4.8**	**2.6**	**2.2**	**0.0**	**0.0**	**0.0**	**17.5**	**22.3**	**6.6**	**0.6**	**9.5**	**3.2**
CV =		**0.37**																					

Table 5. Summary of the incidence of coral damage at all Aleipata permanent baseline sites.

KEY TO CORAL FORM : ACB = *Acropora* branching**, ACC** = *Acropora* corymbose**, ACD** = *Acropora* digitate**, ACT** = *Acropora* table**, CB** = Non-***Acropora*** Coral branching**, CF** = Coral foliose**, CS** = Non-*Acropora* Coral submassive**.**
KEY TO DAMAGE CATEGORIES : BB = Broken Branches; **OT** = Overturned Colony; **SP** = Split Colony; **NO** = No Damage.
KEY TO OTHER TERMS : NO TAKE = No-Take site; **COMPARATIVE** = Comparative site; **TR** = Transect number; **TOT (Coral Form)** = Total damaged and undamaged colonies; **ALL FORMS.TOTAL** = Total Colonies per transect and per site.

FORM =	TR	ACB					ACC					ACD					ACT					ALL AC. TOTAL
DAMAGE =		BB	OT	SP	NO	TOT	BB	OT	SP	NO	TOT	BB	OT	SP	NO	TOT	BB	OT	SP	NO	TOT	
1A. PAPASINA	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	42	0	0	9	51	51
(NO TAKE)	2	1	0	0	0	1	2	0	0	13	15	0	0	0	4	4	63	3	0	4	70	90
	3	1	0	0	0	1	12	0	0	11	23	4	0	0	0	4	25	0	0	0	25	53
	4	1	0	0	0	1	6	0	0	4	10	6	0	0	2	8	44	2	0	1	47	66
	5	3	0	0	0	3	4	0	0	6	10	1	0	0	1	2	89	1	0	2	92	107
TOTAL =		**6**	**0**	**0**	**0**	**6**	**24**	**0**	**0**	**34**	**58**	**11**	**0**	**0**	**7**	**18**	**263**	**6**	**0**	**16**	**285**	**367**
TOT. % DAM. =		**100**	**0**	**0**		**100**	**41**	**0**	**0**		**41**	**61**	**0**	**0**		**61**	**92**	**2**	**0**		**94**	**84**
1B ITU PAPASINA	1	6	0	2	4	12	4	0	0	7	11	1	0	0	2	3	100	3	0	1	104	130
(COMPARATIVE)	2	3	0	0	0	3	11	0	0	8	19	4	0	0	0	4	77	2	0	0	79	105
	3	4	0	0	0	4	3	0	0	2	5	0	0	0	0	0	60	1	0	7	68	77
	4	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	23	3	0	30	56	58
	5	1	0	0	0	1	1	0	0	0	1	0	0	0	0	0	2	8	0	100	110	112
TOTAL =		**14**	**0**	**2**	**4**	**20**	**19**	**0**	**0**	**19**	**38**	**5**	**0**	**0**	**2**	**7**	**262**	**17**	**0**	**138**	**417**	**482**
TOT. % DAM. =		**70**	**0**	**10**		**80**	**50**	**0**	**0**		**50**	**71**	**0**	**0**		**71**	**63**	**4**	**0**		**66**	**66**
2A. SAGAFOE	1	0	0	0	8	8	0	0	0	1	1	0	0	0	1	1	2	0	0	1	3	13
(NO TAKE)	2	3	4	4	12	23	0	0	0	1	1	2	2	0	5	9	5	0	0	4	9	42
	3	4	0	1	6	11	0	0	0	0	0	0	0	1	0	1	1	0	0	1	2	14

FORM =	TR	ACB					ACC					ACD					ACT					ALL AC. TOTAL
DAMAGE =		**BB**	**OT**	**SP**	**NO**	**TOT**	**BB**	**OT**	**SP**	**NO**	**TOT**	**BB**	**OT**	**SP**	**NO**	**TOT**	**BB**	**OT**	**SP**	**NO**	**TOT**	
	4	1	2	1	10	14	0	0	0	0	0	0	0	0	0	0	5	2	0	6	13	27
	5	1	5	6	14	26	0	0	0	1	1	0	0	0	0	0	7	0	0	10	17	44
TOTAL =		**9**	**11**	**12**	**50**	**82**	**0**	**0**	**0**	**3**	**3**	**2**	**2**	**1**	**6**	**11**	**20**	**2**	**0**	**22**	**44**	**140**
TOT. % DAM. =		**11**	**13**	**15**		**39**	**0**	**0**	**0**		**0**	**18**	**18**	**9**		**45**	**45**	**5**	**0**		**50**	**42**
2B. MUTU	**1**	0	2	3	21	26	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	27
(COMPARATIVE)	**2**	0	4	9	30	43	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	44
	3	0	5	17	27	49	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	50
	4	0	9	7	9	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25
	5	0	0	1	1	2	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	3
TOTAL =		**0**	**20**	**37**	**88**	**145**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**2**	**0**	**0**	**0**	**2**	**2**	**149**
TOT. % DAM. =		**0**	**14**	**26**		**39**	**0**	**0**	**0**		**0**	**0**	**0**	**0**		**0**	**0**	**0**	**0**		**0**	**38**
3A. AAU MAGOTO	**1**	0	0	1	4	5	0	0	0	1	1	0	0	0	0	0	4	0	0	9	13	19
(NO TAKE)	**2**	0	0	0	8	8	2	0	0	7	9	0	0	0	2	2	20	1	1	62	84	103
	3	1	0	0	9	10	0	0	0	4	4	0	0	0	9	9	18	2	0	77	97	120
	4	1	0	0	25	26	0	0	0	0	0	0	0	0	6	6	26	3	0	139	168	200
	5	0	0	1	24	25	0	0	0	10	10	0	1	0	5	6	7	4	0	93	104	145
TOTAL =		**2**	**0**	**2**	**70**	**74**	**2**	**0**	**0**	**22**	**24**	**0**	**1**	**0**	**22**	**23**	**75**	**10**	**1**	**380**	**466**	**587**
TOT. % DAM. =		**3**	**0**	**3**		**5**	**8**	**0**	**0**		**8**	**0**	**4**	**0**		**4**	**16**	**2**	**0**		**18**	**16**
3B. I TIMU	**1**	0	0	0	0	0	0	0	0	4	4	0	0	0	1	1	0	1	0	10	11	16
(COMPARATIVE)	**2**	0	0	3	16	19	0	0	1	5	6	0	0	0	0	0	1	1	0	8	10	35
	3	0	1	1	19	21	0	0	0	2	2	0	0	0	1	1	2	1	0	9	12	36
	4	0	2	2	28	32	0	0	0	0	0	0	1	0	1	2	1	2	0	2	5	39
	5	1	4	1	3	9	0	1	0	0	1	0	0	0	0	0	2	0	0	5	7	17
TOTAL =		**1**	**7**	**7**	**66**	**81**	**0**	**1**	**1**	**11**	**13**	**0**	**1**	**0**	**3**	**4**	**6**	**5**	**0**	**34**	**45**	**143**
TOT. % DAM. =		**1**	**9**	**9**		**1819**	**0**	**8**	**8**		**15**	**0**	**25**	**0**		**25**	**13**	**11**	**0**		**24**	**20**

FORM =	TR	ACB					ACC					ACD					ACT					ALL AC. TOTAL
DAMAGE =		BB	OT	SP	NO	TOT	BB	OT	SP	NO	TOT	BB	OT	SP	NO	TOT	BB	OT	SP	NO	TOT	
4A. LALOMANU	**1**	0	3	4	37	44	0	1	0	15	16	0	0	0	0	0	4	10	0	34	48	108
(NO TAKE)	**2**	1	1	2	20	24	1	2	0	9	12	0	0	0	2	2	10	22	0	31	63	101
	3	0	11	0	49	60	0	1	0	15	16	0	0	0	0	0	16	9	0	34	59	135
	4	0	4	0	52	56	1	1	0	12	14	0	0	0	7	7	15	10	0	64	89	166
	5	1	5	2	25	33	0	0	0	4	4	0	0	0	1	1	8	11	0	25	44	82
TOTAL =		**2**	**24**	**8**	**183**	**217**	**2**	**5**	**0**	**55**	**62**	**0**	**0**	**0**	**10**	**10**	**53**	**62**	**0**	**188**	**303**	**592**
TOT. % DAM. =		**2**	**11**	**4**		**16**	**3**	**8**	**0**		**11**	**0**	**0**	**0**		**0**	**17**	**20**	**0**		**38**	**26**
4B. TUIOLEMU	**1**	0	0	0	11	11	0	1	0	8	9	0	0	0	0	0	13	1	0	54	68	88
(COMPARATIVE)	**2**	0	3	0	20	23	0	0	0	10	10	0	0	0	0	0	12	1	0	22	35	68
	3	1	5	2	29	37	0	0	0	4	4	0	0	0	0	0	13	0	0	12	25	66
	4	0	6	1	17	24	0	0	0	2	2	0	0	0	1	1	14	0	0	4	18	45
	5	0	3	1	17	21	0	0	0	8	8	0	0	0	2	2	20	1	0	42	63	94
TOTAL =		**1**	**17**	**4**	**94**	**116**	**0**	**1**	**0**	**32**	**33**	**0**	**0**	**0**	**3**	**3**	**72**	**3**	**0**	**134**	**209**	**361**
TOT. % DAM. =		**1**	**15**	**3**		**19**	**0**	**3**	**0**		**3**	**0**	**0**	**0**		**0**	**34**	**1**	**0**		**36**	**27**

(Growth form categories continued)

FORM =	TR	CB					CF					CS					NON-AC.TOTAL	TR	ALL FORMS TOTAL
DAMAGE CATEGORY =		BB	OT	SP	NO	TOT	BB	OT	SP	NO	TOT	BB	OT	SP	NO	TOT			
1A. PAPASINA	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	**51**
(NO TAKE)	**2**	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	4	**2**	**94**
	3	0	0	0	1	1	0	0	0	0	0	1	0	0	0	1	2	**3**	**55**
	4	0	0	0	0	0	0	0	0	0	0	8	0	0	3	11	11	**4**	**77**
	5	0	0	0	0	0	0	0	0	0	0	1	0	0	2	3	3	**5**	**110**
TOTAL =		**0**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**10**	**0**	**0**	**9**	**19**	**20**		**387**
TOT. % DAM. =		**0**	**0**	**0**		**0**	**0**	**0**	**0**		**0**	**53**	**0**	**0**		**53**	**50**		**83**
1B. ITU PAPASINA	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**1**	**130**

FORM =	TR	CB					CF					CS					NON-AC.TOTAL	TR	ALL FORMS TOTAL
DAMAGE CATEGORY =		BB	OT	SP	NO	TOT	BB	OT	SP	NO	TOT	BB	OT	SP	NO	TOT			
(COMPARATIVE)	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	106
	3	0	0	0	0	0	0	0	0	0	0	1	0	0	1	2	2	3	79
	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	58
	5	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	5	113
TOTAL =		0	0	0	0	0	0	0	0	0	0	2	0	0	2	4	4		486
TOT. % DAM. =		0	0	0		0	0	0	0		0	50	0	0		50	50		66
2A. SAGAFOE	1	1	1	4	10	16	0	0	1	0	1	0	0	0	0	0	17	1	30
(NO TAKE)	2	4	0	5	10	19	0	0	0	2	2	0	0	0	0	0	21	2	63
	3	3	1	2	7	13	0	0	0	0	0	0	0	0	0	0	13	3	27
	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	27
	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	44
TOTAL =		8	2	11	27	48	0	0	1	2	3	0	0	0	0	0	51		191
TOT. % DAM. =		17	4	23		44	0	0	33		33	0	0	0		0	43		42
2B. MUTU	1	0	1	0	15	16	0	0	0	1	1	0	0	0	0	0	17	1	44
(COMPARATIVE)	2	0	0	0	6	6	0	0	0	0	0	0	0	0	0	0	6	2	50
	3	0	0	0	6	6	0	0	0	0	0	0	0	0	0	0	6	3	56
	4	0	0	0	7	7	0	0	0	0	0	0	0	0	0	0	7	4	32
	5	0	3	3	92	98	0	0	0	11	11	0	0	0	0	0	109	5	112
TOTAL =		0	4	3	126	133	0	0	0	12	12	0	0	0	0	0	145		294
TOT. % DAM. =		0	3	2		5	0	0	0		0	0	0	0		0	5		12
3A. AAU MAGOTO	1	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	2	1	21
(NO TAKE)	2	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5	5	2	108
	3	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	3	122
	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	200
	5	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	5	146

FORM =	TR	CB					CF					CS					NON-AC.TOTAL	TR	ALL FORMS TOTAL
DAMAGE CATEGORY =		BB	OT	SP	NO	TOT	BB	OT	SP	NO	TOT	BB	OT	SP	NO	TOT			
TOTAL =		0	0	0	1	1	0	0	0	2	2	0	0	0	7	7	10		597
TOT. % DAM. =		0	0	0		0	0	0	0		0	0	0	0		0	0		16
3B. I TIMU	1	0	0	0	45	45	0	0	0	0	0	0	0	0	0	0	45	1	61
(COMPARATIVE)	2	0	0	0	17	17	0	0	0	1	1	0	0	0	0	0	18	2	53
	3	0	1	0	19	20	0	0	0	0	0	0	0	0	0	0	20	3	56
	4	0	0	0	6	6	0	0	0	0	0	0	0	0	0	0	6	4	45
	5	0	1	0	3	4	0	0	0	0	0	0	0	0	4	4	8	5	25
TOTAL =		0	2	0	90	92	0	0	0	1	1	0	0	0	4	4	97		240
TOT. % DAM. =						2.2					0.0					0.0	2		13.0
4A. LALOMANU	1	0	0	0	15	15	0	0	0	8	8	0	0	0	0	0	23	1	131
(NO TAKE)	2	0	0	0	8	8	0	0	0	8	8	0	0	0	1	1	17	2	118
	3	0	0	0	13	13	0	0	0	6	6	0	0	0	0	0	19	3	154
	4	0	0	0	7	7	0	0	0	2	2	0	0	0	0	0	9	4	175
	5	0	1	0	13	14	0	0	0	1	1	0	0	0	0	0	15	5	97
TOTAL =		0	1	0	56	57	0	0	0	25	25	0	0	0	1	1	83		675
TOT. % DAM. =		0	2	0		2	0	0	0		0	0	0	0		0	1		23.3
4B. TUIOLEMU	1	0	0	0	3	3	0	0	0	2	2	0	0	0	0	0	5	1	93
(COMPARATIVE)	2	0	0	0	4	4	0	0	0	1	1	0	0	0	0	0	5	2	73
	3	0	1	0	5	6	0	0	0	4	4	0	0	0	4	4	14	3	80
	4	0	0	0	1	1	0	0	0	1	1	0	0	0	1	1	3	4	48
	5	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	2	5	96
TOTAL =		0	1	0	15	16	0	0	0	8	8	0	0	0	5	5	29		390
TOT. % DAM. =		0	6	0		6	0	0	0		0	0	0	0		0	3		25

Coral Damage

Damage to coral is used here as an indicator of harvest activity due to the nature of fishing techniques and relative accessibility of the shallow lagoon habitat. Table 5 summarizes the data recorded for each pair of No-Take and Comparative sites. A total of 1771 colonies from the 8 sites were recorded. Each site pair is discussed separately below.

<u>Pair 1. (A) Papasina (No-Take) and (B) Itu Papasina (Comparative)</u>

There was a small difference in the number of colonies between these sites with relatively fewer colonies overall in the No-Take Papasina site (387 colonies) in contrast to the Comparative Itu Papasina site (486 colonies). The majority of colonies present were *Acropora* spp (tablular, corymbose, then equal numbers of branching and digitate forms, in order of abundance) at both sites. Though fewer colonies were present at Papasina, there was a similar high incidence of damage compared to Itu Papasina (83% and 66%, respectively). The relative percentage of damaged colonies was approximately similar among the four *Acropora* growth forms from both sites.

<u>Pair 2. (A) Sagafoe (No-Take) and (B) Mutu (Comparative)</u>

There was a difference in the number of colonies between these sites with fewer colonies overall in the No-Take Sagafoe site (191 colonies) in contrast to the Comparative Mutu site (294 colonies). A similar number of *Acropora* spp was present at both sites (mainly branching and tablular forms, a few digitate and no corymbose forms, in order of abundance). Though fewer colonies were present at Sagafoe, there was a higher incidence of damage compared to Mutu (42% and 22%, respectively). The relative percentage of damaged colonies was varied among the four *Acropora* growth forms at both sites, except for the branching growth form. A high occurrence of a non-*Acropora* coral (*Pocillopora damicornis*) with a low damage index (5%) at Mutu contrasted with the Sagafoe site where there was a high damage index of the non-*Acropora* branching form *Psammocora digitata*.

<u>Pair #3 : (A) Aau Magoto (No-Take) and (B) I Timu (Comparative)</u>

There was a large difference in the number of colonies between the site pairs with fewer colonies overall in the Comparative I Timu site (240 colonies) in contrast to the No-Take Aau Magoto site (597 colonies). However, at both sites the majority of colonies were *Acropora* spp (branching, corymbose, digitate, and tablular forms). Though fewer colonies were present at I Timu, there was a higher incidence of damage to *Acropora* spp growth forms compared to Aau Magoto. The percentage of damaged colonies was more or less similar among the four *Acropora* growth forms at I Timu compared to Aau Magoto where growth form damage was more variable within the site. Non-*Acropora* colonies were rare or not present at both sites, except for branching non-*Acropora* forms (mainly *Porites cylindrica*) at I Timu. Overall, the percentage of colonies with damage was quite similar at both sites (16% at Aau Magoto and 25% at I Timu).

<u>Pair 4. (A) Lalomanu (No-Take) and (B) Tuiolemu (Comparative)</u>

There was a large difference in the number of colonies between the site pair with fewer colonies overall in the Comparative Tuiolemu site (390 colonies) in contrast to the No-Take Lalomanu site (675 colonies). However, the majority of colonies were *Acropora* spp (tablular, branching, corymbose, and digitate forms, in order of abundance) at both sites. Though fewer colonies were present at Tuiolemu, the percentage of colonies with damage was quite similar to Lalomanu (25% and 23% of all colonies assessed, respectively). In addition, relative percentage of damaged colonies was similar among the four *Acropora* growth forms from both sites.

Coral Health and Disturbances

Coral health and disturbance indices were recorded from the same belt transects that were used in the coral damage surveys. Health indices that were used included : bleaching, disease, Crown-of-Thorns Starfish (COTS) feeding scars, and *Drupella* spp gastropod feeding scars. No cases of overgrowth by algae, ascidians, or sponges were observed.

The incidence of coral bleaching in presented in Table 6. Bleaching had been widespread in Samoa from mid-February 2002 and was noticeably in decline at the time of these surveys in June 2002 (pers.obs.). The majority pale colour colonies had only a pale colour and not the white colour symptoms of a major bleaching event. Bleaching frequency was generally low (<10% of colonies) except for 2 sites (Sagafoe and Mutu) from the outer lagoon in the northern part of the large eastern sector lagoon (with 37.2% and 47.6% of colonies bleached, respectively). The high frequency of bleaching at these 2 sites can be explained by the dominance of the most susceptible *Acropora* growth forms. Overall, bleaching was mainly confined to *Acropora* spp, particularly the branching and tabulate *Acropora*. It was not possible to estimate the degree of mortality that may have been a result of the bleaching event, though a low incidence of recently dead *Acropora* spp colonies was observed.

Coral disease was also recorded for colonies in the same belt transects used to estimate coral damage. Only 4 colonies of the 1771 colonies in the belt transects showed signs of disease. All these colonies were exhibiting a white band disease (WBD) that has been observed to occur exclusively in tabulate *Acropora* colonies generally in slope communities in the District (Fisk 2002). The WBD has been observed in colonies for the past 1.5 years (pers.obs., since the author commenced surveys in Samoa) and has been noted mainly to occur on outer slope colonies.

Feeding scars from COTS and *Drupella* gastropods were not common. Three COTS scars were recorded in belt transects at Lalomanu, and 2 COTS scars were observed outside the belt transects at I Timu. Three COTS were also observed in belt transects at Mutu but no scars were observed associated with the starfish. The general distribution of COTS corresponds with the records from the broad scale surveys (Fisk 2002, and see Macro Invertebrates section below). No *Drupella* spp scars were observed on colonies within the belt transects. However, some scars were observed in the vicinity of the transects at Lalomanu, which is also consistent with records from the broad scale surveys (Fisk 2002).

Table 6. Summary of the incidence of bleached colonies that were encountered during the coral damage surveys.

KEY : FORM = Coral Growth Form; **NO BLEACH** = Number of Colonies Without Bleaching Symptons; **PALE BLEACH** = Number of Colonies showing Minor Bleaching or Pale Colour; **WHITE BLEACH** = Number of Colonies showing Major Bleaching or complete lack of colour; (%) = Percentage of all Colonies showing either Pale or White Bleaching; **FORM** = Coral Growth Forms (**ACB** = *Acropora* branching, **ACC** = *Acropora* corymbose, **ACD** = *Acropora* digitate, **ACT** = *Acropora* tabulate, **CB** = Non-*Acropora* Branching, **CF** = Coral Foliose, **CS** = Non-*Acropora* Submassive.

FORM =	**ACB**	**ACC**	**ACD**	**ACT**	**CB**	**CF**	**CS**	**TOTAL**
SITE	**NO BLEACH**							
PAPASINA	6	57	18	282	1	0	19	383
ITU PAPASINA	20	37	7	405	0	0	4	473
SAGAFOE	30	1	10	28	48	3	0	120
MUTU	20	0	2	2	118	12	0	154
AAU MAGOTO	59	21	22	434	1	2	7	546
I TIMU	77	13	4	40	91	1	4	230
LALOMANU	212	60	10	301	54	25	1	663
TUIOLEMU	112	33	3	197	16	8	4	373
TOTAL	536	222	76	1689	329	51	39	2942
	PALE BLEACH							
PAPASINA	0	0	0	3	0	0	0	3 (0.8%)
ITU PAPASINA	0	1	0	12	0	0	0	13 (2.7%)
SAGAFOE	52	2	1	16	0	0	0	71 (37.2%)
AVA MUTU	125	0	0	0	15	0	0	140 (47.6%)
AAU MAGOTO	15	3	1	31	0	0	0	50 (8.4%)
I TIMU	4	0	0	5	1	0	0	10 (4.2%)
LALOMANU	5	2	0	2	2	0	0	11 (1.6%)
TUIOLEMU	2	0	0	12	0	0	1	15 (3.9%)
TOTAL	203	8	2	81	18	0	1	313 (9.6%)
	WHITE BLEACH							
PAPASINA	0	1	0	0	0	0	0	1 (0.3%)
ITU PAPASINA	0	0	0	0	0	0	0	0
SAGAFOE	0	0	0	0	0	0	0	0
AVA MUTU	0	0	0	0	0	0	0	0
AAU MAGOTO	0	0	0	1	0	0	0	1 (0.2%)
I TIMU	0	0	0	0	0	0	0	0
LALOMANU	0	0	0	0	1	0	0	1 (0.2%)
TUIOLEMU	2	0	0	0	0	0	0	2 (0.5%)
TOTAL	2	1	0	1	1	0	0	5 (0.2%)

Fish Abundance and Biomass

Fish densities varied among sites with a range of approximately 17,000 fish / ha (Aau Magoto) to 110,000 fish / ha (Papasina) (Table 7). Relative abundance of fish families among all sites showed a strong dominance of Damsels (Pomacentridae), Surgeon Fish (Acanthuridae) and Parrot Fish (Scaridae) (Table 8). All other surveyed families were present in densities of one or two orders of magnitude less than these three dominant families. Of note is the complete absence or extremely rare occurrence of certain families including : Trevally (Carangidae), Sharks (Carcharhinidae), Rays (Dasyatidae), Mackerel (Scombridae), Grouper (Serranidae), and Rabbit Fish (Siganidae). Habitat preferences (eg, deper water or slope preference) may explain some of the absent families but others (eg, Rays, Trevally, Grouper, Rabbit Fish) would be expected to be present. Rabbit fish schools were sometimes observed when divers first entered the water but quickly dispersed before surveys could commence, so their absence from the data may be a result of aversion behaviour rather than true absence. The expected families that are not present may be absent due to extreme over fishing, and therefore their future presence could be a good indicator of the effectiveness of No-Take sites.

At all sites, the majority of observed Surgeon and Parrot fish were juveniles. This confirms the broad-based Biodiversity Assessment survey conclusion (Fisk 2002) that juveniles from especially these two families dominate the outer lagoon habitat (where most of the permanent baseline sites are located).

Total fish density was relatively similar in 2 site pairs (Aau Magoto (17,640) – I Timu (24,933), and Sagafoe (35,680) – Mutu (26,313)), but were dissimilar in the other site pairs (Lalomanu (94,766) – Tuiolemu (21,407); Papasina (110,606) – Itu Papasina (28,887)).

Table 7. Rank of densities of fish families (individuals / ha) recorded at permanent baseline sites.

FISH FAMILY	RANK (TOTAL INDIV./HA)	FISH FAMILY	RANK (TOTAL INDIV./HA)
Pomacentridae	1 (147,940)	Lethrinidae	10 (1,393)
Acanthuridae	2 (93,533)	Haemulidae	11 (433)
Scaridae	3 (85,913)	Scombridae	12 (420)
Labridae	4 (7,327)	Carangidae	13 (13)
Pomacanthidae	5 (7,093)	Carcharhinidae	14 (0)
Siganidae	6 (6,233)	Dasyatidae	14 (0)
Chaetodontidae	7 (5,873)	Lutjanidae	14 (0)
Mullidae	8 (2,353)	Serranidae	14 (0)
Balistidae	9 (1,707)		

The mean densities of each fish family and for each transect and site is presented in Table 9. The coefficient of variation (CV) is also included to show the degree of variation between sites. Only one No-Take site demonstrated relatively homogeneous total fish densities among transects, ie, Papasina (CV = 0.32). Two Comparative sites also showed relatively homogeneous total fish densities, ie, Tuiolemu (CV = 0.11), and Mutu (CV = 0.32). The other 3 sites with individual transect data were relatively heterogeneous (relatively high CV values), as were the mean densities of individual fish families. In addition, high standard deviations with respect to the means indicate high variation between transect counts with consequent relatively low precision.

Fish sizes (total length) are used as an index of biomass for each family and each site. The data are presented in Table 10 for each transect and in Appendix 2 as a summary of means and standard deviations. The data show that the overall sizes of fish are small in the majority of families recorded in the survey. The coefficient of variation (CV) in Table 10 is also calculated to show the degree of variation of the sample data relative to the magnitude of the mean value. The relative homogeneity of sample data is lower for fish lengths compared to the results above for fish densities.

Table 8. Summary of mean and standard deviation for fish densities (number / ha) of each of the survey families from permanent baseline sites. The coefficient of variation (CV) is also given for the overall mean and SD per site. Fish data for Aau Magoto and I Timu were unintentionally pooled at the time of collection so descriptive statistics are not available.

SITE		Acanthuridae	Balistidae	Carangidae	Carcharhinidae	Chaetodontidae	Dasyatidae	Haemulidae	Labridae	Lethrinidae	Lutjanidae	Mugilidae	Mullidae	Pomacanthidae	Pomacentridae	Scaridae	Scombridae	Serranidae	Siganidae	TOTAL	CV
PAPASINA	**MEAN**	8224.0	0.0	0.0	0.0	88.0	0.0	2.7	62.7	116.0	0.0	0.0	18.7	0.0	9010.6	4598.7	0.0	0.0	0.0	22121.3	0.32
	SD	4279.3	0.0	0.0	0.0	33.5	0.0	6.0	91.1	237.7	0.0	0.0	34.8	0.0	10670.9	2682.3	0.0	0.0	0.0	7132.0	
ITU PAPASINA	**MEAN**	1622.7	8.0	0.0	0.0	16.0	0.0	0.0	72.0	108.0	0.0	0.0	10.7	0.0	797.3	3142.7	0.0	0.0	0.0	5777.3	0.99
	SD	1567.2	17.9	0.0	0.0	21.9	0.0	0.0	72.2	241.5	0.0	0.0	23.9	0.0	913.7	3218.9	0.0	0.0	0.0	5719.0	
SAGAFOE	**MEAN**	660.0	178.7	0.0	0.0	236.0	0.0	0.0	189.3	28.0	0.0	0.0	13.3	420.0	1825.3	2510.7	0.0	0.0	1074.7	7136.0	0.73
	SD	721.4	60.1	0.0	0.0	136.6	0.0	0.0	114.4	62.6	0.0	0.0	16.3	306.2	1416.7	2918.3	0.0	0.0	1095.5	5196.0	
MUTU	**MEAN**	1628.0	98.7	0.0	0.0	201.3	0.0	0.0	538.7	0.0	0.0	0.0	112.0	565.3	353.3	1629.3	0.0	0.0	136.0	5262.7	0.32
	SD	911.4	154.5	0.0	0.0	196.3	0.0	0.0	350.9	0.0	0.0	0.0	90.1	221.6	285.9	1518.6	0.0	0.0	162.3	1703.3	
AAU MAGOTO	**POOLED**	6787	13	0	0	580	0	420	747	40	0	0	460	0	4260	4153	0	0	180	17640	
I TIMU	**POOLED**	2953	80	13	0	760	0	0	653	13	0	0	293	0	18193	1973	0	0	0	24933	
LALOMANU	**MEAN**	3440.0	29.3	0.0	0.0	238.7	0.0	0.0	288.0	13.3	0.0	0.0	146.7	196.0	11712.0	2805.3	84.0	0.0	0.0	18953.3	0.61
	SD	1792.0	28.9	0.0	0.0	269.3	0.0	0.0	99.0	16.3	0.0	0.0	298.6	173.4	9427.6	2237.6	187.8	0.0	0.0	11548.3	
TUIOLEMU	**MEAN**	1184.0	8.0	0.0	0.0	126.7	0.0	0.0	34.7	2.7	0.0	0.0	18.7	237.3	1398.7	1270.7	0.0	0.0	0.0	4281.3	0.11
	SD	570.1	17.9	0.0	0.0	238.8	0.0	0.0	42.8	6.0	0.0	0.0	22.3	79.7	847.8	598.9	0.0	0.0	0.0	475.3	

Table 9. Summary of mean and SD for fish lengths (mid point of length classes) of each of the survey families from permanent baseline sites. The coefficient of variation (CV) is also given for the overall mean and SD per site. Means lengths are calculated for the mean mid point length of each size class per transect except for Aau Magoto and I Timu. *Fish data for Aau Magoto and I Timu were unintentionally pooled at the time of collection so the means are not per transect but means per number of fish within each of the pooled transect groups.

SITE	FISH FAMILY	Acanthuridae	Balistidae	Carangidae	Carcharhinidae	Chaetodontidae	Dasyatidae	Haemulidae	Labridae	Lethrinidae	Lutjanidae	Mugilidae	Mullidae	Pomacanthidae	Pomacentridae	Scaridae	Scombridae	Serranidae	Siganidae	TOT	CV
PAPASINA	MEAN	10.5	0.0	0.0	0.0	10.5	0.0	2.1	7.9	7.2	0.0	0.0	5.3	0.0	10.5	12.3	0.0	0.0	0.0	7.3	0.81
	SD	0.0	0.0	0.0	0.0	0.0	0.0	4.7	4.9	11.2	0.0	0.0	5.8	0.0	0.0	5.0	0.0	0.0	0.0	5.9	
ITU PAPASINA	MEAN	10.5	2.1	0.0	0.0	6.0	0.0	0.0	10.5	2.1	0.0	0.0	3.5	0.0	10.5	11.0	0.0	0.0	0.0	6.5	0.82
	SD	0.0	4.7	0.0	0.0	5.6	0.0	0.0	0.0	4.7	0.0	0.0	5.4	0.0	0.0	2.7	0.0	0.0	0.0	5.3	
SAGAFOE	MEAN	10.5	10.5	0.0	0.0	10.5	0.0	0.0	10.5	2.1	0.0	0.0	7.5	10.5	10.5	10.5	0.0	0.0	9.5	8.2	0.53
	SD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7	0.0	0.0	5.1	0.0	0.0	0.0	0.0	0.0	3.2	4.4	
MUTU	MEAN	10.5	9.3	0.0	2.1	10.5	0.0	0.0	10.5	0.0	0.0	0.0	10.5	10.5	10.5	10.5	0.0	0.0	9.8	8.3	0.51
	SD	0.0	3.5	0.0	4.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7	4.3	
AAU MAGOTO* (TR 1-5 POOLED)	MEAN	10.5	10.5	0.0	0.0	10.5	0.0	10.5	11.3	25.5	0.0	0.0	10.5	0.0	10.5	13.6	0.0	0.0	10.5	10.7	
	SD	0.0				0.0		0.0	3.4				0.0		0.0	6.2			0.0	4.4	
I TIMU (TR 5)*	MEAN	10.5	0.0	0.0	0.0	10.5	0.0	0.0	10.5	0.0	0.0	0.0	10.5		10.5	10.5	0.0	0.0	0.0	7.7	
	SD	0.0				0.0			0.0				0.0		0.0	0.0				4.7	
I TIMU* (TR 1-4 POOLED)	MEAN	10.5	10.5	40.5	0.0	10.5	0.0	0.0	10.5	10.5	0.0	0.0	10.5	0.0	10.5	11.9	0.0	0.0	0.0	10.0	
	SD	0.0	0.0			0.0			0.0				0.0		0.0	4.5				4.7	
LALOMANU	MEAN	10.8	7.5	2.1	0.0	10.5	0.0	2.1	10.5	6.3	0.0	0.0	7.0	10.5	10.5	10.3	4.5	2.1	0.0	8.5	0.50
	SD	2.0	5.1	4.7	0.0	0.0	0.0	4.7	0.0	5.8	0.0	0.0	5.4	0.0	0.0	1.6	5.6	4.7	0.0	4.3	
TUIOLEMU	MEAN	10.5	2.1	0.0	2.1	10.5	0.0	0.0	8.2	2.1	2.1	0.0	7.5	10.5	10.5	10.5	0.0	0.0	0.0	7.3	0.67

SITE	FISH FAMILY	Acanthuridae	Balistidae	Carangidae	Carcharhinidae	Chaetodontidae	Dasyatidae	Haemulidae	Labridae	Lethrinidae	Lutjanidae	Mugilidae	Mullidae	Pomacanthidae	Pomacentridae	Scaridae	Scombridae	Serranidae	Siganidae	TOT	CV
	SD	0.0	4.7	0.0	4.7	0.0	0.0	0.0	4.6	4.7	4.7	0.0	5.1	0.0	0.0	0.0	0.0	0.0	0.0	4.9	
TOTAL	**MEAN**	10.6	6.8	1.5	0.6	10.2	0.0	1.5	10.3	4.1	0.3	0.0	8.2	9.0	10.5	11.2	0.9	0.3	5.5	8.2	0.60
	SD	0.9	5.1	7.2	2.5	1.8	0.0	3.7	2.2	7.1	1.8	0.0	4.4	3.7	0.0	3.3	3.0	1.8	5.3	4.9	

Macro Invertebrates

The presence and abundance of macro invertebrates varied substantially between sites (Table 12). These data support the conclusions of the broad based (manta tow) surveys. In general, these conclusions were :

- **giant clams** and **trochus** have very low population densities and are absent from a large proportion of available habitat;
- the **corallivores** (**crown of thorns starfish** and less abundant ***Drupella*** spp) are particularly abundant in the outer lagoon habitat, especially in the southern coast areas and in the northern lagoon opposite Amailie;
- **Anemones** are present in very low numbers throughout the District;
- **Sea urchins** are extremely abundant in the outer lagoon habitat, particularly in the southern and eastern lagoons (with the exception of the outer sections of the eastern lagoon around Aau Magoto);
- **Holothurians** were sparsely distributed and generally consisted of less desirable species for consumption purposes (even though holothurians were not surveyed in a number of sites).

Table 10. Summary of macro invertebrates recorded in belt transects used for fish and coral baseline studies. Belts were 2m wide by 50m long and there were 5 transects at each site. Density per hectare is calculated from the raw data. Blank spaces indicate where no records were taken. Pairs of No-Take and Comparative sites are identified by the same number next to the site name and by either A (No-Take) or B (Comparative).

1A. PAPASINA								
STATUS : NO TAKE								
DATE : 23/05/02								
SAMOAN NAME	**SCIENTIFIC / COMMON NAME**	**TR1**	**TR2**	**TR3**	**TR4**	**TR5**	**TOTAL**	**DENSITY / ha**
Faisua	Clams	0	0	0	0	0	0	0
Aliao	Trochus	0	0	0	0	0	0	0
Alamea	*Acanthaster planci*	0	0	0	0	0	0	0
	Drupella spp	0	0	0	0	0	0	0
	Anemones	0	0	0	0	0	0	0
Vaga	*Echinothrix* spp	0	0	0	0	0	0	0
Tuitui	*Echinometra mathaei*	0	0	0	0	0	0	0
Fugufuga	*Bohadschia argus*	0	0	0	0	0	0	0
Maisu	*Stichopus chloronotus*	0	0	0	0	0	0	0
Loli	*Holothuria atra*	0	0	0	0	0	0	0
Sea	*Thelenota anas*	0	0	0	0	0	0	0
1B. ITU PAPASINA								
STATUS : COMPARATIVE								
DATE : 23/05/02								
SAMOAN NAME	**SCIENTIFIC / COMMON NAME**	**TR1**	**TR2**	**TR3**	**TR4**	**TR5**	**TOTAL**	**DENSITY / ha**
Faisua	Clams	0	0	0	0	0	0	0
Aliao	Trochus	0	0	0	0	0	0	0
Alamea	*Acanthaster planci*	0	0	0	0	0	0	0
	Drupella spp	0	0	0	0	0	0	0
	Anemones	0	0	0	0	0	0	0
Vaga	*Echinothrix* spp	0	0	0	0	0	0	0
Tuitui	*Echinometra mathaei*	0	0	0	0	0	0	0

Fugufuga	*Bohadschia argus*	0	0	0	0	0	0	0
Maisu	*Stichopus chloronotus*	0	0	0	0	0	0	0
Loli	*Holothuria atra*	0	0	0	0	0	0	0
Sea	*Thelenota anas*	0	0	0	0	0	0	0
2A. SAGAFOE								
STATUS : NO TAKE								
DATE : 24/05/02								
SAMOAN NAME	**SCIENTIFIC / COMMON NAME**	**TR1**	**TR2**	**TR3**	**TR4**	**TR5**	**TOTAL**	**DENSITY / ha**
Faisua	Clams	0	0	0	0	0	0	0
Aliao	Trochus	0	0	0	0	0	0	0
Alamea	*Acanthaster planci*	0	0	0	0	0	0	0
	Drupella spp	0	0	0	0	0	0	0
	Anemones	0	0	0	0	0	0	0
Vaga	*Echinothrix* spp	0	0	0	0	0	0	0
Tuitui	*Echinometra mathaei*	152	20	0	0	2	174	3480
Fugufuga	*Bohadschia argus*	0	0	0	0	0	0	0
Maisu	*Stichopus chloronotus*	0	0	0	0	0	0	0
Loli	*Holothuria atra*	0	0	0	0	0	0	0
Sea	*Thelenota anas*	0	0	0	0	0	0	0
2B. MUTU								
STATUS : COMPARATIVE								
DATE : 24/05/02								
SAMOAN NAME	**SCIENTIFIC / COMMON NAME**	**TR1**	**TR2**	**TR3**	**TR4**	**TR5**	**TOTAL**	**DENSITY / ha**
Faisua	Clams	0	0	0	0	0	0	0
Aliao	Trochus	0	0	0	0	0	0	0
Alamea	*Acanthaster planci*	1	0	1	1	0	3	60
	Drupella spp	0	0	0	0	0	0	0
	Anemones	0	0	0	0	0	0	0
Vaga	*Echinothrix* spp	3	0	2	0	5	10	200
Tuitui	*Echinometra mathaei*	57	26	85	0	2	170	3400
Fugufuga	*Bohadschia argus*	0	0	0	0	0	0	0
Maisu	*Stichopus chloronotus*	0	0	0	0	0	0	0
Loli	*Holothuria atra*	0	0	0	0	0	0	0
Sea	*Thelenota anas*	0	0	0	0	0	0	0
3A. AAU MAGOTO								
STATUS : NO TAKE								
DATE : 21/05/02								
SAMOAN NAME	**SCIENTIFIC / COMMON NAME**	**TR1**	**TR2**	**TR3**	**TR4**	**TR5**	**TOTAL**	**DENSITY / ha**
Faisua	Clams	0	0	0	1	0	1	20
Aliao	Trochus	0	0	0	1	0	1	20
Alamea	*Acanthaster planci*	0	0	0	0	0	0	0
	Drupella spp	0	0	1	0	0	1	20
	Anemones	0	0	0	0	2	2	40
Vaga	*Echinothrix* spp					4	4	
Tuitui	*Echinometra mathaei*	0	0	0	0	0	0	0
Fugufuga	*Bohadschia argus*							
Maisu	*Stichopus chloronotus*							
Loli	*Holothuria atra*	0	0	0	0	0	0	0
Sea	*Thelenota anas*	0	0	0	0	0	0	0
3B. I TIMU								
STATUS : COMPARATIVE								
DATE : 21/05/02								
SAMOAN NAME	**SCIENTIFIC / COMMON NAME**	**TR1**	**TR2**	**TR3**	**TR4**	**TR5**	**TOTAL**	**DENSITY / ha**

Faisua	Clams	0	0	1	0	0	1	20
Aliao	Trochus	0	1	0	0	0	1	20
Alamea	*Acanthaster planci*	0	0	0	0	0	0	0
	Drupella spp	0	0	0	0	0	0	0
	Anemones	0	0	0	0	0	0	0
Vaga	*Echinothrix* spp	0	1	0	8	0	9	180
Tuitui	*Echinometra mathaei*	5	0	0	0	0	5	100
Fugufuga	*Bohadschia argus*	1	0	0	0	0	1	20
Maisu	*Stichopus chloronotus*	0	0	0	0	0	0	0
Loli	*Holothuria atra*	0	0	0	0	0	0	0
Sea	*Thelenota anas*	0	0	0	0	0	0	0
4A. LALOMANU								
STATUS : NO TAKE								
DATE : 22/05/02								
SAMOAN NAME	**SCIENTIFIC / COMMON NAME**	**TR1**	**TR2**	**TR3**	**TR4**	**TR5**	**TOTAL**	**DENSITY / ha**
Faisua	Clams	0	0		0	0	0	0
Aliao	Trochus	0	0		1	0	1	20
Alamea	*Acanthaster planci*	1	0	2	0	0	3	60
	Drupella spp						0	
	Anemones	0	0	0	0	0	0	0
Vaga	*Echinothrix* spp	4	18	32	45	24	123	2460
Tuitui	*Echinometra mathaei*	82	97	30	7	32	248	4960
Fugufuga	*Bohadschia argus*							
Maisu	*Stichopus chloronotus*							
Loli	*Holothuria atra*							
Sea	*Thelenota anas*							
4B. TUIOLEMU								
STATUS : COMPARATIVE								
DATE : 22/05/02								
SAMOAN NAME	**SCIENTIFIC / COMMON NAME**	**TR1**	**TR2**	**TR3**	**TR4**	**TR5**	**TOTAL**	**DENSITY / ha**
Faisua	Clams	0	0	0	0	1	1	20
Aliao	Trochus	0	0	0	0	0	0	0
Alamea	*Acanthaster planci*	0	0	0	0	0	0	0
	Drupella spp	0	0	0	0	0	0	0
	Anemones	0	0	0	0	0	0	0
Vaga	*Echinothrix* spp			17	0	2	19	633*
Tuitui	*Echinometra mathaei*			2	0	2	4	133*
Fugufuga	*Bohadschia argus*							
Maisu	*Stichopus chloronotus*							
Loli	*Holothuria atra*							
Sea	*Thelenota anas*							

1.4. SUMMARY

The results of the Permanent Baseline Surveys should be very useful in gauging the effectiveness of management regimes that are proposed for the Aleipata District as part of the Marine Biodiversity Protection and Management project.

The design and location of the permanent baseline monitoring sites are well placed in the majority of cases and are widely dispersed within the Aleipata District to give a good overall perspective on the impact of the MPA plans on target species.

Variation among the transect replicates for coral cover was acceptable for the majority of site-pair comparisons but was more heterogeneous for the fish samples. Much of the variability can be accounted for by transforming the data prior to analysis. If changes over time in coral cover and fish populations are moderate to large, the sample design should be adequate to detect this shift in these parameters. If the changes in fish populations at the next survey are relatively small, it may be difficult to conclude statistically that the MPA design has had an effect. However, whatever the response by the natural populations, there will be adequate information for a descriptive assessment that will be sufficient to provide feedback to the community.

Many of the macro-invertebrate target species were in such low densities (or were absent) it is unlikely that rigorous statistics can be applied to the data. However, major population shifts (or changes in their presence) in distribution and/or abundance will be detected using the current sample design.

Re-surveys of Permanent Baseline sites are to be done over medium term time frames (3-5 years), which will mean that seasonal abundance in target species will not be detected. However, the Community Based Monitoring Program should be able to describe the major seasonal trends, particularly the appearance and persistence of recruitment pulses of fish and certain macro invertebrates.

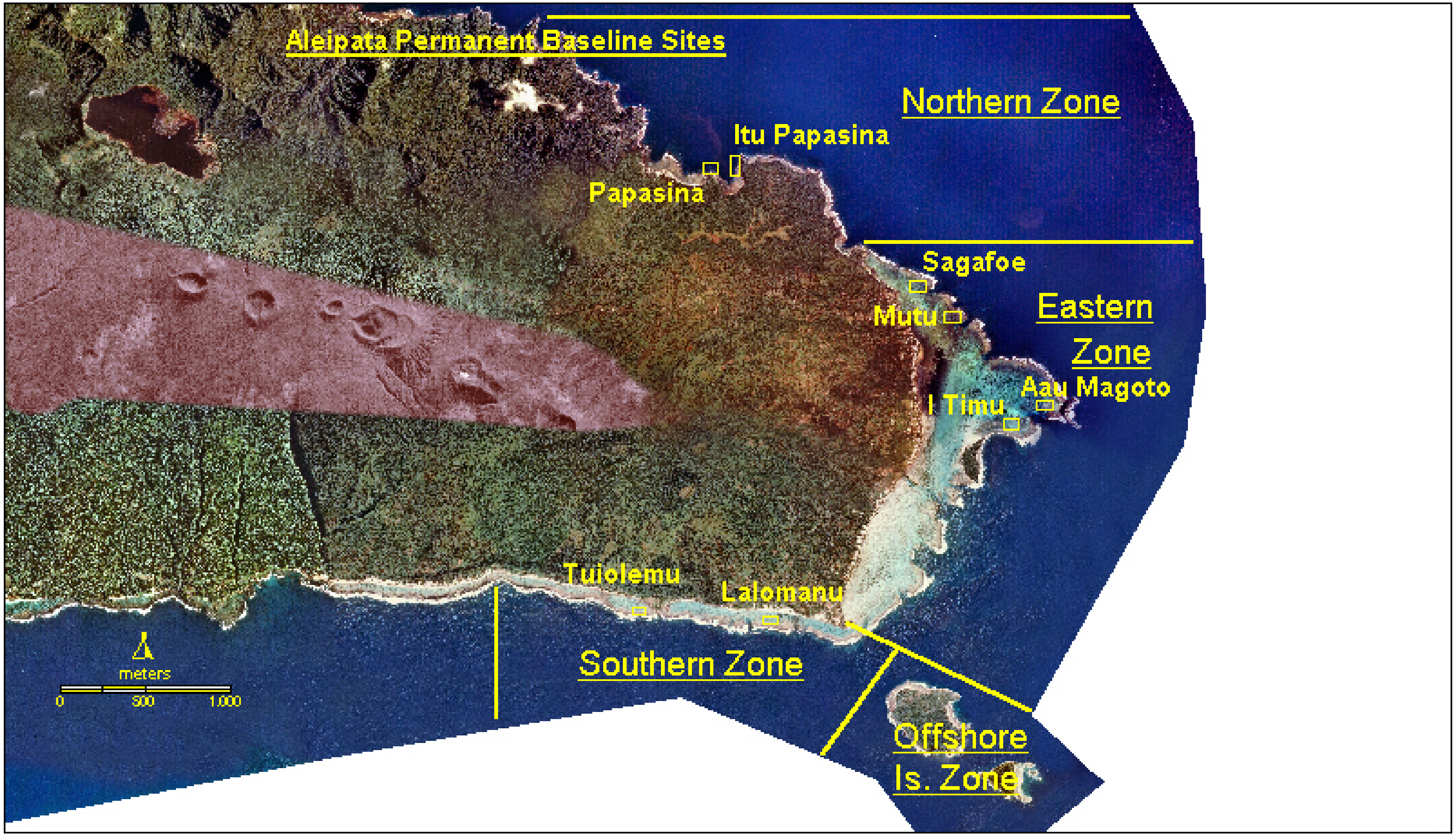

Figure 1. Position of all permanent baseline sites in the Aleipata District.

Figure 2. Permanent baseline sites Papasina (No-Take) and Itu Papasina (Comparative) in the Northern Zone. Approximate position of transects are shown in each site.

Figure 3. Permanent baseline sites Sagafoe (No-Take) and Mutu (Comparative) in the Eastern (North half) Zone. Approximate position of transects are shown in each site.

Figure 4. Permanent baseline sites Aau Magoto (No-Take) and I Timu (Comparative) in the Eastern (North half) Zone. Approximate position of transects are shown in each site.

Figure 5. Permanent baseline sites Lalomanu (No-Take) and Tuiolemu (Comparative) in the Southern Zone. Approximate position of transects are shown in each site.

2. COMMUNITY BASED MONITORING TRIALS

2.1. INTRODUCTION

Community Based (CB) Monitoring Program trials involved the use of appropriate monitoring methods to be used by village volunteers who would monitor their respective No-Take areas. The Community Based Monitoring Program is designed to give immediate and semi-quantitative feedback to the District on the progress of changes that could be attributed to management measures and to natural processes. It also should provide the community with regular up-to-date assessments of the health of their coastal resources.

The community volunteers were instructed in methods that will monitor trends in target species, populations, and/or habitats that are important to the community. This program was also designed to initiate community involvement and to educate and raise awareness of the MPA and its function. In addition, it is desirable that scientifically useful data will be collected that will complement the more detailed Permanent Baseline monitoring of resources within the MPA.

In principle, CB Monitoring should utilise simple techniques that are :

- easily understood,
- easily undertaken,
- require minimum accompanying tools, and are
- easily reported.

Monitoring activities have to be culturally relevant to the community group that is expected to participate in an activity. It is equally important to plan for involvement of community members that are identified as desirable key awareness raising focal groups. Reporting data trends to the community in simple and easy to understand terms or methods, is also a major goal.

In order to maintain a relevant focus for CB Monitoring, the objectives and priority issues outlined in the MPA as well as the expected effect of No-Take areas and other management initiatives, will need to be addressed at all steps in the process. Frequent and timely feedback to the community of the effectiveness of the MPA and its management plan is essential so that the impact of the MPA shows tangible results that will build further community support for these initiatives. Whilst a major objective of the District MPA committee and village members is to enhance local fisheries, the supporting organisations also want to conserve biodiversity and ecosystem integrity. Much of the success of both aims will depend on the choice of No-Take areas and on the adherence of the community to the by laws outlined in the Management Plan

For the Community Based Monitoring trials, volunteers from the villages of **Vailoa** and **Ulutogia** were selected.

MPA Theory

To enhance fisheries, the benefits of No-Take areas have to be experienced outside the protected areas. Positive effects of No-Take areas, supported by scientific data, include an expected increase in the size, abundance, and (less so) species richness of exploited species. These increases are commonly observed even in small reserves within 1-3yrs, but greater gains can be achieved with longer protection periods. Such effects are not universal over short time frames, as some species have not shown positive responses to protection, perhaps due to failure of recruitment and/or inappropriate or degraded habitat within an MPA.

Although it may take a number of years before a significant change can be detected, in the shorter term, monitoring of target species within No-Take areas can encourage the community to continue to support the management regime until such time as 'spillover' and 'seeding' effects are noticed.

To benefit fisheries, any increase in biomass of target species within a No-Take area must eventually result in the export of target species from the protected area to the general fishing areas. This can occur by 'seeding' of new post recruitment individuals outside No-Take areas due to spawning activity or successful settlement of juvenile species within protected areas. Fully protected No-Take areas are particularly important in this regard as there is often an exponential relationship between target species size and fecundity (the abundance of offspring produced). That is, relatively larger individuals have exponentially greater number of potential offspring. Also, benefits are enhanced as higher population densities can result in higher spawning success. Alternatively, transport of larvae or movement of juveniles to adjacent areas is also required from the No-Take areas to produce the 'seeding' effect.

'Spillover' of juveniles and adults of target species may be dependent on relative densities within No-Take and adjacent areas, but not all 'spillover' effects are beneficial to fisheries in the long term. This can be the case where periodic movements of individuals occur due to normal migration to spawning sites, which expose the species from within the No-Take areas to harvest pressures. This can result in no net build up of biomass inside the protected areas. However, this effect depends on the species' vulnerability to fishing and on its mobility. Therefore, unless spillover occurs due to an excess of individuals per unit area within the No-Take area (density dependent effects), there will not be fisheries enhancement. Spillover may be minimal for highly site-attached fish and obviously will not occur in sessile invertebrates like giant clams. In general, seeding by mobile offspring is more likely to be the short term mechanism for enhancing surrounding fisheries, and spillover benefits will occur mostly near No-Take boundaries, when fishing mortality outside the protected areas is high.

Project Approach

The scale and complexity of the project requires innovative approaches and techniques, and constant review of all steps of the process. Extensive consultations and due consideration of local community dynamics have to be the cornerstones of community involvement and awareness raising, and in addressing community expectations. To achieve Project objectives, the design and implementation of community based monitoring activities was approached by adopting a two phase process.

The first phase involves a series of trials and review of appropriate monitoring activities focusing on natural resources that were widely accepted as priority areas for regular monitoring, namely, fish and selected macro invertebrate species groups. Activities outlined in the MPA Project Documents call for training and trials to be conducted by using a few demonstration sites and activities. This report deals with the first phase only.

The second phase was to implement the lessons learnt from the trials to a District wide Community Based Monitoring Program. This is to be coordinated by the Project Team under the specific guidance of the two District volunteers and the Community Liaison Specialist.

2.2. METHODS

A full outline of the Community Based Monitoring trial topics are presented below and on a summary page (one topic and method per page) that can be copied and distributed as required (Appendix 5). Reporting protocols are presented in the Results section with a guide to storing, retrieving, and presenting the information. Throughout the text, Samoan names for organisms or activities are included in italics.

2.2.1. Fish, Invertebrate and Other Benthic Indicators Monitoring

Sample Unit / Transect

Transects or set path swims, are ‘sample units’ of defined distances (and defined width) that are placed within homogeneous habitat. Assessment of biological or habitat characteristics within the defined limits of a transect make up the sample. To simplify field methods, pre-determined distances can be outlined by setting a particular path, thereby eliminating the need for measuring tapes. Though natural habitats can have clear boundaries (it is usually possible to define the boundaries of one habitat and another adjacent one), the variability of resources within a habitat is still usually quite large. To overcome these problems, a number of replicate transects placed throughout a habitat can produce data that can be used to calculate a mean value for a species, habitat characteristic, or indicator that is to be assessed. Alternatively, a single sufficiently long swim or transect can overcome many of the problems inherent in proper sampling techniques, providing that the type of data that is recorded is appropriate to the single swim method.

Therefore, a sample unit can be a :
1. Transect,
2. Defined Path, where a decisions are made on direction and length before a sample is taken, or
3. Sample Device (eg, a quadrat, or a constant area for recording information).

Transects

Transects are specified lengths and widths of lines that define the boundaries and extent of a sample.

Transects vary with respect to the area they sample so as to accommodate the natural distribution patterns of the particular organism that is to be targeted in the monitoring program. That is, for small numerous organisms, a small sample is used with replicates of that sample repeated a number of times within a site. The number of samples or replicates within a site will have to be sufficient to cover the full distribution of the organism at that site. The number of replicates used at a site will have to be sufficient to calculate an accurate mean value which does not have a large amount of variance associated with it.

It is important that the same specified number of replicate transects are used at all sites within any particular monitoring program.

Monitoring methods and standard numbers of transect replicates have to remain unchanged after a program has commenced because every method has a certain bias in what is recorded. That is, comparisons cannot be made between different sample times if the methods are altered in any way, as the inherent bias of each different sample method will change.

In summary, the essential transect requirements of a monitoring program will include:

- **Transect dimensions and transect number per site** that are appropriate to the distribution patterns of the target organism or target groups;
- **The same transect dimensions and number of transects for each target organism** is used at all sites and at all monitoring periods within the same site.

Methods for Recording Abundance and Presence/Absence of Organisms or Benthic Indicators

<u>Belt Transects for Fish, Macro Invertebrates, Other Indicators</u>

In this Community Based Monitoring trial, three similar length belt transects were used as the standard monitoring design for each site and / or habitat, but there were differences in the length of transects between the two villages.

(a) Reef Fish Visual Census Method

The width of each belt is estimated by the observer and was set at 3m wide (this was chosen so as to conform with the permanent baseline methodology included in this report).

The starting point of the first and third set paths were determined by using some stable recognizable point on the shoreline or in the lagoon (Figure 6) and swim paths were in more or less straight lines. The general path is determined from the shoreline before entering the water and should include an approximate finishing point (eg, the edge of a marked reserve, or a well recognized boundary between dark coral or hard substrate areas and sand areas). Whatever paths are decided upon, they should be carefully described and be included in a map so that they can be repeated in the future.

Diagrammatic illustration of the Fish and Other Key Benthos (Set Path) Method

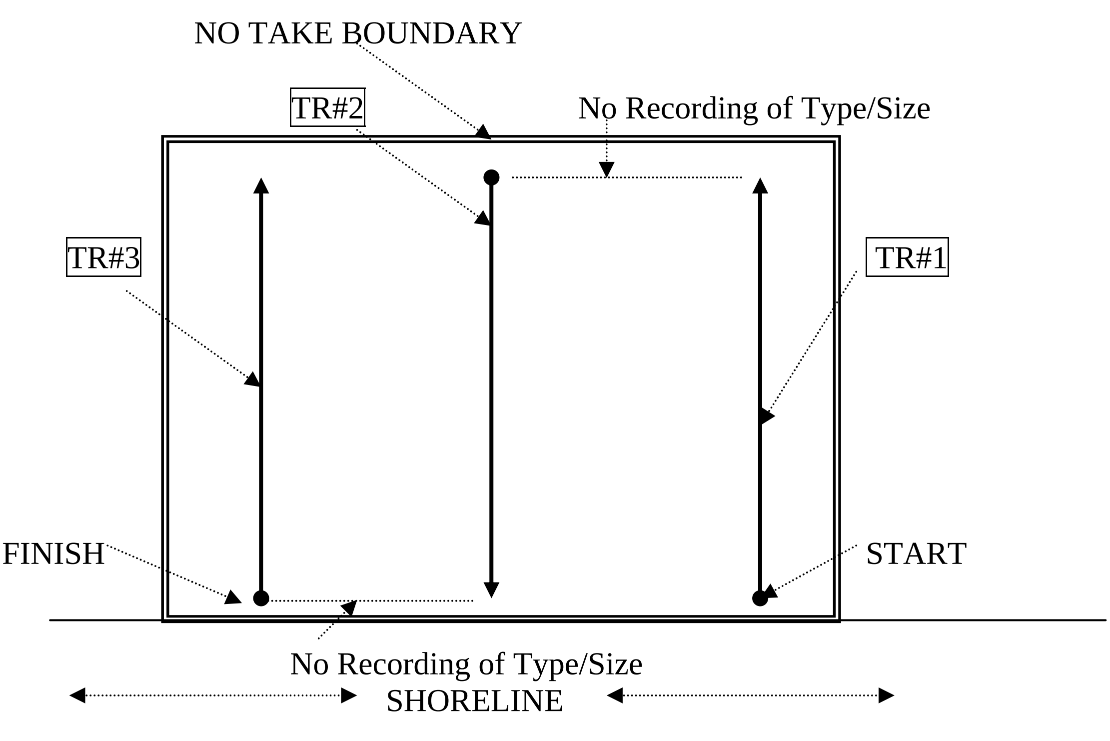

Figure 6. Diagrammatic illustration of a set path sampling design for Visual Fish Census within a typical No Take Area such as a Village Fish Reserve.

The families of fish that are recorded are those that are the most obvious and appropriate with respect to the interest of the villagers. The indicator fish groups are usually always the most desirable fishery species. The method used for Fish visual census by community volunteers require an estimate of :

1. The 3 most numerically abundant fish families or groups (1^{st}, 2^{nd}, and 3^{rd} most abundant groups). The group or family name is written on the dotted line in the data sheet.

2. The most common size of each of the three most abundant groups (length based on different arm section lengths). A tick is written in one of the size category 'circles'.

3. The total number of all fish observed along each set path. This is written at the end of each set path by using the abundance categories outlined on the data sheet. A tick is recorded for one of the abundance categories 'squares'.

These parameters are subjective estimates by the volunteers and are based on the perceived number, and the identity of, fish observed during each of the 3 set path swims.

An example of the basic method of defining the set path for each site area is shown in Figure 2. In the trials, all fish that were present (including the less desirable species) were assessed by the above methods.

The sizes of fish were placed into a number of standard size classes following the completion of each transect. In the Community Based Monitoring the size estimate of fish emulate the commonly used descriptive categories which are based on parts of the human arm. That is, the size of fish are defined as :

1. Fingertip to Wrist (*Tapulima*)
2. Fingertip to elbow (*Tulilima)*,
3. Fingertip to shoulder (*Tau'au*), and
4. Fingertip to >shoulder (>*Tau'au*).

Corresponding maximum sizes and median sizes of fish categories for summary statistics are shown in Table 11.

Table 11. Fish size categories and the corresponding maximum length and median length used in the Community Based Monitoring trials.

Size Category	Maximum Size (cm)	Median Size (cm)
1. Tapulima	20	10
2. Tulilima	50	25
3. Tau'au	80	40
4. > Tau'au	160	80

The abundance or number of fish categories for each swim or replicate is summarized in Table 12. Abundance categories of total fish numbers have maximum range cut off points of 60, 250, 1000, 4000 and 16,000 individual fish. The maximum number of fish was set at 16,000 as it was thought that abundance categories higher than this would not be necessary given the average size of No Take areas.

Table 12. Abundance categories used in estimates of abundance of numerically dominant fish species and the median abundance value used for population estimates.

Category	Range Number of Fish	Median Number
1	1 - 60	30
2	60 – 250	155
3	250 – 1000	625
4	1000– 4000	2,500
5	4000 - 16000	10,000

(b) Reef Macro Invertebrate Belt Transects

The Community Based Monitoring trials include a section for data that records macro invertebrates of interest or of concern for the villagers who are undertaking the monitoring.

Belt transects are commonly used to monitor densities of harvest or indicator invertebrate species. The survey species list can be modified to any organism of interest, but the list should not be changed every survey time unless there are good reasons to do so.

As for fish surveys, invertebrate belt transect samples have to be kept constant within each site and among survey times. Belt widths are usually wider for invertebrate species than for fish as they are normally present in lower densities than most target fish, which means that a greater sample area is required to ensure sufficient numbers are recorded. A good general rule is for belt transects to be at least 5 m wide. Conversely, if a target invertebrate species is very abundant, eg, some sea urchins, then the belt width should be reduced to say 3 m or less for these numerous species only.

Invertebrate belts transects can also be defined in terms of set paths where the transect distance may vary at different sites, but repeat surveys within a site must have constant belt dimensions each sample time.

The macro invertebrates are recorded on a return swim path which covers exactly the same path that is used for the fish monitoring paths. The macro invertebrate surveys are carried out after the fish swims are completed, or are done by additional volunteers who follow behind the fish recorders at a distance that will not disturb the fish present in the area.

It is suggested that for coral reef habitats, suitable macro invertebrates may include :

- **giant clams** (*faisua*),
- **crown of thorns starfish** (*alamea*),
- common **sea urchins** (*tuitui*, *vaga*), and
- **trochus shells** (*aliao*).

Other invertebrates of interest or concern can be added or substituted for the above ones. It is emphasized that once the categories of invertebrates are chosen for use in a village monitoring program, they are always re-surveyed over time. Additional invertebrates or indicators can be added to the monitoring protocol but care should be taken in changing the basic monitoring design after it has been established.

Estimates of abundance are recorded in the following categories for each belt transect of set path swim :

- 1 – 5 individuals,
- 6 – 10 individuals,
- 11 – 20 individuals, and
- >20 individuals.

(c) Other Reef Benthic Indicators from Belt Transects

As an overview of a site, and for little more effort, very useful information on the benthic status and health of a habitat is recorded as part of each transect or swim.

Benthic indicator information is written down at the end of each swim and is recorded as being either present or absent (the appropriate box is ticked if present). The benthic indicators include whether it was observed that :

- significant amounts of **large edible algae** (*limufuafua*) was present within the set swim path;
- the large **brown alga, *Sargassum*** spp (*limu*) which invades lagoon and coastal habitats is present;
- live **corals** were showing clear signs of pale colour which is indicating that **bleaching** (*aau papae*) of the normal darker colour is occurring; and,
- clear evidence of recent **coral breakage** due to destructive collection activities (*aau faamoa* or more correctly, *amu faaleagaina*). Another category that can be important in some situations And may be added to the data recording list) is the presence of overturned coral blocks and coral colonies (*fuliga ma'a*) as a result of gleaning activities.

Data Treatment

Data storage, analysis, and summary information is the next most important step in the program (Figure 7).

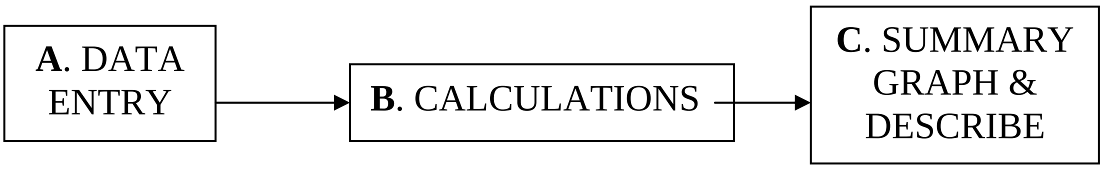

Figure 7. Diagrammatic representation of the steps in summarizing the data collected from the Community Based Monitoring activities.

A. Data Entry

The entry of data can be done directly onto an Excel spreadsheet in the exact way shown in Tables 15 and 16 in Results below for both Reef Fish and Other Indicators data. The same file for these two types of data can be updated with data collected from successive surveys using separate worksheets within each file, and can include data from each village separately (note : not like it is presented in the appendix of this report). Each worksheet can be renamed to indicate which survey period the data are from. That is, monitoring from each village should be kept separate and for each of these villages, two files should be kept, one for Reef Fish data, and one for Other Indicators data.

B. Calculations

Calculations of data from the Community Based Monitoring are specific to each type of data.

(i) For **Fish** data, there are three separate simple calculations that have to be carried out. These are,

- The calculation of a mean median value for the estimate of the total number of fish observed at a site;
- The conclusion of the most abundant fish group observed at the site; and
- The estimation of the size of the most abundant fish group.

Note that these methods refer to data that are recorded from three separate swims per site (as was conducted for the trials). These calculations are not necessary if the data are recorded from a single longer swim in a site.

Details of fish data calculations are done as follows :

- Mean median value of the total number of fish estimated from a site,ie, by adding the median value from swims 1,2 and 3 and dividing by 3. The nearest whole number can be used.

- The most abundant fish identification is calculated by assigning scores to fish within each abundance category, that is :
  Abundance 1 (most abundant) = score of 3,
  Abundance 2 = score of 2, and
  Abundance 3 = score of 1.

(By summing all the fish identifications from all 3 abundance categories, the most abundant fish type (the fish group with the highest score) can be derived)

- The most abundant fish size is estimated by taking a mean value of the sizes (cm) of all records of the most abundant fish type calculated in step (ii).

Appendix (a) contains details of data entry design and calculations, including all keystrokes and formulae.

(ii) For **Macro Invertebrate** data, abundance categories are used to describe relative abundance, and the description of each category is estimated using the 3 swim estimates for that indicator. For example, indicators recorded from the Community Based Monitoring trials were : *Alamea*, *Tuitui/Vaga*, *Aliao*, and *Sea/Loli/Maisu*. For each abundance category :

- Category 1 (1 – 5 individuals) = **Low**;
- Category 2 (6 – 10 individuals) = **Medium**;
- Category 3 (11 – 20 individuals) = **High**; and
- Category 4 (>20 individuals) = **Very High**.

Macro invertebrate data are summarized for descriptive purposes by using the highest category from any one of the three swims, as the general description for that macro invertebrate. This approach was adopted as many of the data records did not always indicate that the volunteer recorded all of the categories required, resulting in ambiguous records in cases where no data was recorded. For example, for the COTS (*alamea*) data recorded for Vailoa VFR, there was a Medium number in one swim but absent records from the other two swims, the conclusion would be that *alamea* was at Medium abundance levels.

Appendix (a) contains details of data entry design and calculations, including all keystrokes and formulae.

(iii) For **Other Benthic Indicators** data (including *Limu*, *Limu fuafua*, *Linu* vaovao, *Aau faamoa*, and *Aau papae*), presence or absence data are recorded from which description of trends through time can be made. This is done by simply adding the number of times each indicator is recorded as present in each transect or set swim. If an indicator is recorded present in all three transects, it is described as present in **high** abundance. If present in two transects, described as present in **medium** abundance, and if in one transect, as **low** abundance. Finally, if there are no observations in any transect it is described as **absent**.

Appendix (a) contains details of data entry design and calculations, including all keystrokes and formulae.

2.2.2. Mangrove Forest Monitoring

Although there was no data recorded for the Lepaga mangrove system in Aleipata, there was a demonstration held of the techniques and a description of how monitoring information is recorded. The full details of the method that was tested in Safata is presented here for future reference and use in Aleipata.

The objective of mangrove forest monitoring is to collect information on the area (spatial extent) and health of the forest, by mapping the perimeter and concentrating on the disturbance and health indicators that are present at the fringe of the forest.

Introduction

Two species of mangrove tree are present in Samoa : *Rhizophora* spp, and *Bruguiera* spp). These and other species were targeted for the demarcation of the mangrove boundary. Both are easily distinguishable by their different growth structure and their different 'knee roots'. *Rhizophora* spp has multiple arching structures that look like roots all around the base, in addition to short, straight, narrow vertical roots that appear above the substrate around a tree. *Bruguiera* spp has a straight, single trunk with rounded, knobby, roots that appear above the substrate around the tree. *Rhizophora* spp tends to be located on the water margin of the forest where a mixture of salt and / or freshwater may be present, while *Bruguiera* spp tends to found on the relatively dryer margins away from zones of maximum sea water inundation.

The definition of a mangrove system generally refers to forests that fringe a tidal estuary and usually include an associated freshwater wetland habitat. Specific mangrove species that tolerate water inundation and various levels of salinity are usually present on the extreme inner parts of a mangrove system. Forests adjacent to mangroves integrate into the mangrove forest community to varying degrees such that it is difficult to distinguish between the two types of forest. In Samoa, most of the accessible and usable land adjacent to mangroves has been cleared or severely altered for agricultural and other purposes. As a result, the perimeters of mangrove systems can be defined by the presence of the two main mangrove species (and some associated mangrove plants like the mangrove fern) or by a narrow fringe of other forest species. Consequently, mangrove perimeter demarcation in Samoa may be associated with a combination of true mangrove species in addition to some adjacent forest species. In a few cases, the mangrove system can be so intact that the forest perimeter is some distance from the main water channels. It is recommended that in such cases, the interior should be left undisturbed and the outer forest perimeter used to define the mangrove system boundary.

Methods for Recording Field Data

Mangrove margins are defined in the field using marked numbers on trees at the perimeter of the forest. A sequence of tree marking is set up with defined seaward margin start and finish points that are joined by a trace of the mangrove margin inland. Trees are marked at various distances such that sequentially numbered trees are easily sighted from the previously marked tree. This is usually an average of 5-15m distance apart, depending on how undulating the mangrove margin is at any one place. The most mature trees are selected for marking whenever possible. An approximate distance from the last marked tree to the next marked tree is recorded, along with a compass direction to the next sequential tree from the previously marked tree.

Condition Indices

In addition to the marking of perimeter trees, a number of descriptive indices are used to monitor the health and threats to mangroves, and these are referred to as condition indices. The condition indices are recorded as present or absent within a standard radius of 5-10m from each marked tree. Condition indices chosen for this study include :

- **Rubbish** (*lapisi*) present that includes all non-organic material such as plastic, iron, building material;
- **Soil Disturbance** (*palapala*) due to animal activity eg pig feeding, cattle / horse presence; this can include obvious human soil disturbances,eg, through digging;
- **Livestock Animals** (*meaola*) present and eg pigs, cattle, horses;
- **Fresh Cuts** (*tipi*) to mangrove tree trunks, branches; and
- **New Trees** (*laau fou*) or small trees present on the **outer margin** radius (not within the boundary line as this index is used to pick up expansion of the mangrove forest margin).

Additional notes and comments are added to the last column. These include :

- the presence of fences or other indicators of disturbance not covered above; and
- the identity of trees that are marked.

Subsequent surveys follow the same path from tree to tree in the same direction as the initial survey. Condition indices are recorded along with any changes to the presence of marked trees (due to human or natural disturbance). Marked trees that are found to be missing are replaced by new marked trees at the mangrove margin with the same number as the original tree (to ensure continuation of the numbering sequence) but with a forward slash (/) followed by the numbers starting at 1 again (eg, if tree number 23 is lost, it is replaced with a new adjacent tree marked 23/1).

Data Treatment

Using the Excel spreadsheet format shown in Appendix 5 (c), data analysis is carried out using a summary tool in Excel called a Pivot Table. This is then followed by a series of calculations to derive summary statistics (Outlined in Appendix 5(c)).

Data interpretation is the third step in the treatment of these data. The following summary interpretations can be done from the Pivot Table :

- The **degree of disturbance** expressed as a percentage of total tree sites with some disturbance of the total number of trees marked (eg, % sites with *tipi* present);

- The **types of disturbance** present expressed as a percentage of different disturbances of the total number of trees of one or more disturbances (eg, the percentage of sites with one or more disturbances); and,

- The relative **significance** of the types of disturbance or condition of areas surrounding the marked trees (eg, Total disturbance per site, and High or Low Disturbance regimes).

All relevant information relating to data entry, analysis and interpretation is presented in a separate reference that was produced as part of this project called "Biodiversity Assessment and Monitoring Manual' (Fisk 2003).

2.3. RESULTS AND DISCUSSION OF TRIALS

Community monitoring trial activities were conducted in the following areas :

SITE & VILLAGE	NO. SWIMS	WHAT MONITORED
1. Vailoa Village Fish Reserve	3	Reef Fish and Other Indicators
2. Lagoon Sand Habitat east of Aau Papa (Malaela Village)	2	Reef Fish
3. Ulutogia Village Fish Reserve	3	Reef Fish and Other Indicators
4. Aau Papa (Malaela Village) & Seagrass Habitat	2	Reef Fish and Other Indicators

Examples of data that was recorded in the monitoring trials are shown in Tables 13 and 14. Note that the full data from all the volunteers are included in Appendices 3 and 4 but only a sub sample of the information is presented here as a demonstration and for discussion.

The data from the sites used for the trial cannot be used as the initial baseline data for Community Based Monitoring Information as there was high variation in the ability of individuals with respect to skills and adherence to data recording protocols. The data on fish populations is unreliable due to the high number of people in the water at any one time during the trails and the likelihood that avoidance behaviour by fish was very high. However, the rapid degree of concurrence of observations by the volunteer group as repeated activities were conducted is a good sign for future Community Based Monitoring activities (Appendix 3, 4).

Notwithstanding the above restrictions and caveats on the trial data, some reliable information for fish populations can be used for future reference. This includes the high total fish abundance within the Vailoa VFR (Table 13; median numbers between 2,500 and 10,000 individuals) and relatively less abundant total fish estimates for the Ulutogia VFR (Appendix 3; median numbers between 625-2,500 individuals). Ideally, a comparable site outside the No-Take sites should be monitored so that the effectiveness of the No-Take areas can be demonstrated to each of the villages. However, because there were restrictions in doing this there were not enough daylight hours to complete full No-Take and Comparable site assessment trials in the villages from where the volunteers came. In addition, there were extremely low tides during the week of the trials, and the timing of the high tides very early and late in the day meant that insufficient depth was available during most of the daylight hours. To compensate, additional sites were used for training purposes in a relatively deeper unrestricted access area adjacent to the MPA centre at Malaela (see Appendix 3).

There was also a reliable record noted for the presence of certain juvenile fish that usually appear in the lagoon during this time of the year. For example, juvenile goatfish (*isina*), juvenile rabbitfish (*pinelo*), and juvenile unicorn surgeon fish (*pauulu*) were noted, underscoring the highly important role the lagoon habitat has for fish populations.

Invertebrate and benthic indicator information can be used in the Community Based Monitoring database where there was high agreement among the volunteers (Table 14). For example, the absence of *alamea* (COTS) and *aliao* (trochus) from all sites are reliable conclusions. In the case of trochus, this is not an unexpected result as the usual habitat for this organism is in the surf zone, not on the inshore habitats. It should also be noted that some volunteers use the term *alamea* to refer to other large starfish as well as COTS. In this trial, the pin cushion starfish (*Culcita* spp) was also called *alamea*. It was also clear from the trial that very high numbers of sea urchins were present at both Vailoa and Ulutogia Village Fish Reserve sites.

Table 13. Example of the trial data recorded by volunteers for the Reef Fish in the Vailoa Village Fish Reserve. Identification of indicators are given in Samoan and numbers represent the abundance category. Fish size refers to the relevant fish size category. * refers to values or information that is added to the datasheets when entering data in the spreadsheet from the field data.

District	Aleipata		
Village	Vailoa		
Site	Vailoa Vfr		
Date	3/12/02		
Recorder	Ab	Ab	Ab
Swim Type	No Take	No Take	No Take
Swim Number	1	2	3
Tot Fish Category	5	3	5
Tot. Fish (Median)*	10000	625	10000
Abundance 1 :			
Id (Samoan)	Iusega	Tuuu	Pone
Id (Common)*	Sardine Juv	Damsel	Surgeon
Size Category 1	1	1	1
Size (Cm)*	10	10	10
Abundance 2 :			
Id (Samoan)	Tuuu	Iusega	Tuuu
Id (Common)*	Damsel	Sardine Juv	Damsel
Size Category 2	1	1	1
Size (Cm)*	10	10	10
Abundance 3 :			
Id (Samoan)	Pone	Sugale	Fuga
Id (Common)*	Surgeon	Wrass	Parrot
Size Category 3	1	1	1
Size (Cm)*	10	10	10
Notes			

Table 14. Example of the trial data recorded by volunteers for Other Indicators (including Benthic Indicators) in the Vailoa Village Fish Reserve. Identification of indicators is given in Samoan and numbers represent the abundance category. Ratings of abundance categories are added using the guide given in the Methods. The common description for these indicators are : *Limu fuafua* = edible reef macro algae; *Limu* = any macro algae; *Aau Faamoa* = broken or disturbed coral from humans searching; *Aau Papae* = Bleached coral; *Alamea* = Crown of thorns starfish; *Vaga/Tuitui* = common sea urchins (lumped together); *Aliao* = Trochus shell; *Sea/Loli/Maisu* = common sea cucumbers (lumped together).

District	Aleipata			
Village	Vailoa			
Site	Vailoa Vfr			
Date	3/12/02			
Swim Type	Other			
Swim Number	1	2	3	
Recorder	AB	AB	AB	
***Benthic Indicators* :**				
Limu Fuafua	Absent	Absent	Absent	
Limu	Present	Absent	Present	
Aau Faamoa	Present	Absent	Absent	
Aau Papae	Absent	Absent	Absent	
***Macro Invertebrates* :**				
Alamea :				
Alamea Category	0	0	2	
Alamea Status	Absent	Absent	Medium	
Vaga/ Tuitui :				
Vaga/Tuitui Category	4	4	4	
Vaga/Tuitui Status	Very High	Very High	Very High	
Aliao :				
Aliao Category	0	0	0	
Aliao Status	Absent	Absent	Absent	
Sea/ Loli/ Maisu :				
Sea Category	4	4	4	
Sea Status	Very High	Very High	Very High	

SUMMARY OF MONITORING DATA FOR VAILOA VFR

As an example of how to complete the data summary phase, a report below for the Vailoa VFR could be outlined in the following way :

FISH STATUS

SITE : Vailoa Village Fish Reserve

DATE : 3/12/02

FISH STATUS :

Total number of fish in the Vailoa VFR is estimated to be approximately 7,000. The fish population is predominantly composed of *tuu'u* (damsel fish) (average size of less than 10 cm), and then by *iusega* (juvenile sardines) (average size of less than 10 cm). The presence of *iusega* is an annual event occurring in early summer along with other juvenile fish aggregations and emphasizes the importance of these No-Take sites as a refuge from harvest to allow the maturation of these and other fish species.

(Note : Future survey reports should include a graph to show trends in the total number of fish recorded at the site. Figure 8 is an example of a graph that will be generated when two or more sample times have been completed. Appendix 5 outlines the steps involved in plotting such a graph.)

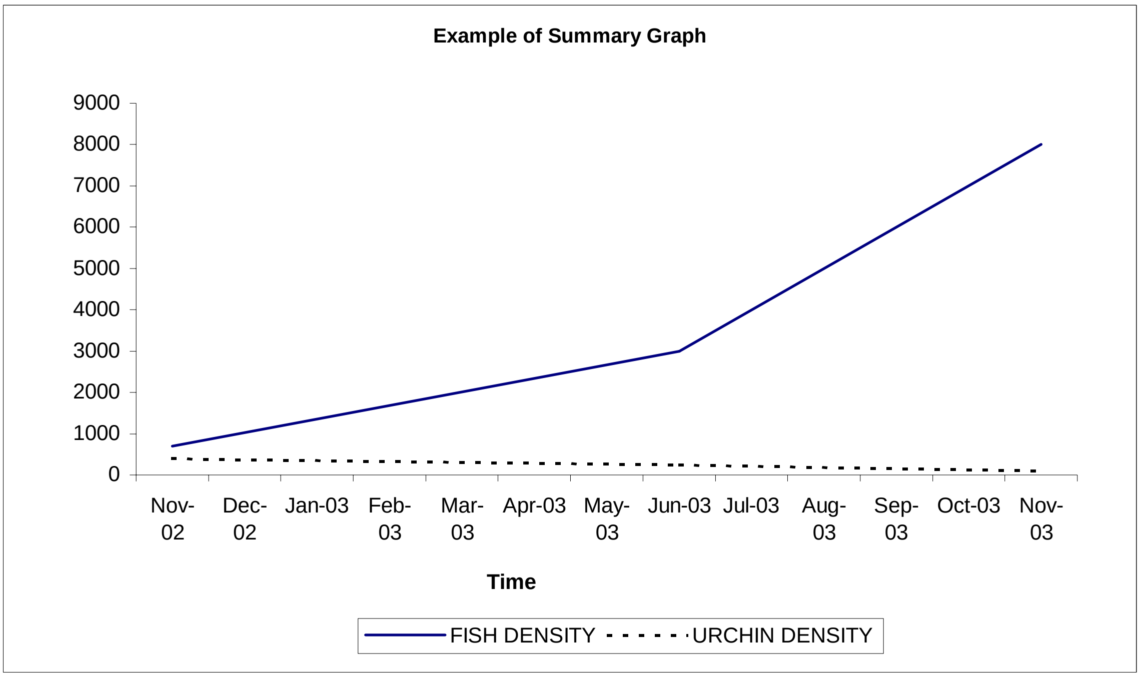

Figure 8. An example of the type of graph that can be presented to show the trends from a number of monitoring in key monitoring indicators. Two contrasting trends are shown for Fish and Urchins. The density of fish and urchins are shown on the y-axis. Note that the relative abundance of fish and urchins on this example is too large to be plotted on the same graph as the x-axis scale will not adequately represent the lower urchin density estimates. In these cases, separate graphs for each indicator is required.

An example of a time series graphical presentation from Community Based Monitoring data is shown in Figure 8 with two contrasting trends. Here, the trends for Fish are going up over time which is a positive result for a No take area. In contrast, the trends for Urchins is going down over time, which is also a positive result when the initial urchin densities were at unsustainable high numbers and were observed to be causing significant bioerosion.

MACRO INVERTEBRATE STATUS

Alamea (COTS) were present in medium abundance and should trigger action to possibly reduce numbers within the site. Of concern also, is the very high numbers of sea urchins, which may be at non sustainable levels and will affect the long term viability of the site. In contrast, very high numbers of sea cucumbers are probably not of concern. Large numbers of the same species of sea urchins and sea cucumbers recorded inside the No Take area are also present outside the site boundaries. No *aliao* (trochus) were recorded in the site, but this is not the preferred habitat for them (the reef crest is the more common habitat for trochus).

BENTHIC INDICATORS STATUS :

No edible macro algae (*limufuafua*) was recorded within the Vialoa VFR but there was other macro algae (*limu*) present. Note that *limu* was intended to be restricted to specific macro algae such as the invasive *Sargassum* spp, but the records may have included other more common macro algae instead or as well. Breakage to live coral (*aau faamoa*) was recorded as present inside the site, suggesting that possibly some interference to the habitat and harvesting has been occurring. No bleached corals were observed at this date.

The information box presented below outlines the steps taken to complete the calculations and summary information for the Vailoa Village Fish Reserve site.

CALCULATIONS FOR VAILOA VILLAGE FISH RESERVE :

Mean Total Fish :

Step 1 : 10,000 + 625 + 10,000 = 20,625

Step 2 : 20,575 / 3 = 6,858 = **7,000** (rounded off)

Dominant Fish :

Tuu'u score = 3 + 2 + 2 = **7**
Iusega score = 3 + 2 = **5**
Pone score = 3 + 1 = **4**
Sugale score = **1**
Fuga score = **1**

Average Size of Dominant Fish :

Step 1 : *Tuu'u* size = 10 + 10 + 10 = 30
Iusega size = 10 + 10 = 20

Step 2 : *Tuu'u* mean = 30 / 3 = 10
Iusega mean = 20 / 2 = 10

Macro Invertebrate Abundance

Step 1 : *Alamea* category 2 = Medium
Vaga/Tuitui category 4 = Very High
Sea/Loli/Maisu category 4 = Very High

SUMMARY OF MONITORING DATA FOR ULUTOGIA VFR

The data used for this summary was from Volunteer 1 and Volunteer 2 (the first reorder for each swim, see Appendix 3).

SITE : Ulutogia Village Fish Reserve

DATE : 4/12/02

FISH STATUS :

Total number of fish in the Ulutogia VFR is estimated to be approximately 1,000. The fish population is predominantly composed of *tuu'u* (damsel fish) (average size of less than 10 cm), and then by *pinelo* (juvenile rabbitfish) (average size of less than 10 cm). The presence of *pinelo* is an annual event occurring in early summer along with other juvenile fish aggregations and emphasizes the importance of these No-Take sites as a refuge from harvest to allow the maturation of these and other fish species.

Future survey report should include a graph to show trends in the total number of fish recorded at the site.

OTHER INDICATORS STATUS :

No edible macro algae (*limu fuafua*) or other types of macro algae (*limu*) were recorded within the Ulutogia VFR. Breakage to live coral (*aau faamoa*) was recorded as present inside the site, suggesting that possibly some interference to the habitat and harvesting has been occurring. Low levels of bleached corals were also observed at this date.

Alamea (COTS) and a*liao* (trochus) were not recorded at the site. There were very high numbers of sea urchins (*tuitui* mainly), which may be at non sustainable levels and could affect the long term viability of the site through bioerosion of hard substrata. In addition, very high numbers of sea cucumbers (*loli* mainly) were present.

SUMMARY OF MONITORING DATA FOR AAU PAPA

The data used for this summary was from Volunteer 1 (see Appendix 3).

SITE : Aau Papa

DATE : 5/12/02

FISH STATUS :

Total number of fish at Aau Papa is estimated to be approximately 2,000. The fish population is predominantly composed of *pinelo* (juvenile rabbitfish) (average size of less than 10 cm), followed by *tuu'u* (damsel fish) (average size of less than 10 cm). The presence of *pinelo* is an annual event occurring in early summer along with other juvenile fish aggregations and emphasizes the importance of the inshore lagoon areas as a refuge from harvest to allow the maturation of these and other fish species.

Future survey reports should include a graph to show trends in the total number of fish recorded at the site.

OTHER INDICATORS STATUS :

No edible macro algae (*limufuafua*) was recorded at Aau Papa but there was other types of macro algae (*limu*) present. Breakage to live coral (*aau faamoa*) was recorded as present inside the site, suggesting that possibly some interference to the habitat and harvesting has been occurring. Low levels of bleached corals were also observed.

Alamea (COTS) and a*liao* (trochus) were absent at the site. There were medium numbers of sea urchins (*tuitui* mainly) in the hard substrate areas. In addition, low numbers of sea cucumbers (*loli* and *maisu* mainly) were present.

DATA PROCESSING FEEDBACK FROM PROJECT TEAM

The above methodology for analysing and summarizing data from the trials was assessed by the Project Team in a project review meeting at the end of the trials. Though the analysis and reporting protocols were thought to be a simple and relatively straight forward approach, it was decided that a few aspects of the protocols would be relatively difficult to explain to the village volunteers. Overall, examples of the reporting summaries presented in this report were thought the project team to be good.

The particular aspect of the analytical protocol that was thought to be too complex to grasp for the volunteers, was the method of summarizing the fish abundance ranks from separate swims within a site. The described approach is the only reliable way of summarizing this type of data in a meaningful way. The problem arises from the use of replicate swims and the type of data that is required to be recorded, ie, subjective ranking of relative abundance of the major fish groups that are present.

In addition, summarizing presence / absence data from multiple replicate swims is not very satisfactory. The alternative would be to conduct similar ranking summary procedures to the above discussed fish data. However, it was decided to persist with the above methods, as the alternative of having no replication was not thought to be sufficiently robust.

LOGISTIC REQUIREMENTS LIST

Logistic requirements needed for Mangrove Monitoring field work include the following :

- **Waterproof Paper with appropriate Designed & pre-printed Pro forma** data sheets;
- **Bright colour spray paint** cans to mark individual trees ;
- **Compass** for taking bearings from one marked tree to the next tree;

- **GPS** for fixing strategic positions;
- **Measuring Tape** for taking distances between trees and other measurements;
- **HB Lead Pencils** attached with string to clipboards;
- **Clip boards** for holding paper and pencils.

2.4. IMPROVEMENTS AND LESSONS LEARNT FROM THE TRIALS

A number of improvements to the initial design and to the type of information to be recorded were discussed during and after the trials. Changes to the original format was due to direct feedback from the volunteers as to what is important to them and what seemed to be inadequately covered in the original design and information content. Many useful improvements came out of follow-up work with the Project Team as well. Changes to methods and reproting protocols are presented in the 'Biodiversity Assessment and Monitoring Manual' (Fisk 2003). The following lessons from the trials are outlined below with an accompanying discussion.

(a) It was obvious that the range of ability and in-water skills of the volunteers meant that the training schedule required for each village (here volunteers from two villages were involved) will have to be a minimum of 2 to 3 days each time. The data consistency across different volunteers appeared to vary less over time though some volunteers found it difficult to become familiar with being in the water and with using mask and fins. Assuming that different volunteers will be available for each scheduled monitoring time, this presents a high workload for the District Officer if volunteers are to record relatively consistent data.

(b) Given the amount of time and effort required to train volunteers and to ensure that the data was consistent and adequately recorded, no more than 2 sets of village volunteers (3 per village) should be trained at any one time.

(c) Analysis and summary data was discussed during the review sessions held with Project Team but little discussion was held as to the best way it can be presented to each village, though it is an important aspect to consider.

(d) It is important that recorders add any additional information on the data sheet that is not part of the core data. For example, it is important to explain the annual timing of aggregations of high juvenile fish numbers of *iusega* (sardines) and *pinelo* (juvenile rabbitfish), which are usually present in the inshore reefs at this time of year. This may be contrary to the approach that stresses the focus on a few most highly desirable species of fish rather than trying to record all fish present. As a general rule it is recommended that no records be taken of the presence of *tuu'u* (damsel fish), *tifitifi* (butterfly and angel fish), and *sugale* (wrass), as they are ubiquitous and most likely will always be present in large numbers.

(e) It was suggested that the smallest fish size category be split into a size that describes fish that are much less than the minimum 10 cm length. This was thought to be necessary as the majority of fish are in the smallest size category and many are significantly smaller than the maximum length. The two smallest sizes that will be adopted are : fingertip to less than middle finger length (*limatusi*) and fingertip to wrist (*tapulima*). In addition, the largest size category (>*tau'au*) was omitted because it is thought that fish of this size would always be extremely rare. The revised fish sizes are shown in Table 15 below. That is, the revised size of fish for future use are defined as :

Table 15. Revised fish size categories and the corresponding maximum length and median length.

Size Category	Maximum Size (cm)	Median Size (cm)
1. *Limatusi* (fingertip to knuckle)	10	5
2. *Tapulima* (fingertip to wrist)	20	10
3. *Tulilima* (fingertip to elbow)	50	25
4. *Tau'au* (fingertip to shoulder)	80	40

(f) There needs to be clarity as to what is recorded when referring to *limu*. It should refer to a particular few species that are invasive in nature or are particularly dominant, eg, *Sargassum* spp (*limu vaovao*). In the notes there should be a record of what *limu* the recorder is referring to, or to use the specific name as above.

(g) All categories of macro invertebrates should include a zero or absent category so as to ensure that a non written record is not counted as an actual observation of zero presence.

(h) It was noted that the size of urchins (in this case, *tuitui* (*Echinometra mathaei*)), were larger inside the Vailoa Village Fish Reserve compared to outside the Reserve. This may be the situation for a number of other macro invertebrates as well, and probably is a response to reduced harvesting pressure. Though it is probably outside the scope of the current Community Based Monitoring design at this stage, it may be a good indicator of the effectiveness of the No-Take area in species that may naturally vary their numbers on a seasonal basis. Note that the present situation does not indicate significant population fluctuations in the most common urchins present in the inshore habitat, but is consistent with consistent high abundance levels due to a lack of natural predation (eg, by fish) that would control numbers.

(i) It is important that the separation or identification of counts for the edible sea urchin ***savai'i*** (*Toxopneustes pilosa*) be incorporated into the standard monitoring design, as it is an important food species in isolated communities.

(j) The inclusion of sea cucumber counts was thought to be important as there were very high numbers of a range of species. A distinction between the main species can be made using different samoan names (eg, *sea*, *loli*, *maisu*, *fugafuga*) which should pick up the relative abundance of desirable/commercial species compared to less desirable species.

(k) It is recommended that the layout of the Reef Fish and Other Indicators data sheet should be improved for ease of use by re-arranging the data 'boxes' for both Fish and Other Indicators together for each separate swim.

2.5. SUMMARY

The most important aspect of any type of monitoring is to rigorously stick to the methods that are adopted in the beginning. There has to be a measure of replication within a site, that is, an action that is repeated in exactly the same way a number of times within a site.

An important lesson from the trials is that there is a source of highly proficient and accurate observer village volunteers available to undertake this type of monitoring work and that the information recorded will be extremely beneficial to the communities and the project. At the same time, a relatively high number of equally keen volunteers will need more intensive training and support before it can be assumed that all volunteers are at a similar level of proficiency. This last point is important, as it will be expected that a continuous turnover of volunteers will be a feature of Community Based Monitoring. It is therefore paramount that the Project Officers be the one ‘stable participant’ who can continuously assess quality levels in data records and can provide training and input to the volunteer program.

The second phase is the full implementation of the Community Based Monitoring program in all villages. A range of commonly identified target species and habitats that could be the focus of community monitoring teams, has been included in the summary below. The choice of monitoring activities and how they are to be implemented will be the responsibility of the Project Team.

In summary, there will need to be a series of steps that have to be addressed for each activity in the second phase. The steps will include discussion and agreement on the following :

- WHAT is going to be the focus (activity, species, habitat)?
- WHERE can the activity be conducted such that the Management Plan is also addressed?
- WHO is the community group that will be responsible for the selected activity?
- HOW is the monitoring going to be carried out (methods, frequency, reporting)?
- WHEN will the monitoring start and what is the frequency of future surveys?

Full details of broad scale ecosystem assessment, permanent baseline monitoring, and community based monitoring methods are outlined in the accompanying ‘Biodiversity Assessment and Monitoring Manual’ (Fisk 2003). As well, all data sheet templates are also included in the Manual as well as in this report.

Potential Community Based Monitoring Activities, Target Species, and Habitats

A description of potential target species and habitats that could be included in community based monitoring is outlined below. Many suggestions originate from direct concerns by community members that were expressed during community consultations. Other suggestions have arisen from the results of the broad based monitoring and assessment program that was conducted as part of the biodiversity assessment phase of the project. The latter results and implications have been explained and brought to the attention of the community.

1. Mangrove Area Delineation. One of the performance criteria for the project is that no net loss in the area of mangroves will be a result of the MPA regime. Samoa is most likely going to become a signatory of the RAMSAR convention which will mean that more detailed assessment and monitoring of mangroves will be required by government and MPA managers to ensure sustainable use, and that conservation values are maintained. To measure mangrove area, either costly aerial photographs have to be periodically taken and analysed, or more indirectly, ground measurement changes in mangrove boundaries can be monitored over time. The latter approach will be adopted in the program, and the trials have tested the efficiency of marking and locating trees for boundary delineation around the mangrove edges.

2. Fish Abundance and Biomass. The abundance, size, and species of fish are of primary concern to all communities, but not all No-Take areas will necessarily show immediate or positive responses to protective measures. As mentioned above, the impact of protected sites will not be recognized in adjacent areas until there is spillover and/or enhanced seeding of fishing grounds of breeding species from within No-Take areas. In the short term, there is merit in commencing surveys of a small number of possible indicator fish and to use monitoring techniques that are instantly understood by the local community. The focus of Community Based Monitoring should be in No-Take areas and adjacent unprotected areas so that the observed effects can be passed on to communities to encourage them to persist with the management regime. Consideration of how to record monitoring data so that the community participants can relate the findings back to the rest of the community is therefore a significant issue.

3. Giant Clams. The discussion above relating to fish also applies to giant clams. That is, the recovery of clam stocks is a highly desirable outcome in all communities. It is therefore imperative that breeding stocks in No-Take areas be monitored for growth and recruitment rates. As clam numbers are generally very low in the District, high clam abundance will be a long term outcome.

4. Coastal Erosion. Though monitoring of resources is the main focus of this phase of the project, there are compelling reasons to set baseline measurements (and a long term monitoring commitment) of coastal shorelines, particularly in relation to the rate of erosion as well as the location of erosion and deposition points. Reasons for including this monitoring activity is to raise awareness, to gather some simple baseline information on where current coastal processes are present, and in particular, to get basic information on the rate of build up of sand. It is also an activity that can be done by those community members who do not usually have an aptitude for marine based activities.

5. Birds (Sea birds & Mangrove Birds). The abundance of both seabirds on offshore islands and birds inhabiting mangroves are important indicators of the general health of the marine ecosystem. No net loss in endangered sea bird populations has also been a defined as a key performance criterion for the MPA. Bird

populations would be expected to slowly respond to management regimes, and recovery of depauperate species is dependent on many extraneous factors, so this activity needs to be established with a long term timeframe for assessment of success or failure of community management efforts.

6. Turtles. Turtles have reached critically low population sizes in Samoa, and higher protective actions are required if they are going to continue to be present in the future. Though a vary long timeline will be required before positive responses to conservation efforts will be observed, there is a need to establish current benchmark population estimates. It will take a number of census years to establish a reliable population estimate.

7. Whales & Dolphins. An opportunity exists to record standardised observations of whales and dolphins in both inshore and offshore habitats. The presence of organisational structures (the District MPA, government agencies (especially Fisheries and Natural Resources) and with support of SPREP and its sea mammal database) can help to centralise and coordinate efforts. The Samoan government will also be interested to gather information in relation to a potential whale sanctuary within territorial waters.

8. Coral Rehabilitation. There is considerable local interest in and concern for the deterioration of certain areas of lagoons due to past use of dynamite and ava-NG. It is feasible to rehabilitate suitable areas providing seed coral stock is available. This activity has a high potential to produce tangible results and can be a valuable tool in education and awareness raising, as it will involve substantial local involvement both in rehabilitation activities and monitoring of progress.

9. Sea Urchin Densities. Sea urchins were observed to be in very high population densities at many lagoon locations. Urchins were at densities that were adversely affecting the hard substrata on which they were grazing. The intense grazing pressure by urchins limits recruitment of other reef organisms, including hard and soft corals and macro algae. In addition, urchin grazing pressure is undermining and weakening hard coral colonies that currently remain in place. A recommendation from the baseline assessment was that trial interventions be undertaken to test if it was feasible to reduce this threat and to restore sites back to healthy communities. The first stage of such a project will be to have accurate assessments of current densities of urchins prior to any intervention, as well as an assessment of the current status of benthic communities that are most likely being affected by the high urchin numbers (especially algae).

10. Crown of Thorns Starfish (COTS) Densities. Abnormally high densities of COTS were reported from the broad based assessments of the District. The locations of current populations were relatively site specific. The presence of high COTS densities was also a concern that was raised by some village members. A recommendation from the baseline assessment was that trial interventions be undertaken to test if it was feasible to remove this threat and restore sites back to healthy communities. The first stage of such a project will be to have accurate assessments of current densities of COTS prior to any intervention, as well as an assessment the current status of coral communities that are most likely being affected by the high COTS numbers.

11. Macro Algae Dominance. Certain macro algae (*Sargassum* spp in particular) have been a source of concern for some villages as there have been perceived expansion of this species in areas where they did not previously occur. The presence of such species is not always thought to be a positive development as the alga can alter the nature of the habitat and reduce harvest levels of certain species.

12. Seagrass Communities. Seagrass communities are important habitats that provide nursery areas for juvenile fish and invertebrate species. Seagrass also play a role in coastal dynamics, particularly in relation to sediment movement. There are also a range of seagrass dependent or related species that are harvested for food.

13. Bivalve Communities. Bivalves such as *tugane* (*Gafrarium tumidum*) are important sources of food and though their status is not of particular concern within most communities, there is a strong case to commence monitoring these organisms as a baseline for future assessments, should their status change.

Appendix 1. Fish densities per transect (number / hectare) from permanent baseline sites. Fish density was calculated from the sample data area of 750m^2 per site. Transects 1 to 5 at Aau Magoto and I Timu were unintentionally pooled while recording in the field. Data for each transect at all other sites were recorded separately.

SITE	TRAN	Acanthuridae	Balistidae	Carangidae	Carcharhinidae	Chaetodontidae	Dasyatidae	Haemulidae	Labridae	Lethrinidae	Lutjanidae	Mugilidae	Mullidae	Pomacanthidae	Pomacentridae	Scaridae	Scombridae	Serranidae	Siganidae	TOTAL
PAPASINA	**1**	9260	0	0	0	120	0	0	40	540	0	0	0	0	13360	6633	0	0	0	29953
	2	11140	0	0	0	80	0	13	0	0	0	0	0	0	293	3680	0	0	0	15207
	3	12640	0	0	0	40	0	0	0	40	0	0	13	0	5100	3940	0	0	0	21773
	4	6180	0	0	0	120	0	0	220	0	0	0	0	0	680	7780	0	0	0	14980
	5	1900	0	0	0	80	0	0	53	0	0	0	80	0	25620	960	0	0	0	28693
TOTAL		41120	0	0	0	440	0	13	313	580	0	0	93	0	45053	22993	0	0	0	110606
ITU PAPASINA	**1**	513	40	0	0	40	0	0	40	0	0	0	0	0	233	180	0	0	0	1047
	2	360	0	0	0	0	0	0	53	0	0	0	0	0	320	3993	0	0	0	4727
	3	4040	0	0	0	40	0	0	200	540	0	0	0	0	2400	8320	0	0	0	15540
	4	840	0	0	0	0	0	0	40	0	0	0	0	0	333	1140	0	0	0	2353
	5	2360	0	0	0	0	0	0	27	0	0	0	53	0	700	2080	0	0	0	5220
TOTAL		8113	40	0	0	80	0	0	360	540	0	0	53	0	3987	15713	0	0	0	28887
SAGAFOE	**1**	180	233	0	0	387	0	0	93	0	0	0	13	53	2913	53	0	0	720	4647
	2	0	80	0	0	173	0	0	360	0	0	0	0	413	733	3180	0	0	0	4940
	3	1080	180	0	0	40	0	0	80	140	0	0	13	413	400	747	0	0	2333	5427
	4	320	220	0	0	333	0	0	180	0	0	0	40	320	1400	1273	0	0	180	4267
	5	1720	180	0	0	247	0	0	233	0	0	0	0	900	3680	7300	0	0	2140	16400
TOTAL		3300	893	0	0	1180	0	0	947	140	0	0	67	2100	9127	12553	0	0	5373	35680
MUTU	**1**	753	40	0	0	193	0	0	107	0	0	0	13	553	440	513	0	0	133	2747
	2	1473	0	0	0	500	0	0	360	0	0	0	220	513	773	400	0	0	413	4653

SITE	TRAN	Acanthuridae	Balistidae	Carangidae	Carcharhinidae	Chaetodontidae	Dasyatidae	Haemulidae	Labridae	Lethrinidae	Lutjanidae	Mugilidae	Mullidae	Pomacanthidae	Pomacentridae	Scaridae	Scombridae	Serranidae	Siganidae	TOTAL
	3	1040	373	0	0	260	0	0	427	0	0	0	193	900	220	3853	0	0	80	7347
	4	1773	40	0	0	40	0	0	887	0	0	0	53	280	0	2560	0	0	53	5687
	5	3100	40	0	0	13	0	0	913	0	0	0	80	580	333	820	0	0	0	5880
TOTAL		8140	493	0	0	1007	0	0	2693	0	0	0	560	2827	1767	8147	0	0	680	26313
AAU MAGOTO	**1 - 5**	6787	13	0	0	580	0	420	747	40	0	0	460	0	4260	4153	0	0	180	17640
TOTAL		6787	13	0	0	580	0	420	747	40	0	0	460	0	4260	4153	0	0	180	17640
I TIMU	**1 - 5**	2953	80	13	0	760	0	0	653	13	0	0	293	0	18193	1973	0	0	0	24933
TOTAL		2953	80	13	0	760	0	0	653	13	0	0	293	0	18193	1973	0	0	0	24933
LALOMANU	**1**	5840	67	0	0	40	0	0	393	13	0	0	13	360	11900	2187	0	0	0	20813
	2	2440	40	0	0	180	0	0	360	13	0	0	0	400	24220	2993	0	0	0	30647
	3	4200	0	0	0	13	0	0	180	0	0	0	680	40	16760	6227	0	0	0	28100
	4	3620	0	0	0	280	0	0	320	0	0	0	40	140	5680	2620	0	0	0	12700
	5	1100	40	0	0	680	0	0	187	40	0	0	0	40	0	0	420	0	0	2507
TOTAL		17200	147	0	0	1193	0	0	1440	67	0	0	733	980	58560	14027	420	0	0	94766
TUIOLEMU	**1**	627	40	0	0	13	0	0	0	0	0	0	0	180	2860	500	0	0	0	4220
	2	1800	0	0	0	13	0	0	13	13	0	0	13	140	760	1980	0	0	0	4733
	3	640	0	0	0	553	0	0	0	0	0	0	27	320	1280	1000	0	0	0	3820
	4	1740	0	0	0	13	0	0	67	0	0	0	53	313	860	1760	0	0	0	4807
	5	1113	0	0	0	40	0	0	93	0	0	0	0	233	1233	1113	0	0	0	3827
TOTAL		5920	40	0	0	633	0	0	173	13	0	0	93	1187	6993	6353	0	0	0	21407
TOTAL ALL SITES		93533	1707	13	0	5873	0	433	7327	1393	0	0	2353	7093	147940	85913	420	0	6233	360232

Appendix 2. Mean and standard deviation (SD) for fish lengths per transect of each of the survey families from permanent baseline sites. Mean lengths are calculated from the mean mid point length of each size class per transect except for Aau Magoto and I Timu. *Fish data for the latter two sites were unintentionally pooled in the field so the data are expressed as the median size of all fish pooled.

SITE	TRAN	FISH FAMILY LENGTH	Acanthuridae	Balistidae	Carangidae	Carcharhinidae	Chaetodontidae	Dasyatidae	Haemulidae	Labridae	Lethrinidae	Lutjanidae	Mugilidae	Mullidae	Pomacanthidae	Pomacentridae	Scaridae	Scombridae	Serranidae	Siganidae	TOTAL
PAPASINA	1	MEAN	10.5	0.0	0.0	0.0	10.5	0.0	0.0	10.5	10.5	0.0	0.0	0.0	0.0	10.5	13.8	0.0	0.0	0.0	8.0
		SD	0.0				0.0									0.0	6.6				6.4
	2	MEAN	10.5	0.0	0.0	0.0	10.5	0.0	10.5	0.0	0.0	0.0	0.0	0.0	0.0	10.5	12.6	0.0	0.0	0.0	7.2
		SD	0.0				0.0									0.0	5.7				5.9
	3	MEAN	10.5	0.0	0.0	0.0	10.5	0.0	0.0	0.0	25.5	0.0	0.0	10.5	0.0	10.5	13.0	0.0	0.0	0.0	7.9
		SD	0.0													0.0	6.1				6.5
	4	MEAN	10.5	0.0	0.0	0.0	10.5	0.0	0.0	10.5	0.0	0.0	0.0	0.0	0.0	10.5	10.5	0.0	0.0	0.0	6.6
		SD	0.0				0.0			0.0						0.0	0.0				5.1
	5	MEAN	10.5	0.0	0.0	0.0	10.5	0.0	0.0	10.5	0.0	0.0	0.0	10.5	0.0	10.5	10.5	0.0	0.0	0.0	6.3
		SD	0.0				0.0			0.0				0.0		0.0	0.0				5.2
ITU PAPASINA	1	MEAN	10.5	10.5	0.0	0.0	10.5	0.0	0.0	10.5	0.0	0.0	0.0	0.0	0.0	10.5	10.5	0.0	0.0	0.0	6.2
		SD	0.0				0.0									0.0	0.0				5.3
	2	MEAN	10.5	0.0	0.0	0.0	0.0	0.0	0.0	10.5	0.0	0.0	0.0	0.0	0.0	10.5	12.4	0.0	0.0	0.0	6.2
		SD	0.0							0.0						0.0	5.3				6.3
	3	MEAN	10.5	0.0	0.0	0.0	10.5	0.0	0.0	10.5	10.5	0.0	0.0	0.0	0.0	10.5	10.5	0.0	0.0	0.0	7.2
		SD	0.0							0.0						0.0	0.0				4.9
	4	MEAN	10.5	0.0	0.0	0.0	0.0	0.0	0.0	10.5	0.0	0.0	0.0	0.0	0.0	10.5	10.5	0.0	0.0	0.0	5.8
		SD	0.0													0.0	0.0				5.3
	5	MEAN	10.5	0.0	0.0	0.0	0.0	0.0	0.0	10.5	0.0	0.0	0.0	10.5	0.0	10.5	10.5	0.0	0.0	0.0	6.9
		SD	0.0							0.0				0.0		0.0	0.0				5.0

SITE	TRAN	FISH FAMILY LENGTH	Acanthuridae	Balistidae	Carangidae	Carcharhinidae	Chaetodontidae	Dasyatidae	Haemulidae	Labridae	Lethrinidae	Lutjanidae	Mugilidae	Mullidae	Pomacanthidae	Pomacentridae	Scaridae	Scombridae	Serranidae	Siganidae	TOTAL
SAGAFOE	1	**MEAN**	10.5	10.5	0.0	0.0	10.5	0.0	0.0	10.5	0.0	0.0	0.0	10.5	10.5	10.5	10.5	0.0	0.0	10.5	8.2
		SD	0.0	0.0			0.0			0.0					0.0	0.0	0.0			0.0	4.4
	2	**MEAN**		10.5	0.0	0.0	10.5	0.0	0.0	10.5	0.0	0.0	0.0	0.0	10.5	10.5	10.5	0.0	0.0	0.0	7.5
		SD		0.0			0.0			0.0					0.0	0.0	0.0				4.8
	3	**MEAN**	10.5	10.5	0.0	0.0	10.5	0.0	0.0	10.5	10.5	0.0	0.0	10.5	10.5	10.5	10.5	0.0	0.0	10.5	8.5
		SD	0.0	0.0						0.0					0.0	0.0	0.0			0.0	4.2
	4	**MEAN**	10.5	10.5	0.0	0.0	10.5	0.0	0.0	10.5	0.0	0.0	0.0	10.5	10.5	10.5	10.5	0.0	0.0	10.5	8.1
		SD	0.0	0.0			0.0			0.0				0.0	0.0	0.0	0.0			0.0	4.5
	5	**MEAN**	10.5	10.5	0.0	0.0	10.5	0.0	0.0	10.5	0.0	0.0	0.0	0.0	10.5	10.5	10.5	0.0	0.0	10.5	8.5
		SD	0.0	0.0			0.0			0.0					0.0	0.0	0.0				4.2
MUTU	1	**MEAN**	10.5	10.5	0.0	0.0	10.5	0.0	0.0	10.5	0.0	0.0	0.0	10.5	10.5	10.5	10.5	0.0	0.0	10.5	8.6
		SD	0.0				0.0			0.0					0.0	0.0	0.0			0.0	4.1
	2	**MEAN**	10.5	0.0	0.0	0.0	10.5	0.0	0.0	10.5	0.0	0.0	0.0	10.5	10.5	10.5	10.5	0.0	0.0	10.5	8.6
		SD	0.0				0.0			0.0				0.0	0.0	0.0	0.0			0.0	4.1
	3	**MEAN**	10.5	10.5	0.0	0.0	10.5	0.0	0.0	10.5	0.0	0.0	0.0	10.5	10.5	10.5	10.5	0.0	0.0	10.5	8.7
		SD	0.0	0.0			0.0			0.0				0.0	0.0	0.0	0.0			0.0	4.0
	4	**MEAN**	10.5	10.5	0.0	0.0	10.5	0.0	0.0	10.5	0.0	0.0	0.0	10.5	10.5		10.5	0.0	0.0	10.5	7.5
		SD	0.0							0.0				0.0	0.0		0.0			0.0	4.8
	5	**MEAN**	10.5	10.5	0.0	10.5	10.5	0.0	0.0	10.5	0.0	0.0	0.0	10.5	10.5	10.5	10.5	0.0	0.0	0.0	7.7
		SD	0.0							0.0				0.0	0.0	0.0	0.0				4.7
AAU MAGOTO*	1 TO 5	**MEAN**	10.5	10.5	0.0	0.0	10.5	0.0	10.5	11.3	25.5	0.0	0.0	10.5	0.0	10.5	13.6	0.0	0.0	10.5	10.7
		SD	0.0				0.0		0.0	3.4				0.0		0.0	6.2			0.0	4.4
I TIMU*	5	**MEAN**	10.5	0.0	0.0	0.0	10.5	0.0	0.0	10.5	0.0	0.0	0.0	10.5		10.5	10.5	0.0	0.0	0.0	7.7
		SD	0.0				0.0			0.0				0.0		0.0	0.0				4.7

SITE	TRAN	FISH FAMILY LENGTH	Acanthuridae	Balistidae	Carangidae	Carcharhinidae	Chaetodontidae	Dasyatidae	Haemulidae	Labridae	Lethrinidae	Lutjanidae	Mugilidae	Mullidae	Pomacanthidae	Pomacentridae	Scaridae	Scombridae	Serranidae	Siganidae	TOTAL
	1 TO 4	**MEAN**	10.5	10.5	40.5	0.0	10.5	0.0	0.0	10.5	10.5	0.0	0.0	10.5	0.0	10.5	11.9	0.0	0.0	0.0	10.0
		SD	0.0	0.0			0.0			0.0				0.0		0.0	4.5				4.7
LALOMANU	1	**MEAN**	10.5	10.5	0.0	0.0	10.5	0.0	0.0	10.5	10.5	0.0	0.0	10.5	10.5	10.5	10.5	0.0	0.0	0.0	8.6
		SD	0.0	0.0						0.0					0.0	0.0	0.0				4.0
	2	**MEAN**	10.5	10.5	0.0	0.0	10.5	0.0	0.0	10.5	10.5	0.0	0.0	0.0	10.5	10.5	10.5	0.0	0.0	0.0	8.6
		SD	0.0				0.0			0.0					0.0	0.0	0.0				4.1
	3	**MEAN**	10.5	0.0	0.0	0.0	10.5	0.0	0.0	10.5	0.0	0.0	0.0	10.5	10.5	10.5	10.5	0.0	0.0	0.0	8.6
		SD	0.0							0.0				0.0		0.0	0.0				4.1
	4	**MEAN**	11.7	0.0	0.0	0.0	10.5	0.0	0.0	10.5	0.0	0.0	0.0	10.5	10.5	10.5	10.5	0.0	0.0	0.0	8.3
		SD	4.2				0.0			0.0						0.0	0.0				5.2
	5	**MEAN**	10.5	10.5	10.5	0.0	10.5	0.0	10.5	10.5	10.5	0.0	0.0	0.0	10.5		0.0	10.5	10.5	0.0	8.6
		SD	0.0				0.0			0.0								0.0			4.1
TUIOLEMU	1	**MEAN**	10.5	10.5	0.0	0.0	10.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.5	10.5	10.5	0.0	0.0	0.0	6.6
		SD	0.0												0.0	0.0	0.0				5.2
	2	**MEAN**	10.5	0.0	0.0	0.0	10.5	0.0	0.0	10.5	10.5	0.0	0.0	10.5	10.5	10.5	10.5	0.0	0.0	0.0	7.1
		SD	0.0													0.0	0.0				5.0
	3	**MEAN**	10.5	0.0	0.0	10.5	10.5	0.0	0.0	0.0	0.0	10.5	0.0	10.5	10.5	10.5	10.5	0.0	0.0	0.0	7.7
		SD	0.0				0.0							0.0	0.0	0.0	0.0				4.7
	4	**MEAN**	10.5	0.0	0.0	0.0	10.5	0.0	0.0	10.5	0.0	0.0	0.0	10.5	10.5	10.5	10.5	0.0	0.0	0.0	7.4
		SD	0.0							0.0				0.0	0.0	0.0	0.0				4.9
	5	**MEAN**	10.5	0.0	0.0	0.0	10.5	0.0	0.0	10.5	0.0	0.0	0.0	0.0	10.5	10.5	10.5	0.0	0.0	0.0	7.4
		SD	0.0							0.0					0.0	0.0	0.0				4.8

Appendix 3. Summary of Reef Fish data recorded for the Community Based Monitoring Trial. TOT FISH CATEGORY = Abundance category used to record the data in the field; TOT FISH (MEDIAN) = Abundance number corresponding to the abundance category,,ie, the mid point number for each category; SIZE CATEGORY = size category used to record the data in the field; SIZE (cm) = maximum size of the fish group corresponding to the size category.

DISTRICT	Aleipata												
VILLAGE	Vailoa												
SITE	Vailoa VFR												
DATE	3/12/02												
RECORDER	Vol1	Vol2	Foua	Vol3	Vol4	Foua	Vol5	Vol6					
SWIM TYPE	Reef Fish	Reef Fish	Reef Fish	Reef Fish	Reef Fish	Reef Fish	Reef Fish	Reef Fish					
SWIM NO.	1	1	1	2	2	2	3	3					
TOT FISH CATEGORY	5	3	5	5	4	5	4	4					
TOT FISH (MEDIAN)	10000	625	10000	10000	2500	10000	2500	2500					
ABUNDANCE 1 :		1	1	1	1	1	1	1					
ID (SAMOAN)	Iusega	Tuuu	Tuuu	Pone	Tuuu	Iusega	Tuuu	Tuuu					
ID (COMMON)	Sardine Juv	Damsel	Damsel	Surgeon	Damsel	Sardine Juv	Damsel	Damsel					
SIZE CATEGORY 1	1	1	1	1	1	1	1	1					
SIZE (CM)	10	10	10	10	10	10	10	10					
ABUNDANCE 2 :													
ID (SAMOAN)	Tuuu	Iusega	Iusega	Tuuu	Fuga	Tuuu	Fuga	Pone					
ID (COMMON)	Damsel	Sardine Juv	Sardine Juv	Damsel	Parrot	Damsel	Parrot	Surgeon					
SIZE CATEGORY 2	1	1	1	1	1	1	1	1					
SIZE (CM)	10	10	10	10	10	10	10	10					

ABUNDANCE 3 :														
ID (SAMOAN)	Pone	Sugale	Sugale	Fuga	Iusega	Pone	Pone	Pinelo						
ID (COMMON)	Surgeon	Wrass	Wrass	Parrot	Sardine Juv	Surgeon	Surgeon	Rabbitfish Juv						
SIZE CATEGORY 3	1	1	1	1	1	1	1	1						
SIZE (CM)	10	10	10	10	10	10	10	10						
NOTES														
DISTRICT	Aleipata													
VILLAGE	Malaela													
SITE	E. Aau Papa													
DATE	5/12/02													
RECORDER	Vol1	Vol1	Vol2	Vol3	Vol4	Vol5	Vol6	Foua						
SWIM TYPE	Reef Fish	Reef Fish	Reef Fish	Reef Fish	Reef Fish	Reef Fish	Reef Fish	Reef Fish						
SWIM NO.	1	2	1	1	1	1	1	1						
TOT FISH CATEGORY	3	1	4	3	2	3	2	3						
TOT FISH (MEDIAN)	625	30	2500	625	155	625	155	625						
ABUNDANCE 1 :	1	1	1	1	1	1	1	1						
ID (SAMOAN)	Pinelo	Tuuu	Lo	Lo	Pinelo	Pinelo	Sugale	Manini						
ID (COMMON)	Rabbitfish Juv	Damsel	Rabbitfish	Rabbitfish	Rabbitfish Juv	Rabbitfish Juv	Wrass	Surgeon						
SIZE CATEGORY 1	1	1	1	1	1	1	1	1						
SIZE (CM)	10	10	10	10	10	10	10	10						
ABUNDANCE 2 :														

ID (SAMOAN)	I Sina	Mataeleele	Sugale	Tifitifi	Mataeleele	Mataeleele	Tuuu	Mataeleele						
ID (COMMON)	Goatfish	Emperor	Wrass	Butterflyfish	Emperor	Emperor	Damsel	Emperor						
SIZE CATEGORY 2	1	1	1	1	1	1	1	1						
SIZE (CM)	10	10	10	10	10	10	10	10						
ABUNDANCE 3 :														
ID (SAMOAN)	Matu	Sugale	Vete	Tuuu	Manoo	Manoo	Mataeleele	Lo						
ID (COMMON)	Mojarra	Wrass	Goatfish	Damsel	Goby	Goby	Emperor	Rabbitfish						
SIZE CATEGORY 3	1	1	1	1	1	1	1	1						
SIZE (CM)	10	10	10	10	10	10	10	10						
NOTES														
DISTRICT	Aleipata													
VILLAGE	Ulutogia													
SITE	Ulutogia VFR													
DATE	6/12/02													
RECORDER	Vol1	Vol2	Vol2	Vol3	Vol4	Vol3								
SWIM TYPE	Reef Fish	Reef Fish	Reef Fish	Reef Fish	Reef Fish	Reef Fish								
SWIM NO.	1	1	2	2	3	3								
TOT FISH CATEGORY	4	4	3	4	3	3								
TOT FISH (MEDIAN)	2500	2500	625	2500	625	625								
ABUNDANCE 1 :	1	1	1	1	1	1								
ID (SAMOAN)	Tuuu	Tuuu	Tuuu	Tuuu	Pinelo	Pinelo								
ID (COMMON)	Damsel	Damsel	Damsel	Damsel	Rabbitfish Juv	Rabbitfish Juv								

SIZE CATEGORY 1	1	1	1	1	1	1							
SIZE (CM)	10	10	10	10	10	10							
ABUNDANCE 2 :													
ID (SAMOAN)	Pinelo	Pinelo	Afulu	Fuga	Tuuu	Tuuu							
ID (COMMON)	Rabbitfish Juv	Rabbitfis h Juv	Goatfish	Parrot	Damsel	Damsel							
SIZE CATEGORY 2	1	1	2	1	1	1							
SIZE (CM)	10	10	25	10	10	10							
ABUNDANCE 3 :													
ID (SAMOAN)	Sugale	Sugale	Pinelo	Sugale	Mataeleele	Mataeleele							
ID (COMMON)	Wrass	Wrass	Rabbitfish Juv	Wrass	Emperor	Emperor							
SIZE CATEGORY 3	1	1	1	2	1	2							
SIZE (CM)	10	10	10	25	10	25							
NOTES													
DISTRICT	Aleipata												
VILLAGE	Malaela												
SITE	Aau Papa												
DATE	6/12/02												
RECORDER	Vol1	Vol2	Vol3	Vol4	Vol5	Vol6	Vol7	Vol1	Vol2	Vol3	Vol4	Vol5	Vol6
SWIM TYPE	Reef Fish	Reef Fish	Reef Fish	Reef Fish	Reef Fish	Reef Fish	Reef Fish	Reef Fish	Reef Fish	Reef Fish	Reef Fish	Reef Fish	Reef Fish
SWIM NO.	1	1	1	1	1	1	1	2	2	2	2	2	2
TOT FISH CATEGORY	4	3	3	4	4	4	4	3	4	4	4	4	3
TOT FISH (MEDIAN)	2500	625	625	2500	2500	2500	2500	625	2500	2500	2500	2500	625

ABUNDANCE 1 :	1	1	1	1	1	1	1	1	1	1	1	1	1
ID (SAMOAN)	Pinelo	Pinelo	Tuuu	Pinelo	Pinelo	N/A	Pinelo	Pinelo	Pinelo	Lo	Pinelo	Pinelo	Pinelo
ID (COMMON)	Rabbirfish Juv	Rabbitfis h Juv	Damsel	Rabbitfish Juv	Rabbitfish Juv	N/A	Rabbitfish Juv	Rabbitfish Juv	Rabbitfish Juv	Rabbitfish	Rabbitfish Juv	Rabbitfish Juv	Rabbitfish Juv
SIZE CATEGORY 1	1	1	1	1	1	1	1	1	1	1	1	1	1
SIZE (CM)	10	10	10	10	10	10	10	10	10	10	10	10	10
ABUNDANCE 2 :													
ID (SAMOAN)	Pauulu	Sugale	Afulu	Tuuu	Mataeleele	N/A	Pauulu	Tuuu	Tuuu	Tuuu	Mataeleele	Tuuu	Mataeleele
ID (COMMON)	Unicorn Surgeon Juv	Wrass	Goatfish	Damsel	Emperor	N/A	Unicorn Surgeon Juv	Damsel	Damsel	Damsel	Emperor	Damsel	Emperor
SIZE CATEGORY 2	1	1	1	1	1	1	1	1	1	1	1	1	1
SIZE (CM)	10	10	10	10	10	10	10	10	10	10	10	10	10
ABUNDANCE 3 :													
ID (SAMOAN)	Sugale	Tuuu	Pinelo	Mataeleele	Sugale	N/A	Sugale	Mataeleele	Sugale	Mataeleele	Tamala	Sugale	Tamala
ID (COMMON)	Wrass	Damsel	Rabbitfish Juv	Emperor	Wrass	N/A	Wrass	Emperor	Wrass	Emperor	Paddletail	Wrass	Paddletail
SIZE CATEGORY 3	1	1	1	1	1	1	1	2	1	1	1	1	1
SIZE (CM)	10	10	10	10	10	10	10	25	10	10	10	10	10

Appendix 4. Summary of "Other Indicators" recorded from the Community Based Monitoring trial.

DISTRICT	Aleipata												
VILLAGE	Vailoa												
SITE	Vailoa VFR												
DATE	3/12/01												
SWIM TYPE	No Take												
SWIM NUMBER	1	2	3										
RECORDER	Vol 1&2	Vol 1&2	Vol 1&2										
INDICATORS :													
LIMU FUAFUA	Absent	Absent	Absent										
LIMU	Present	Present	Present										
AAU FAAMOA	Present	Present	Present										
AAU PAPAE	Absent	Absent	Absent										
MACRO INVERTEBRATES :													
ALAMEA :													
ALAMEA CATEGORY	0	0	2										
ALAMEA STATUS	Absent	Absent	Medium										
VAGA/ TUITUI :													
VAGA/TUITUI CATEGORY	4	4	4										
VAGA/TUITUI STATUS	Very High	Very High	Very High										
ALIAO :													
ALIAO CATEGORY	0	0	0										
ALIAO STATUS	Absent	Absent	Absent										
SEA/ LOLI/ MAISU :													
SEA CATEGORY	4	4	4										
SEA STATUS	Very High	Very High	Very High										
DISTRICT	Aleipata												
VILLAGE	Ulutogia												
SITE	Ulutogia												

	VFR											
DATE	4/12/02											
SWIM TYPE	No Take											
SWIM NUMBER	1	1	1	2	2	2	2	3	3	3	3	
RECORDER	Vol1	Vol2	Vol3	Vol2	Vol3	Vol4	Vol5	Vol1	Vol2	Vol3	Vol4	
INDICATORS :												
LIMU FUAFUA	Absent	Absent	Absent	Absent	Absent	Absent	Absent	N/A	N/A	Absent	Absent	
LIMU	Absent	Present	Absent	Absent	Absent	Present	Present	N/A	N/A	Absent	Absent	
AAU FAAMOA	Present	Absent	Present	Present	Present	Present	Absent	N/A	N/A	Absent	Present	
AAU PAPAE	Absent	Present	Absent	Absent	Absent	Present	Absent	N/A	N/A	Present	Absent	
MACRO INVERTEBRATES :												
ALAMEA :												
ALAMEA CATEGORY	0	0	0	0	0	0	0	0	0	0	0	
ALAMEA STATUS	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	
VAGA/ TUITUI :												
VAGA/TUITUI CATEGORY	4	3	4	4	4	4	4	4	4	4	4	
VAGA/TUITUI STATUS	Very High	High	Very High	Very High	Very High	Very High	Very High	Very High	Very High	Very High	Very High	
ALIAO :												
ALIAO CATEGORY	0	0	0	0	0	0	0	0	0	0	0	
ALIAO STATUS	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	
SEA/ LOLI/ MAISU :												
SEA CATEGORY	4	4	N/A	4	4	4	4	4	4	4	4	
SEA STATUS	Very High	Very High		Very High	Very High	Very High	Very High	Very High	Very High	Very High	Very High	
DISTRICT	Aleipata											
VILLAGE	Malaela											
SITE	Aau Papa											
DATE	5/12/02											
SWIM TYPE	No Take											
SWIM NUMBER	1	1	1	1	1	1	1	2	2	2	2	2
RECORDER	Vol1	Vol2	Vol3	Vol4	Vol5	Vol6	Vol7	Vol1	Vol2	Vol3	Vol4	Vol5

INDICATORS :												
LIMU FUAFUA	N/A	Absent	Absent	Absent	Absent	Absent	N/A	Absent	Present	Absent	N/A	Absent
LIMU	N/A	Present	Present	Present	Present	Present	N/A	Present	Present	Absent	N/A	Absent
AAU FAAMOA	N/A	Absent	Absent	Absent	Present	Absent	N/A	Present	Absent	Present	N/A	Present
AAU PAPAE	N/A	Absent	Absent	Absent	Absent	Absent	N/A	Present	Absent	Absent	N/A	Absent
MACRO INVERTEBRATES :												
ALAMEA :												
ALAMEA CATEGORY	0	0	0	0	0	0	0	0	0	0	0	0
ALAMEA STATUS	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
VAGA/ TUITUI :												
VAGA/TUITUI CATEGORY	2	3	3	3	3	4	2	2	3	2	3	2
VAGA/TUITUI STATUS	Medium	High	High	High	High	Very High	Medium	Medium	High	Medium	High	Medium
ALIAO :												
ALIAO CATEGORY	0	0	0	0	0	0	0	0	0	0	0	0
ALIAO STATUS	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
SEA/ LOLI/ MAISU :												
SEA CATEGORY	0	3	N/A	4	1	4	1	1	4	0	1	0
SEA STATUS	Absent	High		Very High	Low	Very High	Low	Low	Very High	Absent	Low	Absent

Appendix 5. Summary pages of Templates and Excel keystrokes involved in Community Based Monitoring of Mangroves, Fish, and Other (Macro Invertebrates and Benthic) Indicators. .

(a) Fish Census

Basic Excel Database Format

The format for an Excel database for fish is shown below. An example of the data that is entered to this template is given in the Results section of this report (in Table 15). Each village data should be kept together in a separate spreadsheet file and multiple samples over time added to the same file. Median values for abundance and size categories are added at the time of data entry.

DISTRICT				
VILLAGE				
SITE				
DATE				
SWIM TYPE				
SWIM NUMBER	1	2	3	
RECORDER				
TOT FISH CATEGORY				
TOT. FISH (MEDIAN)*				Mean (Swims #1,#2,#3)
ABUNDANCE #1 (SCORE):	(3)	(3)	(3)	
ID (SAMOAN)				
ID (COMMON)*				
SIZE CATEGORY #1				
MEDIAN SIZE (CM)*				
ABUNDANCE #2 (SCORE):	(2)	(2)	(2)	
ID (SAMOAN)				
ID (COMMON)*				
SIZE CATEGORY #2				
MEDIAN SIZE (CM)*				
ABUNDANCE #3 (SCORE):	(1)	(1)	(1)	
ID (SAMOAN)				
ID (COMMON)*				
SIZE CATEGORY #3				
MEDIAN SIZE (CM)*				
NOTES				
[Dominant Fish = Sum of scores of all fish recorded from 3 swims and the 3 most abundant groups]				
[Average size of Dominant Fish calculated by taking the mean of all size records of the most dominant fish]				

Calculations and Summary Information

Calculations and summary information is included in the above Excel template. See the Methods section for further detail.

(Appendix 5 continued)

Site Description Template

A site description and map has to be outlined on a separate data sheet that will be stored in the database files and re-used in subsequent surveys to ensure the basic sampling design is replicated each time. Updated maps may be required from time to time as environmental features can change.

The elements of a good Site Description template should include the following :

- Name of **Village** (where site is located).
- **Date** of first survey/when description was made (as features may change over time).
- A **Map** showing approximate position and direction of transects including obvious land and sea marks in relation to the transects.
- A **Description** of the site that complements and is necessary duplicates the map.
- A stated **Aim** for undertaking the survey, which would include a list of the target indicators (here fish groups) that have been chosen as the focus for that village (including what is not to be surveyed).

Creating a Graph of Time Series Data from a Site

1. In Excel, add summary fish data from all surveys of a site on a separate worksheet in the following manner (example dates and abundance added) :

	A	B	C
1	Date/Year	Abundance	
2	Nov.02	7,000	
3	June 03	12,000	
4	Nov.03	20,000	

2. Select all cells that have data (including the Column Headings of Date & Abundance).

3. Choose **graph tool** from menu.

Select **Chart Type –** select **Line**, and Chart Sub-Type : **Lines with markers at each data value**. → Click *Next*

→ Select **Data Range** (already selected), and **Series in Column** → Click *Next*

→ Type in **Chart Title** ("Fish Abundance from Village …….”); **Category (X) axis** as "Date"; **Category (Y) axis** as " Abundance (No./ha)"; in **Legend** un-select **Show Legend**, if only graphing one indicator, but leave if graphing more than one indicator; → Click *Next*

→ In **Place Chart**, select **As Object in Sheet '#'** (where data table is) → *Finish*

(Appendix 5 continued)

(The graph will be placed in current data sheet. Note that the graph can be selected and then moved, re-sized, and copied for placement in a Word report)

(b) Macro Invertebrate and Benthic Indicators (Other Indicators)

Basic Excel Database Format

The Excel database format for macro invertebrates and benthic indicators is shown below. An example of the data that is entered to this template is given in the Results section of this report (in Table 16). Each village data should be kept together in a separate spreadsheet file and time series data added to the same file. Median values for abundance and size categories are added as the data is entered.

DISTRICT				
VILLAGE				
SITE				
DATE				
SWIM TYPE				
SWIM NUMBER	1	2	3	
RECORDER				
BENTHIC INDICATORS **:**				
LIMU FUAFUA				
LIMU				
AAU FAAMOA				
AAU PAPAE				
MACRO INVERTEBRATES **:**				
ALAMEA :				
ALAMEA CATEGORY				
ALAMEA STATUS				
VAGA/ TUITUI :				
VAGA/TUITUI CATEGORY				
VAGA/TUITUI STATUS				
ALIAO :				
ALIAO CATEGORY				
ALIAO STATUS				
SEA/ LOLI/ MAISU :				
SEA CATEGORY				
SEA STATUS				

Calculations and Summary Information

For Benthic Indicators (using presence/absence data), the following descriptions are determined : Present in 1 transect out of 3 = **Low** Presence; Present in 2 transects out of 3 = **Medium Presence**; and Present in all 3 transects = **High Presence**. For Macro Invertebrate indicators (using abundance categories), the highest abundance categories for each indicator from any of the three swims is used to describe the status of that indicator.

(Appendix 5 continued)

<u>Site Description Template</u>

See template for Fish census above. The addition of target indicators that are chosen by the community for monitoring should be added to the Site Description page.

(c) <u>Mangrove Data</u>

<u>Basic Excel Database Format</u>

Data from the "**MANGROVE PERIMETER MONITORING**" data sheet is entered into an Excel spreadsheet in the following way :

1. The Excel spread sheet is set up with the following columns (examples of data are included).

DISTRICT	SITE	DATE	LAT / LONG	REC	TREE NO.	CONDIT-ION	DIRECT-ION	TREE ID	NOTES
Aleipata	*Lepaga*	*26/11/02*	*13.2356S, 171.4567W*	*LA*	*1*	*Lapisi*	*Start on beach at W side (30m) from estuary*	*HIBISCUS*	
Aleipata	*Lepaga*	*26/11/02*	*13.2356S, 171.4567W*	*LA*	*1*	*Meaola*	*10m @ 45^0*	*FAU*	
Aleipata	*Lepaga*	*26/11/02*	*13.2378S, 171.4977W*	*LA*	*2*	*Palapala*	*20m @ 36^0*	*NUU*	*(from #1)*
Aleipata	*Lepaga*	*26/11/02*	*13.23523, 171.4457W*	*LA*	*3*	*Laau Fou*	*16m @ 38*	*IFI*	*Fence <10m Away*
Aleipata	*Lepaga*	*26/11/02*	*13.2339S, 171.4617W*	*LA*	*4*	*Palapala*	*10m @ 29*	*MANGO*	
Aleipata	*Lepaga*	*26/11/02*	*13.2357S, 171.4727W*	*LA*	*4*	*Meaola*	*10m @ 29*	*FAU*	*Fale < 10m away*
Aleipata	*Lepaga*	*26/11/02*	*13.2736S, 171.4589W*	*LA*	*5*	*No Disturb-ance*	*17m @ 40*	*FATAU*	
		(Lapisi = Rubbish, Meaola = Animals present, Palapala = Soil disturbance, Laau Fou = New Trees)							

(Appendix 5 continued)

NB. Where there was only a record of *Laau Fou* in the data sheet, you will have to add a *1* to the column under 'No Disturbance' as well for that Tree # Site.

2. Save file and call it : **'Village' Mangrove Perimeter CB Monitoring (date)**

Site Description Template

The following elements should be included in a Site Description for mangrove perimeter monitoring :

- **Village** associated with mangrove system;
- **Date** site description made;
- **Map** showing general position and shape of main water channels, the adjacent coastline, approximate position and line of marked trees, and any references features including houses, clearings, fences, roads, culverts;
- **Description** of the system and start-end points of perimeter track of marked trees, including any tree numbers that are adjacent to recognizable features;
- **Aim** of the perimeter marking, including any notes of threats/issues present at time of description,eg, presence of water hyacinth from freshwater spring to culvert over waterway.

Keystrokes for Calculations and Summary Information

Steps required to complete data analyses and summary are :

1. Open **'Village' Mangrove Perimeter CB Monitoring (date)**
2. **Select** all of the entered data in columns and rows including the top Headings.
3. **Create Pivot Table** (see below).
4. **Edit** and **Format** Pivot Table (see below).
5. **Calculate** Summary Information from Pivot Table (see below).
6. **Print** and/or **Export** to Word Document (see below).

Detail information of some of the above Data Analysis Steps are presented below :

Step 3 : Creating a Pivot Table

Using the drop down Menu do the following steps : *1)Data → 2) Pivot Table Report → 3) Next → 4) Next* (if data selected already) *→ 5) Construct Pivot Table (see details below) → 6) Next → 7) Select 'Existing Worksheet' → 8) Select 'Sheet 2'* (On Spreadsheet Bottom LH corner) *→ 9) Select "Cell B2" → 10) Click : Finish.*

5) Constructing Pivot Table :

Add Column Headings by dragging boxes with names from the list on the RHS of the screen :
ADD to LH column : SITE, then secondly, TREE NO;
ADD to TOP row : CONDITION;

(Appendix 5 continued)

ADD to centre space (like a cell reference in a spreadsheet) the box named CONDITION (will show 'Count of CONDITION');

THEN, Continue to create Pivot Table (Point 6 onwards above).

Step 4 : Edit and Format Pivot Table

To Edit and Format a table you have to make the Pivot Table Editable and then format the Pivot Table. To do this, the following steps can be made.

To make Pivot Table 'Editable' :

Menu : *(1) Select 'Sheet 2' →(2) Click 2x on Pivot Table* (in top LH corner cell) (will highlight whole Table) →*(3)* Menu : *Edit →4) Copy →5) Edit →6) Paste Special →7) Select 'Values' →8) Click OK..*

Note, nothing should visibly change when these actions have been carried out, except that now you can access the contents of the Pivot Table and perform edits or tasks using the table contents.

To Format the Pivot Table :

After making the Table editable, there are a number of actions that can be used to make the data more presentable. For example, the positioning or altering of text can be done, column widths can be changed, text alignment rearranged, eg, to the centre in cells, some rows deleted, etc. Also, further calculations can be done on the table contents (see below).

Step 5 : Calculate Summary Information from Pivot Table

A number of steps are carried out to complete the summary information in Excel (after the Pivot Table has been created and made editable (see above). First, a number of extra columns and rows will now be added to finalized the summary information. The formulas below include text in brackets [ ]. These are descriptions of where or what is to typed in, and is not the exact text to be used in the spreadsheet.

(a) *Total Disturbances per site and Low and High Disturbance percentages.*

Three columns to the RHS of the Pivot Table to be added are :

1. Next to 'Grand Total' on the RHS of the top headings type '**Total Disturbance'**, referring to the number of different indicators recorded
2. Next to Heading 1 type '**Tipi &/or Lapisi Only'**, referring to Low Disturbance Indicators, and
3. Next to Heading 2 type '**Meaola &/or Palapala'**, referring to High Disturbance Indicators.

(Appendix 5 continued)

(1) Total Disturbance

The following steps are used to calculate the results for this column which will give you the number of disturbance indicators that were recorded at each tree/site (totals of 0 to 4 usually). Note that you can count up each of the relevant scores for this column manually but a quicker, formula based counting method is given here.

1) In RH end of row opposite Tree #1, and under a column heading you add : 'Total Disturbance', write the formula :

=[<u>Grand Total</u> cell reference]-[<u>Lauu Fou</u> cell reference]-[<u>No Disturbance</u> cell reference] ; (eg, =K4-D4-G4);

2) *Enter*;
3) Press arrow *Up* to place cursor in first cell with the formula;
4) Move cursor to bottom RH corner of cell 'frame' where have + sign, then press LH mouse hold down and drag the cursor down that column until the last tree record is reached (the formula will be copied into all of the selected cells in that column;
5) RH mouse click within the selected column with the formulas, select *Copy*, then RH mouse click again within the selected column, choose *Paste Special*, and *Values*, then *OK*. This leaves the numerical value of the formula results only in the column.

The following steps are made to count the number of sites where there are 1, 2, 3,or 4 disturbances recorded for those sites :

1. With the cursor on the column heading 'Total Disturbance', go to the Menu and select *Data* → *Filter* → *Autofilter* ; (the arrow point appears on RH of the heading cell).
2. LH mouse on the arrow head :→ Select 1,2,3, and 4, in succession, each time manually count the number of cells with the corresponding number of indicators → Write or type them down the bottom of the Pivot Table in the corresponding Summary table cell (&/or calculate the percentage of Sites (of the total number of sites recorded) with each number of disturbance indicators).

(2) Tipi &/or Lapisi Only (= **Low Disturbance Sites** Only)

The following steps are used to calculate the results for this column :

1. Start at top cell under the 'Tipi &/or No Disturbance Only' heading : Write the formula :

=IF([Lapisi Cell Reference]=1,"Present",IF([Tipi Cell Reference]=1,"Present')) ;

2. *Enter* and *Arrow Up* to where the formula is;

(Appendix 5 continued)

3. Select RH corner + sign and drag down the column to the last Tree # Site; (this will calculate all the correct 'Present or 'FALSE' records.
4. RH mouse select within the column, select *Copy*, then RH mouse again and *Paste Special* →V*alues* → *OK.*

(3) Meaola &/or Palapala (= **High Disturbance Sites**)

Repeat the same procedure (Steps 1 to 4) as for **2.** Lapisi &/or No Disturbance Only' above, only use the formula under the 'Meaola &/or Palapala' heading :

=IF([Meaola Cell Reference]=1,"Present",IF([Palapala Cell Reference]=1,"Present')) ;

(b) *Percentage of sites where each Indicator was recorded.*

At the bottom of the LHS of the Pivot Table, and in the next row below 'Grand Total' for each Indicator type : '**% of All Sites'**.

Under the first column (LHS) write the formula :

1. Write in a formula for calculating the percentages.

*=+[cell reference directly above (write it in or click/select this cell)]/[total number of trees/sites]*100*

2. Copy this formula across the column for all the percentages of each status type.

Copy the formula by putting the cursor on the bottom RH corner of the selected cell with the first formula, then drag it across to the cells to the right (by holding down the LH mouse).

(c) *Summary percentages of different indicators at sites, and with low and high disturbances (of composite indicators).*

Below the Pivot Table a number of summary percentages will be calculated from the table by typing in the appropriate column the formula above. Type in each of these summary statistics with a spare line in between each summary item so as to make it easy to see what you are doing. The summary statistics will include :

1. '**% No Disturbance (including Laau Fou)**',

This parameter is calculated by:

1) Adding the number of **No Disturbance** and **Laau Fou** only trees/sites (which is calculated in the **Total Disturbance** column above and shown as a zero there).
2) Then dividing by the total number of trees/sites used.

(Appendix 5 continued)

3) Multiplying that answer by 100 to convert to percentages.

You can use the formula :

*=+[Number No Disturbance (=0)]+[Number of Laau Fou]/[Total No. Trees/Sites]*100*

2. '**% Sites with 1 Disturbance Indicator**',

Calculated by adding up all the trees/sites with 1 disturbance only recorded in the **Total Disturbance** column calculated earlier (see above), and using the same formula given in 1.

3. '**% Sites with 2 Disturbance Indicators**',

Calculated by adding up all the trees/sites with 2 disturbances only recorded in the **Total Disturbance** column calculated earlier (see above), and using the same formula given in 1.

4. '**% Sites with 3 Disturbance Indicators**',

Calculated by adding up all the trees/sites with 3 disturbances only recorded in the **Total Disturbance** column calculated earlier (see above), and using the same formula given in 1.

5. '**% Sites with Low Disturbance Indicators (Tipi &/or Lapisi Only)**', and '**% Sites with High Disturbance Indicators (Meaola &/or Palapala)**'.

Calculated by adding up all the trees/sites with either or both of the Low and High disturbances recorded, ie, in the **Tipi &/or Lapisi** and/or in the **Meaola &/or Palapala** column calculated earlier (see above), and using the same formula given in 1.

Step 6 : Print / Export to Word Document :

1) *Select Pivot Table → 2)* Menu : *File → 3) Click 'Print Area' → 4) Click 'Set Print Area' → 5)* Menu : *File → 6) Print → 7) Selection → 8) Click 'Preview' → 9)* (Change Format if necessary : eg, to set print out material for a single page :

<u>To Change Print Out Format</u>

1) Menu : *File → 2) Page Setup → 3) (Eg) 'Fit to 1 page wide and 1 tall' → Select "Sheet" 4) Tick 'Gridlines'* (to print out Table with lines) → 5) Click *OK → 6) Click 'File' → 7) Selection → 8) OK.*

Appendix 6. Data sheet pro-formas for Community Based Monitoring program. Note that the improved/recommended examples or sheets from the trials are given here. Sheets with blank spaces for macro invertebrate and benthic indicators are included so that the latter can be used to custom design sheets for individual village needs (in terms of what is described as important for the village to monitor). Both English and Samoan versions are given here. (Following Pages)

MANGROVE PERIMETER MARKING

VILLAGE: ______________ SITE : ________________ DATE: ____________ RECORDER: _____

TREE NO.	**GPS FIX**	**CONDITION (√ tick one or more if present) (X cross if not present)**	**DIRECTIONS TO NEXT TREE**	**NOTES TREE ID**
		Rubbish_ Soil_Animals__Cuts__New Trees__	____ m @ ____^{0}	
		Rubbish_ Soil_Animals__Cuts__New Trees__	____ m @ ____^{0}	
		Rubbish_ Soil_Animals__Cuts__New Trees__	____ m @ ____^{0}	
		Rubbish_ Soil_Animals__Cuts__New Trees__	____ m @ ____^{0}	
		Rubbish_ Soil_Animals__Cuts__New Trees__	____ m @ ____^{0}	
		Rubbish_ Soil_Animals__Cuts__New Trees__	____ m @ ____^{0}	
		Rubbish_ Soil_Animals__Cuts__New Trees__	____ m @ ____^{0}	
		Rubbish_ Soil_Animals__Cuts__New Trees__	____ m @ ____^{0}	
		Rubbish_ Soil_Animals__Cuts__New Trees__	____ m @ ____^{0}	
		Rubbish_ Soil_Animals__Cuts__New Trees__	____ m @ ____^{0}	
		Rubbish_ Soil_Animals__Cuts__New Trees__	____ m @ ____^{0}	
		Rubbish_ Soil_Animals__Cuts__New Trees__	____ m @ ____^{0}	
		Rubbish_ Soil_Animals__Cuts__New Trees__	____ m @ ____^{0}	
		Rubbish_ Soil_Animals__Cuts__New Trees__	____ m @ ____^{0}	
		Rubbish_ Soil_Animals__Cuts__New Trees__	____ m @ ____^{0}	
		Rubbish_ Soil_Animals__Cuts__New Trees__	____ m @ ____^{0}	
		Rubbish_ Soil_Animals__Cuts__New Trees__	____ m @ ____^{0}	
		Rubbish_ Soil_Animals__Cuts__New Trees__	____ m @ ____^{0}	
		Rubbish_ Soil_Animals__Cuts__New Trees__	____ m @ ____^{0}	
		Rubbish_ Soil_Animals__Cuts__New Trees__	____ m @ ____^{0}	
		Rubbish_ Soil_Animals__Cuts__New Trees__	____ m @ ____^{0}	
		Rubbish_ Soil_Animals__Cuts__New Trees__	____ m @ ____^{0}	
		Rubbish_ Soil_Animals__Cuts__New Trees__	____ m @ ____^{0}	
		Rubbish_ Soil_Animals__Cuts__New Trees__	____ m @ ____^{0}	
		Rubbish_ Soil_Animals__Cuts__New Trees__	____ m @ ____^{0}	
		Rubbish_ Soil_Animals__Cuts__New Trees__	____ m @ ____^{0}	
		Rubbish_ Soil_Animals__Cuts__New Trees__	____ m @ ____^{0}	
		Rubbish_ Soil_Animals__Cuts__New Trees__	____ m @ ____^{0}	
		Rubbish_ Soil_Animals__Cuts__New Trees__	____ m @ ____^{0}	
		Rubbish_ Soil_Animals__Cuts__New Trees__	____ m @ ____^{0}	

More than 1 page for this Site? Yes / No **Page _____ of _____ Pages**

FAAILOGAINA TUAOI O TOGATOGO

NU'U: ___________ NOFOAGA : ____________ ASO: _________ TAGATA FAAMAUINA:

NUMERA O LE LAAU	TULAGA O LE GPS	TULAGA O SE VAAAIGA (√ faamau pea iai vaega nei; (X leai))	MAMAO MA LE TULAGA O LOO IAI LE ISI LAAU	NOTES TREE ID
		Lapisi__ Palapala__Meaola__Tipi__Laau Fou __	____ m @ ____^{0}	
		Lapisi__ Palapala__Meaola__Tipi__Laau Fou __	____ m @ ____^{0}	
		Lapisi__ Palapala__Meaola__Tipi__Laau Fou __	____ m @ ____^{0}	
		Lapisi__ Palapala__Meaola__Tipi__Laau Fou __	____ m @ ____^{0}	
		Lapisi__ Palapala__Meaola__Tipi__Laau Fou __	____ m @ ____^{0}	
		Lapisi__ Palapala__Meaola__Tipi__Laau Fou __	____ m @ ____^{0}	
		Lapisi__ Palapala__Meaola__Tipi__Laau Fou __	____ m @ ____^{0}	
		Lapisi__ Palapala__Meaola__Tipi__Laau Fou __	____ m @ ____^{0}	
		Lapisi__ Palapala__Meaola__Tipi__Laau Fou __	____ m @ ____^{0}	
		Lapisi__ Palapala__Meaola__Tipi__Laau Fou __	____ m @ ____^{0}	
		Lapisi__ Palapala__Meaola__Tipi__Laau Fou __	____ m @ ____^{0}	
		Lapisi__ Palapala__Meaola__Tipi__Laau Fou __	____ m @ ____^{0}	
		Lapisi__ Palapala__Meaola__Tipi__Laau Fou __	____ m @ ____^{0}	
		Lapisi__ Palapala__Meaola__Tipi__Laau Fou __	____ m @ ____^{0}	
		Lapisi__ Palapala__Meaola__Tipi__Laau Fou __	____ m @ ____^{0}	
		Lapisi__ Palapala__Meaola__Tipi__Laau Fou __	____ m @ ____^{0}	
		Lapisi__ Palapala__Meaola__Tipi__Laau Fou __	____ m @ ____^{0}	
		Lapisi__ Palapala__Meaola__Tipi__Laau Fou __	____ m @ ____^{0}	
		Lapisi__ Palapala__Meaola__Tipi__Laau Fou __	____ m @ ____^{0}	
		Lapisi__ Palapala__Meaola__Tipi__Laau Fou __	____ m @ ____^{0}	
		Lapisi__ Palapala__Meaola__Tipi__Laau Fou __	____ m @ ____^{0}	
		Lapisi__ Palapala__Meaola__Tipi__Laau Fou __	____ m @ ____^{0}	
		Lapisi__ Palapala__Meaola__Tipi__Laau Fou __	____ m @ ____^{0}	
		Lapisi__ Palapala__Meaola__Tipi__Laau Fou __	____ m @ ____^{0}	
		Lapisi__ Palapala__Meaola__Tipi__Laau Fou __	____ m @ ____^{0}	
		Lapisi__ Palapala__Meaola__Tipi__Laau Fou __	____ m @ ____^{0}	
		Lapisi__ Palapala__Meaola__Tipi__Laau Fou __	____ m @ ____^{0}	
		Lapisi__ Palapala__Meaola__Tipi__Laau Fou __	____ m @ ____^{0}	
		Lapisi__ Palapala__Meaola__Tipi__Laau Fou __	____ m @ ____^{0}	
		Lapisi__ Palapala__Meaola__Tipi__Laau Fou __	____ m @ ____^{0}	

Sili atu I le tasi le itulau mo le Nofoaga lenei? Ioe / Leai **Itulau e _____ o _____ Itulau**

FAAILOGAINA TUAOI O TOGATOGO

NU'U: ________ NOFOAGA : ________ ASO: ________ TAGATA NA FAAMAUINA: _____

Faamatalaga o le Nofoaga & Faafanua mai le Amataga I le Faiuga :

REEF FISH & OTHER INDICATORS MONITORING

VILLAGE: _______________ SITE : _______________ ASO: _________ RECORDER: _________

FISH SWIM #1

Total Number Fish	1. 1st Most Abundant	2. 2nd Most Abundant	3. 3rd Most Abundant
	-----------------------	-----------------------	-----------------------
☐ 1 - 60	1. Knuckle ○	1. Knuckle ○	1. Knuckle ○
☐ 60 - 250	2. Wrist ○	2. Wrist ○	2. Wrist ○
☐ 250 - 1000	3. Elbow ○	3. Elbow ○	3. Elbow ○
☐ 1000 - 4000	4. Shoulder ○	4. Shoulder ○	4. Shoulder ○
☐ > 4000			

OTHER SWIM #1

Present (√) or Absent (X)	Coral :	1. COTS	2. Urchins	3. Trochus
		1. 0 ○	1. 0 ○	1. 0 ○
Edible Macro Algae ☐	Broken ☐	2. 1 - 5 ○	2. 1 – 5 ○	2. 1 - 5 ○
Other Macro Algae ☐	Bleached ☐	3. 6 -10 ○	3. 6 – 10 ○	3. 6 - 10 ○
		4. 11 -20 ○	4. 11 - 20 ○	4. 11 20 ○
		5. >20 ○	5. >20 ○	5. >20 ○

FISH SWIM #2

Total Number Fish	1. 1st Most Abundant	2. 2nd Most Abundant	3. 3rd Most Abundant
	-----------------------	-----------------------	-----------------------
☐ 1 - 60	1. Knuckle ○	1. Knuckle ○	1. Knuckle ○
☐ 60 - 250	2. Wrist ○	2. Wrist ○	2. Wrist ○
☐ 250 - 1000	3. Elbow ○	3. Elbow ○	3. Elbow ○
☐ 1000 - 4000	4. Shoulder ○	4. Shoulder ○	4. Shoulder ○
☐ > 4000			

OTHER SWIM #2

Present (√) or Absent (X)	Coral :	1. COTS	2. Urchins	3. Trochus
		1. 0 ○	1. 0 ○	1. 0 ○
Edible Macro Algae ☐	Broken ☐	2. 1 - 5 ○	2. 1 – 5 ○	2. 1 - 5 ○
Other Macro Algae ☐	Bleached ☐	3. 6 -10 ○	3. 6 – 10 ○	3. 6 - 10 ○
		4. 11 -20 ○	4. 11 - 20 ○	4. 11 20 ○
		5. >20 ○	5. >20 ○	5. >20 ○

FISH SWIM #3

Total Number Fish	1. 1st Most Abundant	2. 2nd Most Abundant	3. 3rd Most Abundant
	-----------------------	-----------------------	-----------------------
☐ 1 - 60	1. Knuckle ○	1. Knuckle ○	1. Knuckle ○
☐ 60 - 250	2. Wrist ○	2. Wrist ○	2. Wrist ○
☐ 250 - 1000	3. Elbow ○	3. Elbow ○	3. Elbow ○
☐ 1000 - 4000	4. Shoulder ○	4. Shoulder ○	4. Shoulder ○
☐ > 4000			

OTHER SWIM #3

Present (√) or Absent (X)	Coral :	1. COTS	2. Urchins	3. Trochus
		1. 0 ○	1. 0 ○	1. 0 ○
Edible Macro Algae ☐	Broken ☐	2. 1 - 5 ○	2. 1 – 5 ○	2. 1 - 5 ○
Other Macro Algae ☐	Bleached ☐	3. 6 -10 ○	3. 6 – 10 ○	3. 6 - 10 ○
		4. 11 -20 ○	4. 11 - 20 ○	4. 11 20 ○
		5. >20 ○	5. >20 ○	5. >20 ○

COMMENTS : ____

REEF FISH & OTHER INDICATORS MONITORING

VILLAGE: _______________ SITE : _______________ ASO: _________ RECORDER: _________

FISH SWIM #1

Total Number Fish	1. 1st Most Abundant	2. 2nd Most Abundant	3. 3rd Most Abundant
☐ 1 - 60 ☐ 60 - 250 ☐ 250 - 1000 ☐ 1000 - 4000 ☐ > 4000	---------------------- 1. Knuckle ○ 2. Wrist ○ 3. Elbow ○ 4. Shoulder ○	----------------------- 1. Knuckle ○ 2. Wrist ○ 3. Elbow ○ 4. Shoulder ○	------------------------ 1. Knuckle ○ 2. Wrist ○ 3. Elbow ○ 4. Shoulder ○

OTHER SWIM #1

Present (√) or Absent (X)	1. _______	2. _________	3. _________
☐ ☐	1. 0 ○ 2. 1 - 5 ○ 3. 6 -10 ○ 4. 11 -20 ○ 5. >20 ○	1. 0 ○ 2. 1 – 5 ○ 3. 6 – 10 ○ 4. 11 - 20 ○ 5. >20 ○	1. 0 ○ 2. 1 - 5 ○ 3. 6 - 10 ○ 4. 11 20 ○ 5. >20 ○

FISH SWIM #2

Total Number Fish	1. 1st Most Abundant	2. 2nd Most Abundant	3. 3rd Most Abundant
☐ 1 - 60 ☐ 60 - 250 ☐ 250 - 1000 ☐ 1000 - 4000 ☐ > 4000	---------------------- 1. Knuckle ○ 2. Wrist ○ 3. Elbow ○ 4. Shoulder ○	----------------------- 1. Knuckle ○ 2. Wrist ○ 3. Elbow ○ 4. Shoulder ○	------------------------ 1. Knuckle ○ 2. Wrist ○ 3. Elbow ○ 4. Shoulder ○

OTHER SWIM #2

Present (√) or Absent (X)	1. _______	2. _________	3. _________
☐ ☐	1. 0 ○ 2. 1 - 5 ○ 3. 6 -10 ○ 4. 11 -20 ○ 5. >20 ○	1. 0 ○ 2. 1 – 5 ○ 3. 6 – 10 ○ 4. 11 - 20 ○ 5. >20 ○	1. 0 ○ 2. 1 - 5 ○ 3. 6 - 10 ○ 4. 11 20 ○ 5. >20 ○

FISH SWIM #3

Total Number Fish	1. 1st Most Abundant	2. 2nd Most Abundant	3. 3rd Most Abundant
☐ 1 - 60 ☐ 60 - 250 ☐ 250 - 1000 ☐ 1000 - 4000 ☐ > 4000	---------------------- 1. Knuckle ○ 2. Wrist ○ 3. Elbow ○ 4. Shoulder ○	----------------------- 1. Knuckle ○ 2. Wrist ○ 3. Elbow ○ 4. Shoulder ○	------------------------ 1. Knuckle ○ 2. Wrist ○ 3. Elbow ○ 4. Shoulder ○

OTHER SWIM #3

Present (√) or Absent (X)	1. _______	2. _________	3. _________
☐ ☐	1. 0 ○ 2. 1 - 5 ○ 3. 6 -10 ○ 4. 11 -20 ○ 5. >20 ○	1. 0 ○ 2. 1 – 5 ○ 3. 6 – 10 ○ 4. 11 - 20 ○ 5. >20 ○	1. 0 ○ 2. 1 - 5 ○ 3. 6 - 10 ○ 4. 11 20 ○ 5. >20 ○

COMMENTS : ____

MATAITUINA O IA O LE AAU MA ISI MEAOLA

NU'U: __________ NOFOAGA : ___________ ASO: _______ TAGATANA FAAMAUINA: _____

AUSAGA O IA #1

Faitauaofai o Ia	1. Ia Taatele	2. Ia Taatele	3. Ia Taatele
☐ 1 - 60 ☐ 60 - 250 ☐ 250 - 1000 ☐ 1000 - 4000 ☐ > 4000	---------------------- 1. Limatusi ○ 2. Tapulima ○ 3. Tulilima ○ 4. Tau'au ○	---------------------- 1. Limatusi ○ 2. Tapulima ○ 3. Tulilima ○ 4. Tau'au ○	---------------------- 1. Limatusi ○ 2. Tapulima ○ 3. Tulilima ○ 4. Tau'au ○

ISI AUSAGA #1

Iai (√) po'o Leai (X)		1. Alamea	2. Tuitui/Vaga	3. Aliao
Limufuafua ☐ Limu ☐	Aau : Faamoa ☐ Bleached ☐	1. 0 ○ 2. 1 - 5 ○ 3. 6 -10 ○ 4. 11 -20 ○ 5. >20 ○	1. 0 ○ 2. 1 – 5 ○ 3. 6 – 10 ○ 4. 11 - 20 ○ 5. >20 ○	1. 0 ○ 2. 1 - 5 ○ 3. 6 - 10 ○ 4. 11 20 ○ 5. >20 ○

AUSAGA O IA #2

Faitauaofai o Ia	1. Ia Taatele	2. Ia Taatele	3. Ia Taatele
☐ 1 - 60 ☐ 60 - 250 ☐ 250 - 1000 ☐ 1000 - 4000 ☐ > 4000	---------------------- 1. Limatusi ○ 2. Tapulima ○ 3. Tulilima ○ 4. Tau'au ○	---------------------- 1. Limatusi ○ 2. Tapulima ○ 3. Tulilima ○ 4. Tau'au ○	---------------------- 1. Limatusi ○ 2. Tapulima ○ 3. Tulilima ○ 4. Tau'au ○

ISI AUSAGA #2

Iai (√) po'o Leai (X)		1. Alamea	2. Tuitui/Vaga	3. Aliao
Limufuafua ☐ Limu ☐	Aau : Faamoa ☐ Bleached ☐	1. 0 ○ 2. 1 - 5 ○ 3. 6 -10 ○ 4. 11 -20 ○ 5. >20 ○	1. 0 ○ 2. 1 – 5 ○ 3. 6 – 10 ○ 4. 11 - 20 ○ 5. >20 ○	1. 0 ○ 2. 1 - 5 ○ 3. 6 - 10 ○ 4. 11 20 ○ 5. >20 ○

AUSAGA O IA #3

Faitauaofai o Ia	1. Ia Taatele	2. Ia Taatele	3. Ia Taatele
☐ 1 - 60 ☐ 60 - 250 ☐ 250 - 1000 ☐ 1000 - 4000 ☐ > 4000	---------------------- 1. Limatusi ○ 2. Tapulima ○ 3. Tulilima ○ 4. Tau'au ○	---------------------- 1. Limatusi ○ 2. Tapulima ○ 3. Tulilima ○ 4. Tau'au ○	---------------------- 1. Limatusi ○ 2. Tapulima ○ 3. Tulilima ○ 4. Tau'au ○

ISI AUSAGA #3

Iai (√) po'o Leai (X)		1. Alamea	2. Tuitui/Vaga	3. Aliao
Limufuafua ☐ Limu ☐	Aau : Faamoa ☐ Bleached ☐	1. 0 ○ 2. 1 - 5 ○ 3. 6 -10 ○ 4. 11 -20 ○ 5. >20 ○	1. 0 ○ 2. 1 – 5 ○ 3. 6 – 10 ○ 4. 11 - 20 ○ 5. >20 ○	1. 0 ○ 2. 1 - 5 ○ 3. 6 - 10 ○ 4. 11 20 ○ 5. >20 ○

MANATU FAAOPOOPO :____

MATAITUINA O IA O LE AAU MA ISI MEAOLA

NU'U: ___________ NOFOAGA : ____________ ASO: ________ TAGATANA FAAMAUINA: ______

AUSAGA O IA #1

Faitauaofai o Ia	1. Ia Taatele	2. Ia Taatele	3. Ia Taatele
☐ 1 - 60 ☐ 60 - 250 ☐ 250 - 1000 ☐ 1000 - 4000 ☐ > 4000	----------------------- 1. Limatusi ○ 2. Tapulima ○ 3. Tulilima ○ 4. Tau'au ○	----------------------- 1. Limatusi ○ 2. Tapulima ○ 3. Tulilima ○ 4. Tau'au ○	----------------------- 1. Limatusi ○ 2. Tapulima ○ 3. Tulilima ○ 4. Tau'au ○

ISI AUSAGA #1

Iai (√) po'o Leai (x)	Iai (√) po'o Leai (x)	1.___________	2.___________	3. ___________
☐ ☐	☐ ☐	1. 0 ○ 2. 1 - 5 ○ 3. 6 -10 ○ 4. 11 -20 ○ 5. >20 ○	1. 0 ○ 2. 1 – 5 ○ 3. 6 – 10 ○ 4. 11 - 20 ○ 5. >20 ○	1. 0 ○ 2. 1 - 5 ○ 3. 6 - 10 ○ 4. 11 20 ○ 5. >20 ○

AUSAGA O IA #2

Faitauaofai o Ia	1. Ia Taatele	2. Ia Taatele	3. Ia Taatele
☐ 1 - 60 ☐ 60 - 250 ☐ 250 - 1000 ☐ 1000 - 4000 ☐ > 4000	----------------------- 1. Limatusi ○ 2. Tapulima ○ 3. Tulilima ○ 4. Tau'au ○	----------------------- 1. Limatusi ○ 2. Tapulima ○ 3. Tulilima ○ 4. Tau'au ○	----------------------- 1. Limatusi ○ 2. Tapulima ○ 3. Tulilima ○ 4. Tau'au ○

ISI AUSAGA #2

Iai (√) po'o Leai (x)	Iai (√) po'o Leai (x)	1.___________	2.___________	3. ___________
☐ ☐	☐ ☐	1. 0 ○ 2. 1 - 5 ○ 3. 6 -10 ○ 4. 11 -20 ○ 5. >20 ○	1. 0 ○ 2. 1 – 5 ○ 3. 6 – 10 ○ 4. 11 - 20 ○ 5. >20 ○	1. 0 ○ 2. 1 - 5 ○ 3. 6 - 10 ○ 4. 11 20 ○ 5. >20 ○

AUSAGA O IA #3

Faitauaofai o Ia	1. Ia Taatele	2. Ia Taatele	3. Ia Taatele
☐ 1 - 60 ☐ 60 - 250 ☐ 250 - 1000 ☐ 1000 - 4000 ☐ > 4000	----------------------- 1. Limatusi ○ 2. Tapulima ○ 3. Tulilima ○ 4. Tau'au ○	----------------------- 1. Limatusi ○ 2. Tapulima ○ 3. Tulilima ○ 4. Tau'au ○	----------------------- 1. Limatusi ○ 2. Tapulima ○ 3. Tulilima ○ 4. Tau'au ○

ISI AUSAGA #3

Iai (√) po'o Leai (x)	Iai (√) po'o Leai (x)	1.___________	2.___________	3. ___________
☐ ☐	☐ ☐	1. 0 ○ 2. 1 - 5 ○ 3. 6 -10 ○ 4. 11 -20 ○ 5. >20 ○	1. 0 ○ 2. 1 – 5 ○ 3. 6 – 10 ○ 4. 11 - 20 ○ 5. >20 ○	1. 0 ○ 2. 1 - 5 ○ 3. 6 - 10 ○ 4. 11 20 ○ 5. >20 ○

MANATU FAAOPOOPO :____

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