Marine Resources of Tokelau Atolls

ATAFU

Marine Resource Management Plan

Background Report

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Government of Tokelau

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for

South Pacific Regional Environment Programme

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Executive Summary & Recommendations

Background to this Survey

In 2002, the Tokelau government approached SPREP for assistance with management and conservation of the marine resources of their Atolls. A scoping study was undertaken over two separate visits in 2002 / 2003 to assess the level of community and leadership interest in revitalizing the previously proposed marine resource management project[1]. The scoping study found that the communities and their traditional leaders were very supportive of the government proposal and that all three atoll communities were keen to be involved.

SPREP put together a multi-disciplinary team of scientists and managers to visit each of the Tokelau Atolls to undertake an assessment of the possible options for conservation areas and looking at the status of the inshore and lagoon resources (from a conservation perspective) as first step towards establishing a marine conservation program in Tokelau. The team also worked with the communities to establish a picture of community perceptions of the status of resources and community attitudes towards conservation of marine resources.

The project did not focus on assessing the biodiversity of Tokaleau's marine resources. Instead, it was designed to address issues raised by the community in particular, and to assess the general state of the marine environment and the status of harvested resources. In addition, the project was designed to assess the effectiveness of any management measures in place and the level of community support for management. The surveys aimed to:

- Undertake a rapid assessment of the status of significant marine resources and ecosystems, inside existing conservation areas in particular;
- Undertake a series of surveys to gauge types and intensity of fishing activity;
- Conduct a series of workshops and interviews to engage all sectors of the community and traditional leaders, enabling the community of each atoll to identify their aspirations for their marine environment and identify actions that need to be undertaken to ensure sustainable use of their marine resources; and,
- Recommend actions / measures that should be incorporated into Marine Resource Management Plans for each Atoll, or portions of each Atoll as appropriate, for the establishment of Marine Protected Areas.

Ecological Condition

The survey results show that there are specific characteristics of the habitats and biotic communities on Atafu Atoll that should be taken into account when considering sustainable management of marine resources.

The relative geographical isolation of Atafu atoll from other Tokelau atolls, and from other regional reef systems means that marine resources on Atafu are effectively isolated from all other sources of marine species replenishment,. The Atoll is, in effect, virtually a "closed" biological system. As a consequence, replenishment of reef fish, corals, clams and other stocks of marine species must usually occur from within the atoll's marine ecosystem. For this to

[1] Marine Conservation Areas previously proposed to SPREP under the South Pacific Biodiversity Conservation Project. Tokelau Government (1995). Tokelau Marine Conservation Area Project: Concept Proposal – A submission to the South Pacific Biodiversity Conservation Program. Environment Unit, Division of Natural Resources and Environment, Government of Tokelau.

happen there must be viable (or reproductively successful) populations of adults of each species of interest present within Atafu Atoll.

Atafu lagoon is a partially open lagoon system with small steep sided patch reefs scattered throughout the western lagoon which are surrounded by deep water. The lagoon does not have any deep water passages to the open ocean. Multiple shallow passageways between motu (islets) allow the transfer of water between the lagoon and the open ocean, but none are deeper than approximately a meter at low tide and most are no wider than approximately 40 - 50 m. The central and north-western sectors of the lagoon are subdivided into a series of wall reefs that run approximately south-west to north-east with interconnecting walls running south-east to north-west. These walls create semi enclosed cells which restrict water movement within the lagoon.

The status of marine resources on Atafu is one of general depletion of most commonly harvested species. Some species are severely depleted to the point that they may never recover. The reasons for these depletions are not always easy to determine but they no doubt include natural fluctuations and natural disturbance events in addition to contemporary harvesting activities. Modern fishing technologies that are leading to increased harvest pressure include improved food storage and preservation (fridges and freezers) and highly efficient fishing tools like monofilament nets, motorised dinghies and other non-traditional fishing gear.

There is a representative suite of species present from the major groups that you would expect to find in this region (i.e. herbivores (plant eating fish), planktivores (plankton eating fish), detritivores (fish that eat detritus or waste particles) and predators (fish that eat other fish and reef animals). However, the fish communities of Atafu reef and lagoon are generally low in diversity and in many areas are also low in abundance. There appears to have been major reductions in some of the targeted predator fish species such as hump headed wrass, black trevally, and coral trout, that were apparently once quite abundant in preceding decades. There also is a noticeably low presence of some major reef invertebrate species groups, such as echinoderms (starfish, holothurians, etc) and crustaceans (crabs, crayfish, etc). Among the non-harvested animals, there is the likelihood that a small number of coral species are present that have not previously been recorded from the Central Pacific and there may be one or two species that will be new to science.

There is clear evidence that significant impacts have occurred from recent bleaching events (in 2002-3) that have affected major components of the reef on the outer slope and also in the lagoon, where it would be expected that species in the lagoon were relatively adapted to high temperature fluctuations due to the enclosed nature of the lagoon system. The bleaching events correlate with observations of low sea levels within the lagoon and prolonged periods of dry still weather. Similar periods of low sea levels in the lagoon have been reported from 1983.

Ship groundings in the past (last large ship went aground in 1979 in the NW corner) have caused widespread damage to coral reef communities (Salvat, 2001). This most recent wreck was blown up and the remaining pieces dispersed in 1981. A survey of the grounding area in 1987 (Laboute 1987), revealed very little regeneration of coral. There are current reports of ciguatoxic Pacific Long Nose Parrotfish from the wreck site portion of the atoll which may be related to this past event.

Atafu Community's Resource and Conservation Perceptions

Community investigations demonstrated that there are specific community perceptions, concerns and issues that should be taken into account when developing a resource management plan and implementing management prescriptions. Some of the issues and perceptions are outlined below (note that sections written in italics are direct quotes from interviews with community members and from community meetings).

Atafu is the smallest atoll of the Tokelaus, this is a fact that all Atafuans are starkly aware of. They understand that this means their lagoon and reef fisheries and land resources are more limited than the other atolls. The concept of the need to care for their '*small atoll*' and be careful with its limited resources was more apparent here then on the other atolls.

Certain changes in the environment and in the status of resources and also the in behaviour of people interacting with resources were identified:

- Fishers used to leave fish nets out all day but this practice is no longer allowed, a participant at the final meeting asked what will happen if villagers continue to use nets;
- the amount of daily fishing activity has decreased due to improved fishing gear, motorised boats, freezers and availability of regularly imported goods from Samoa;
- water flow in and out of the lagoon has decreased (not flushing as much);
- water clarity and quality has declined due to pollution and building extensions (reclaimed land);
- the community has started dumping rubbish at sea in the deep in an attempt to address the ever pressing waste problems facing the atoll;
- there is an awareness of the link between an observed decrease in coconut crabs and an increase in harvesting for relatives overseas.

Many people felt that conservation was a new idea. However, some drew a comparison to traditional resource management practices, such as *te lafu (faka-lafu)* which respondents noted was only ever implemented on land. Many were unaware of the concept and practice of lafu areas or felt that it was an old way that was no longer practiced, "*lafu? I wonder what lafu means…fakalafu, there's no more of that*".

The greatest change noted by respondents and by participants in the community workshops, is the decline in populations of reef fish and giant clams (faisua) within the lagoon. Fish populations and species diversity is declining, fish are either not seen or rarely seen (compared to before) included: tonu (coral trout), manini, atule, o, lai, maiava, feke (octopus), ufu, pone (surgeonfish), laulauhau and honu (turtle).

The following issues were noted by workshop participants and interview respondents:

- coral cover has decreased;
- cowry shells, octopus and coconut crab size and numbers have declined;
- the number of clams has decreased dramatically;
- the fish size, quantity and diversity have declined, *"there are some fish that we no longer see"*;
- crayfish have been completely depleted;
- there has been an increase of black algae in the lagoon, especially near the motu where the rubbish is dumped;
- there has been a loss of seaweed within the lagoon;
- water clarity of the lagoon near the village is now poor, it was once clear;

- the shoreline on the village islet has changed as erosion has increased; and
- "*the atoll is being ruined by rubbish*".

Respondents felt that the existing *fakahao area* (Conservation Area or Marine Protected Area) provided both advantages and disadvantages. The perceived advantages included improved resources, especially an increase in fish numbers (schools) and in individual fish sizes. It was noted by some that some fish species that were thought to have disappeared are now returning. Disadvantages of the *fakahao area* according to participants include a perception of disparity in costs amongst village members. One side of the village is not bounded by the *fakahao area* therefore their fishing area is not restricted,

It is generally felt that while the whole village is responsible for the *fakahao area*, it is managed directly by the village elders (*toeiga*). Community members are responsible to respect the *fakahao area* rules and ensure no-one breaks the rules, thereby they must act as "wardens" for the *fakahao area*. Some respondents felt however that the fakahao was not actively managed and the area was regularly accessed and fished. Most community members shared the view that generally the rules of the *fakahao area* were not complied with. Punishment for non-compliance is rarely implemented according to respondents.

Perceptions of current and future success in the conservation area were explored. People felt that success would require active management of the *fakahao* by the *taupulega*. There was a need to have people working there, monitoring and patrolling the area frequently to ensure no one breaks the rules.

Recommendations

Considering the findings of the resource surveys and the interaction with all groups of the community, a number of recommendations are suggested as a way to improve resource management on Atafu. The recommendations are directed towards management actions that will contribute to the conservation and preservation of the atoll, by providing a framework for achieving sustainable management of human activities. The recommendations address the major management issues raised by the community and encompass the following principles:

1. ***Conservation***
   - Conserve the integrity of the natural and cultural values of Atafu Atoll; and
   - Restore, where possible, the natural biodiversity and cultural values of the atoll.
2. ***Community involvement and support***
   - Enhance community awareness, understanding and appreciation of the biological and physical diversity of the atoll;
   - promote community involvement in, and support for, its protection, conservation, and restoration; and
   - incorporate traditional and modern resource management practices to form a comprehensive and integrated community-based Resource Management Plan.
3. ***Commercial and other uses***
   - Manage commercial and other uses in an ecologically sustainable way.
4. ***Research and Monitoring***
   - Implement a data collection and analysis program that provides for a much greater understanding of the impacts of use and management activities within the atoll;
   - to better understand the potential and real impacts resulting from resource use; and
   - encourage and support community-based participatory research and monitoring.

Fish Aggregation Sites

Seasonal protection for these aggregations, especially from the very effective netting practices currently being used, would be a very significant step forward for long term sustainable management of finfish stocks of importance to subsistence livelihoods. It is also wise to nominate for protection more than one such species-related aggregation site for each species, so that annual variations in the degree of use of these sites is taken into account by protecting more than one of each of the species-specific sites.

RECOMMENDATION 1:
It is highly recommended that more than one species-specific site, known for seasonal fish aggregations, be protected from harvest activities during these critical phases. This should be applied to sufficient sites so that all the major target fish species included.

Giant Clams

Ggiant clams were restricted predominantly to *Tridacna maxima*. Only a few individuals of *T.squamosa* were observed during the entire survey. The densest aggregations of clams were observed in the eastern sectors of the lagoon. In all other locations, densities were low or clams were not present at all. If clam densities are to be improved, strict restrictions on their harvesting will have to be enforced.

RECOMMENDATION 2:
It is recommended that relatively large areas of reef flat and adjacent shallow lagoon area on the western and southern margins, on the scale of 500m - 1 km, be set aside as long term refuges for giant clams, to as sources of clam larvae for other parts of the atoll.

Permanent and Temporary Closures

While there is a role for traditional temporary closures for resource management, it must be recognised that this strategy is of limited effectiveness for long term sustainability of fisheries if it is the only management technique adopted. Some permanent closures are also necessary.

Temporary closures should be target the most productive areas and be rotated between a number of similar habitat areas that are important for the various target species.

RECOMMENDATION 3:
It is recommended that both temporary and permanent closure systems be employed to enhance overall fisheries yields for Atafu. Also, a clear distinction should be made between areas that are intended to be permanently closed to harvest activities and those that are to be more temporary (in terms of a number of years or on a seasonal basis).

RECOMMENDATION 4:
Where harvesting is to be periodically allowed following temporary closures, there should be a systematic rotation of open and closed areas that are easily applied and the boundaries readily understood with reference to reef features.

Permanent Conservation Areas

The current Conservation Areas (Figure I) includes the northern western corner of the lagoon and the seaward reef flat surrounding Atafu village on Vao Island (Te Kakai). A second Conservation Area is located on the middle of western atoll margin, in a channel between Te Alofi motu and Alofi Lahi motu, and includes the motu of Tamahaka but is not large enough. The south eastern corner of the Atoll has potential as an alternative or additional area for fish stock protection.

RECOMMENDATION 5:
It is recommended that the two current Conservation Areas be maintained as specific clam recovery areas. To be effective, the boundaries should be extended to the lower slope and further into the lagoon to maximize benefits of a Conservation Area. The closures should be permanent.

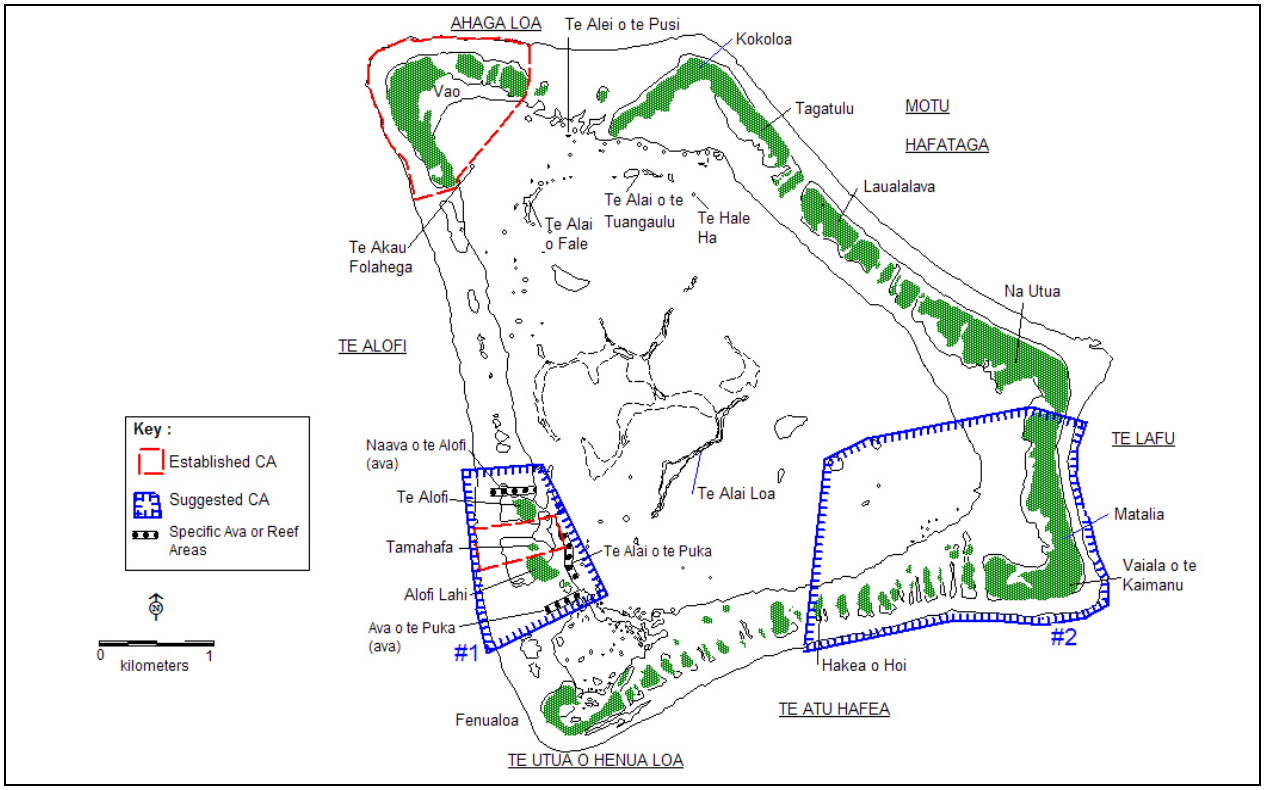

Figure I: **Map of Atafu Atoll showing the existing Conservation Areas, including an extension of the boundaries to CA #1, and an additional suggested Conservation Area (CA #2).**

RECOMMENDATION 6:
It is recommended that consideration be given to setting aside a section of the south eastern margin and Matalia Island, as a major Conservation Area. The reef slope, reef flat, and a portion of the adjacent lagoon (to approximately 20 m depth) should be included in an area that excludes the harvesting of any species.

Control of harvesting (methods and activities)

Current harvest activities on Atafu that are significantly contributing to the over harvesting of resources include: the widespread use of fish gill nets in the shallow and narrow channels that dissect the reef flat; the use of small mesh nets; the targeting of fish aggregation areas; and the taking of all sizes.

RECOMMENDATION 7:
Good practice fisheries regulations need to be adopted that address the common causes of over fishing like small mesh net sizes, the targeting of most fish aggregation sites in any one year, and the taking of small fish sizes. These regulations have to be understood by all members of the community and have to be adequately.

Control of Exports

The practice of exporting marine products for either family reasons or income needs to be carefully managed so that over exploitation of limited resources does not occur. A careful policy in relation to commercial export industries will have to be developed before any scheme is approved.

RECOMMENDATION 8:
It is recommended that the export of marine resources be either significantly controlled and monitored, or prohibited. It is essential to obtain figures on the amount of product leaving the atoll.

Improved Waste Management

There is a significant problem on Atafu relating to the management of solid and liquid waste. Waste management plans are needed to address the importation of plastics and disposal of effluent and chemical use.

RECOMMENDATION 9:
It is recommended that a wide ranging management plan for waste in all its forms be developed as a matter of urgency and that it be implemented as soon as is practical. Immediate measures may include restrictions on the import of certain material (e.g plastics) onto the atoll.

Atoll Wide Management Issues

Seabird and turtle numbers were extremely low and appear to have significantly declined according to the community.

RECOMMENDATION 10:
It is strongly recommended that an Atoll-wide ban be placed on the harvesting of turtles and sea birds.

Monitoring Program

Biological Monitoring provides ongoing data on the health and status of resource stocks. This data is essential for re-assessing and reviewing management strategies.

RECOMMENDATION 11:

It is strongly recommended that a Biological Monitoring Program be so that information can be provided to the decision makers on the effectiveness of their decisions. Alterations and improvements to the rules governing the management of resources can also be made using the information obtained from monitoring efforts.

1 INTRODUCTION

1.1 Background

The Tokelau Government prepared a State of Environment Report in 1994[2] (SOE) and an Environmental Management Strategy[3] in 1995. An Environmental Legislation Review[4] has also been undertaken which gives an overview of existing legislation that impacts on the environment and proposes recommendations for improved environmental planning and management. In all of these reports priority was given to the development of a conservation strategy to address the protection of lagoon and reef fisheries from the effects of pollution, siltation, sand and coral extraction and over-fishing. Recommendations included the establishment of an ecosystem profile, protected areas, regulation of fishing, resource monitoring, as well as monitoring the effects of land-based pollution.

In 1995 the Tokelau Government submitted a proposal to the South Pacific Regional Environment Programme's (SPREP) South Pacific Biodiversity Conservation Program (SPBCP) for assistance to establish a marine protected area program[5]. However, as the SPBCP was a GEF-UNDP funded program, Tokelau was deemed ineligible for assistance under the Program and no action eventuated.

In 2002, the Tokelau government again approached SPREP for assistance with marine resource management in the Atolls. A scoping study was undertaken in Tokelau over two separate visits in 2002 / 2003 to assess the level of community and leadership interest in revitalizing the proposed marine resource management project. The scoping study found that the communities and their traditional leaders were very supportive of the government proposal and that all three atoll communities were keen to be involved.

SPREP convened a multi-disciplinary team of scientists and managers to undertake an assessment of the status and use patterns of the inshore and lagoon resources of all three atolls as a first step towards establishing a marine conservation program in Tokelau. The team also worked with the communities to establish a picture of community perceptions of the status of marine resources and community attitudes towards conservation of these resources.

A combination of activities and methods were used to assess the status and health of major ecological zones and habitats on each atoll and to quantify the relative abundance and diversity of target species, invertebrates and finfish. Observations of seabird populations and turtles were also made and incidental observations of marine mammals were also recorded.

This report and the management recommendations developed from this process, provides the essential information and direction to empower the communities and their leaders to sustainably manage their environment and resources within the atoll. The survey aims are outlined below.

[2] Ioane M K 1994 Tokelau State of the Environment Report, SPREP, Apia Samoa.
[3] Toloa F. 1994 Tokelau Environment Managemental Strategy: Action Strategy for strengthening environmental management and sustainable development (Tokelau 2000). SPREP, Apia, Samoa
[4] Angelo A. H. 1993 Environmental Legislation Review –Tokelau Report for SPREP and the Tokelau Affairs Office.
[5] Environment Unit, DNRE 1995 Tokelau Marine Conservation Area Proejct – Concept Proposal. A submission to the South Pacific Marine Biodiversity Conservation Programme.

The surveys aimed to:

- **Undertake a rapid assessment of the status of significant marine resources and ecosystems;**
- **Undertake a series of surveys to gauge types and intensity of fishing activity.**
- **Conduct a series of workshops to engage all sectors of the community and traditional leaders to enable community to identify their aspirations for their marine environment and identify actions that need to be undertaken to ensure sustainable use of their marine resources;**
- **Recommend actions / measures that should be incorporated into Marine Resource Management Plans for each Atoll or portions of each Atoll as appropriate for the establishment of Marine Protected Areas**

The management strategies and goals of this project reinforce and support the Tokelau Environmental Management Strategy (TEMS). The strategies of the TEMS Action Plan that are directly relevant to management and utilization of the Tokelau's natural resources are:

Strategies of the TEM Strategy and Action Plan

1. ***Conservation of biodiversity and biological resources***
   - Blend new and traditional conservation and management .
2. ***Protection of the marine environment***
   - Training and capacity building towards conserving our resources.
   - Sustainable fishing practices.
3. ***Traditional culture and practices***
   - Apply traditional skills and knowledge.
   - Institute learning of the culture through the traditional way of passing knowledge from elders to the young, through schools, community meetings and workshops.
4. ***People and Biodiversity***
   - Self-reliance through traditional values and cultures.
   - Community wareness.
   - Working cooperatively and.
   - Clean up the environment.

These points were reinforced during the scoping visit and the marine assessment visit in 2003 by community members and leaders.

1.2 Methodology

Consultations and Community Surveys

The development and sustainable management of Atafu's resources requires active involvement from all sectors of the community. Meetings were held with all stakeholder groups to document their concerns and perceptions of the status of atoll resources and current and historic resource use. These were further supplemented by semi-structured interviews conducted at random with individuals from all community groups to obtain more details perceptions on the status and use of resources and also on management systems and their success or otherwise.

Key stakeholders include:

- **Local Community –** recognising that all sectors of the community who live on the atoll and are an integral part of both the problems and solutions of environmental resource management:
  - ***Fatupaepae* –** womens (mothers) group
  - *Taulelea* - married men and *Taumalo* - unmarried men
  - ***Toeinga*** – elders
  - ***Kau talavou*** – youth and school children

- **General Community Meeting –** A full community meeting was held at the end of the surveys to provide immediate preliminary feedback on the findings of the surveys, to reconfirm the issues and concerns raised and to provide a brief overview of the resource status. Broad concepts for the Management Initiatives proposed here were presented. These meeting were well attended and also broadcast by radio throughout the community.

Community Consultations

Issues raised

- Depletion of marine resource stocks.
- Recent depletion of certain resource stocks.
- Poor enforcement of traditional management system.
- Concern with commercial harvesting.
- Lack of general knowledge of reef biology and life histories.
- Lack of legislative support.
- The need for ordinances to support and 'back-up' traditional law.

- **Local Government -Atoll Council** – the ***Taupulega* -** This group is required to take a lead role in establishing atoll ordinances, enforcing protocols and increasing public awareness.

- **National (*Fono)* and Regional Government -** government agencies that provide advice and support to the atolls. National government agencies need to actively assist the Council and the community in managing natural resources by providing advice and expertise on a wide range of legislative and environmental resource management issues. Leading roles will need to be taken by SPC and SPREP to assist.

Government Consultation

Issues raised

- *Role of government agencies in the resource management.*
- *Depletion of marine resource stocks.*
- *Balance between commercial activities and resource depletion.*
- *Need for development opportunities.*

All efforts were taken to ensure widespread consultation with all these groups to make sure that all concerns and issues were considered and to ensure there was widespread ownership of the process and thereby the proposed management initiatives.

Ecological Surveys

Ecological surveys were conducted using both quantitative (standardised sampling techniques) and qualitative (descriptive) approaches. Significant and valuable use was made of the local information and knowledge offered to the team during initial consultations.

Sampling techniques were mainly confined to broad scale surveys using the manta tow technique, and also finer scale surveys (timed swims in the lagoon or slope, walking transects on the reef flat). Standard sampling techniques were used so that meaningful comparisons could be made about the presence and abundance of indicator species of the reef system (including density estimates for specific reef species; distribution patterns, relative presence / absence or broad relative abundance category estimates; and the presence and distribution pattern of disturbance indicators.

This methodology does not allow for the establishment of fishery stock calculations (standing stock or biomass) though the methodology does lend itself to the broad assessment of the status of resource stocks. The assessment approach adopted was considered the most appropriate to yield a holistic assessment of the general health of the ecosystem and major reef populations with the time and resources at hand, to support decision making with regard to recommendations on future best management options. Extensive use was made of photographic and video records so that permanent records were obtained of the major habitat features and major species present.

Two sites were assessed using rigorous quantitative assessment methods to establish permanent monitoring sites for the slope habitat. One site was established in the western slope of the Te Ahaga Loa Conservation Area, and a comparative site was established some 500 m south of this site, outside the Conservation Area and south of the harbour entrance.

1.3 Previous Studies

Prior to the 2003 rapid marine assessment no thorough inventory of Tokelau's marine resources had been conducted. The only know previous inventory of inshore resource in Tokelau was a limited survey undertaken in 1998 by Kelvin Passfield. This inventory however is limited in that it only focused on Fakaofo. A more general report on the effects of cyclone Tusi (1987) for all three atolls was conducted in 1987 by Pierre Laboute

The following compilation of studies, reports and papers on Tokelau are also relevant and were closely consulted during the development of the project.

Anon. (1991) Matagi Tokelau: History and traditions of Tokelau. Apia, Samoa, Office for Tokelau Affairs & Institute of Pacific Studies, University of the South Pacific. Gillet R. 1985 Traditional Tuna Fishing in Tokelau: Topic Review Number 7: South Pacific Regional Environment Programme

Hooper, A. (1983). Tokelau Fishing in Traditional and Modern contexts. The Traditional Knowledge and Management of Coastal Systems in Asia and the Pacific: Papers presented at a UNESCO-ROSTSEA Regional Seminar held at the UNESCO Regional Office for Science and Technology for Southeast Asia 5-9 December 1983. K. Ruddle and B. Johannes. Jakarta, Indonesia, UNESCO. **1**.

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SPREP 1994 A Waste Management Study for TokelauTokelau Government 1995. Tokelau marine Conservation Area Project: Concept Proposal – A submission to the South Pacific Biodiversity Conservation Program. Environment Unit, Division of Natural Resources and Environment, Government of Tokelau.

Tokelau Government 1995 Tokelau marine Conservation Area Project: Concept Proposal – A submission to the South Pacific Biodiversity Conservation Program. Environment Unit, Division of Natural Resources and Environment, Government of Tokelau.

Toloa, F., R. Gillett &M, Pelasio. (1993). 'Traditional Marine Conservation in Tokelau. Can it be adapted to meet today's situation?' Inshore Fisheries Research Project Technical Document No. 5. Workshop on People, Society and Pacific Islands Fisheries Development and Management: Selected Papers. SPC, Noumea, New Caledonia

2 ECOLOGY AND MARINE RESOURCES OF ATAFU ATOLL

2.1 Geography

Tokelau consists of three relatively small atolls that cover a total land area of approximately 12.25 sq km in an EEZ of 290,000 sq. km. The three atolls, Atafu, Nukunono, and Fakaofo are located at between $8^{0}20'$S, $172^{0}30'$W (Atafu) and $9^{0}\ 20'$S, $171^{0}15'$W (Fakaofo), with Nukunonu approximately midway between the other two atolls (Figure 1). Fakaofo, the southernmost atoll is 65 km from Nukunono, with a further 105km to Atafu, the northern most atoll. The country lies approximately 500km to the north of Samoa, 600km west of Pukapuka in the Cook Islands and about 100km north east of Tuvalu. The three atolls are orientated along a south east to north east axis. The absence of an airport or airstrip on any of the atolls makes the territory one of the most remote countries in the South Pacific.

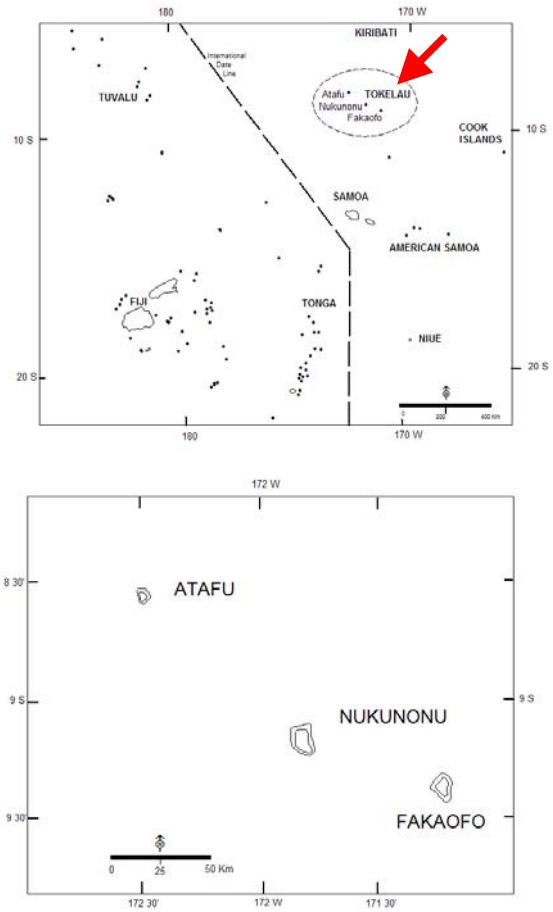

Figure 1. Location of Tokelau in the Pacific and relative location of the three atolls.

2.2 Environmental Conditions and Biogeography

Tokelau sits in the path of slow moving easterly flowing Southern Equatorial Current. The predominant winds for most of the year are the NE Trade Winds with the SE Trade Winds common in July (SPREP 1994). The strength of the ocean currents vary from 0.75 – 1.0 knots for most of the year but are relatively slower in November – December at an average of 0.5 – 0.75 knots. These currents can vary substantially within any given month and can increase up to 2 – 3 knots. Mean sea surface temperatures are between 28^0 C and 29^0 C throughout the year.

The three atolls of Tokelau are 65 to 95 km apart (Fakaofo to Nukunonu, and Nukunonu to Atafu, respectively), making them relatively isolated from each other. This geographical isolation, both from a regional perspective and relative to the other atolls of Tokelau is of major significance for the maintenance of ecological systems in Atafu as discussed in this section.

Motus or Islets

Atafu atoll is relatively small in total area compared to many other inhabited Pacific Ocean atolls. The land area of Atafu consists of about 40 small motu surrounding a rectangular reef approximately 6 km in its longest axis (approximately south to north) and 6.5 km wide (approximately west to east) (Figure 2). The total land area of the motu is only about 3.5 sq km. With their linking reef system, these encircle a large lagoon of about 17 sq km. Individual motu vary greatly in size (from 4 km to less than 90m in length, measuring parallel to the outer reef edge) and none are greater than 5 m above mean sea level. Most motu have extensive accumulation of shifting coral sand around the intertidal shoreline and more permanent sand deposits above high tide levels. The intertidal and littoral sand beaches form a veneer on top of solid beach rock which is periodically exposed and buried according to the seasonal shifts in sea conditions. The permanently exposed portions of motu are heavily vegetated by coconut trees in addition to pockets of natural vegetation, but soils are poorly developed and highly porous. Storm surges during cyclones frequently result in waves sweeping across the motus and into the lagoon.

The main Atafu Village, which houses the entire atoll population is located on the island of Vao. The island also house a significantly large communal piggery which is situated on the north end of the island. Atafu is the second most populous of Tokelau's Atolls, with 499 people (SPC 1998).

Erosion of the shoreline on Atafu was not obvious nor was there particular concerns raised on the issue during consultations. However, beach sand was thought to have reduced in volume on the main island of Atafu, possibly due to use for construction purposes. Building material f sand, rubble, and even coral rock is obtained from uninhabited motu along the southern atoll edge (Te Atu Hafea, Figure 3). Significant reef and coastal alteration due to major cyclones appears to be most pronounced in the northern and western sections of the atoll. This is very similar to other island states in this part of the Central South Pacific (for example in Samoa and Niue, Fisk pers.obs.)

Lagoon

Atafu lagoon is a partially open lagoon with small steep sided patch reefs scattered throughout the western lagoon which are surrounded by deep water. The lagoon does not have any deep water passages to the open ocean (Figure 2). The only significant water exchange between the lagoon and the open sea occurs through tidal inundation of the reef flat and from water that is pushed over the crest by oceanic waves and swells. Multiple shallow passageways between motu transfer water between the lagoon and the open ocean. None are deeper than approximately a meter at low tide and most are no wider than approximately 50 m.

The central and north-western sectors of the lagoon are subdivided into a series of wall reefs that run approximately south-west to north-east with interconnecting walls running south-east to north-west. These walls create semi-enclosed lagoon cells which impede water flushing in the lagoon. The most enclosed lagoon area is located behind (to the north of) Tenualoa Island at the southern tip of the atoll. Figure 2 shows the scattering of patch reefs within the lagoon, and indicates the areas of low flushing. The most well flushed open section of the lagoon is located along the southern atoll margin (Te Atu Hafea). The western margin (Te Alofi) is the least developed sector of the reef flat with respect to motu and exposed rock formation, and would therefore be most exposed to tidal flushing, but the lagoon in this area is partially sealed off by the presence of the wall reefs.

The closed nature of the lagoon means that the removal of waste and toxic substances will be very slow. These will possibly remain in the deeper parts of the lagoon for a considerable time (than would occur in a more open lagoon system). Naturally occurring conditions, such as elevated sea temperatures during prolonged dry and calm weather, will also persist inside the lagoon for longer than normal periods. Therefore the lagoon is highly susceptible to natural disturbances as well as to human induced ones, such as toxic substances from ship groundings, and land based sources of pollution. The potential for overheating of lagoon waters that can result in coral and other organisms becoming bleached and possibly dying is very high because of this lack of exchange of water with the open ocean.

The closed and segmented nature of the lagoon has implications if fishery species for mariculture are introduced (as was discussed by the Taupelega). High density mariculture of molluscs (pearl shell, clams) produces high nutrient loads in the surrounding water that can kill the animals if water exchange is not sufficiently high to remove these potentially toxic substances. Trochus (*Trochus niloticus*) culture is different in that animals require the reef flat and crest habitat to live where there is very high water rates of flusing. The success of previous attempts with trochus and pearl oyster introductions is discussed below in the status section.

The lagoon has steep edges along the southern outer perimeter that drop away into deep water from 40 to 70 m depth from the inner reef flat. The inner reef flat is either composed of conglomerate coral rock or loose rubble. The lagoon is extremely shallow in places around the margin, particularly the northern (Ahaga Loa) and eastern (Motu Hafataga) margins where there are extensive shallow sand flats.

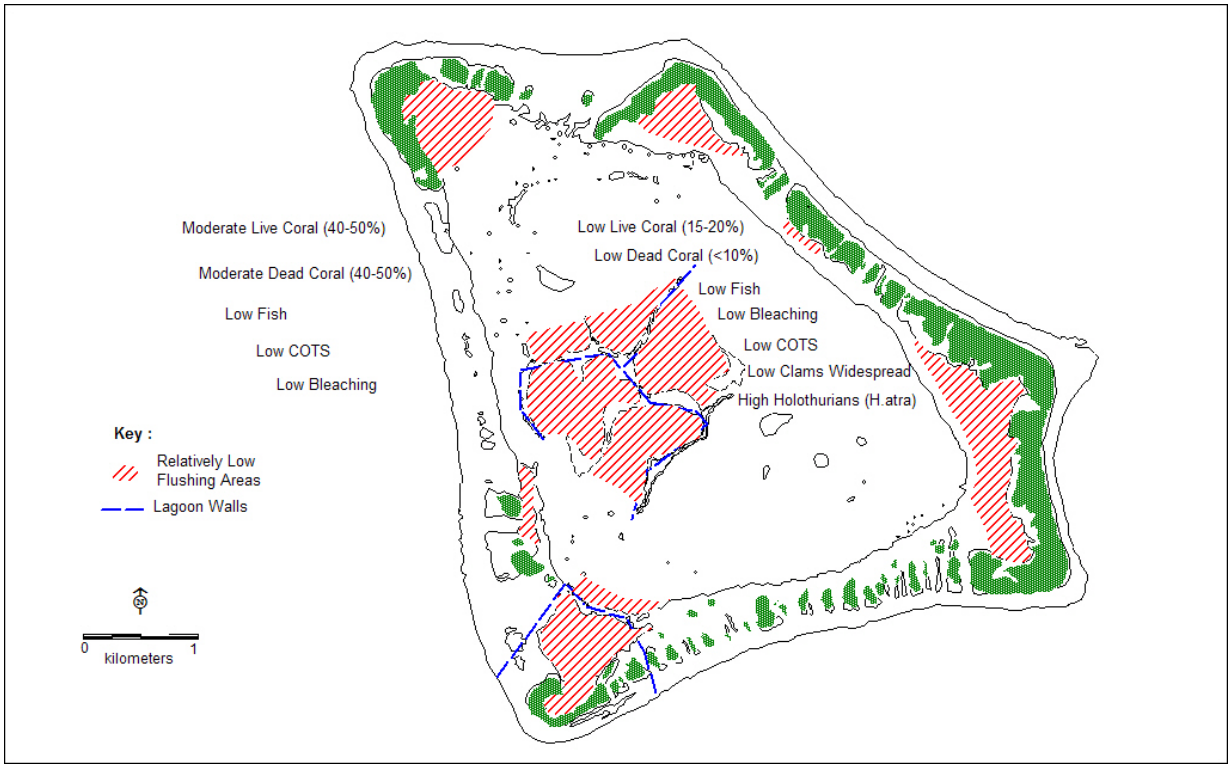

Figure 2. Atafu Atoll resource status summary and physical characteristics of the lagoon (note semi enclosed lagoon cells and low flushing zones within the lagoon).

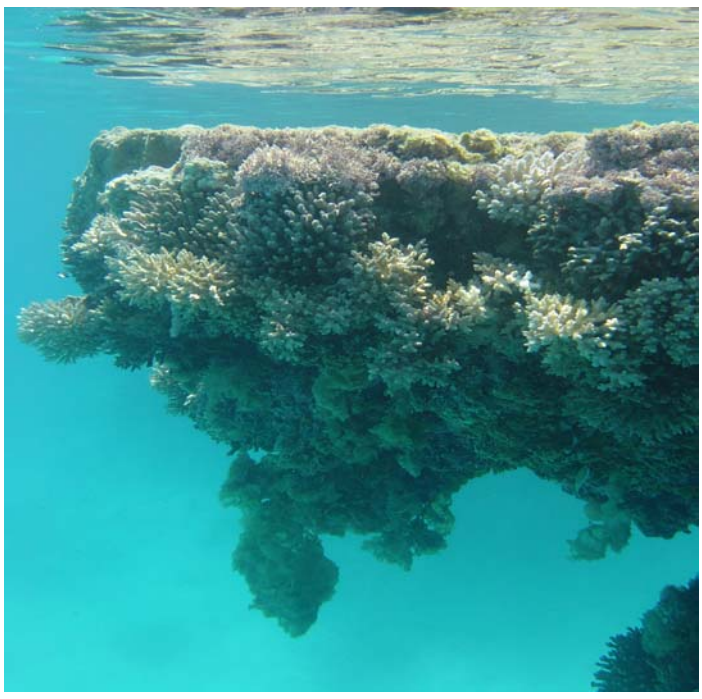

Photo 1. Patch reef growth has extended the upper surface out from the sides of the patch reef, creating a wide overhang. These overhangs are unstable and eventually break off or are tossed up onto the top of the patch reef by large waves. The overhangs also tend to shade the sides of the patches, creating poor living habitat for many light dependent species.

Photo: Gordon LaPraik

The upper portions of the patch reefs frequently extend horizontally near the surface, giving a profile that typically shades the patch reef flanks (see photo 1 above). The flat tops and the crevices and holes under the overhangs offer refuge for many reef organisms. Eventually these

upper portions collapse under their own weight or are dislodged during storms to fall to the base of the reef or are thrown up on top of the reef.

Photo 2. A piece of reef tossed up onto a lagoon patch reef becomes a roosting place for white capped noddy terns. The shallow near surface portions of reef surfaces in the lagoon can be seen coloured pink by the dominant coralline algae growing on the top surface.

Photo: Mary Power

The shallow embayment adjacent to Vao and Kokoloa Islands is a very turbid area which indicates that the water flushing is very low in these areas. Similar high turbidity areas are located in the southern semi enclosed lagoon cell behind (north) of Tenualoa Island and along the eastern lagoon edge adjacent to motus (Figure 2).

Fish abundances were generally very low in the lagoon, with the exception of areas along the lagoon edge which were adjacent to the shallow channels that allow movement between the lagoon and the open ocean. The higher fish aggregation areas adjacent to the channels may represent accumulation areas for fish intending to move through the channels out to the open ocean. The survey period (October – November) coincided with the time of year when many reef fish commonly undertake mass spawning (usually in areas adjacent to deep water and with access to the open ocean). Most fish observed in the lagoon were either the common herbivorous fish families of Acanthuridae or Scaridae along with typical site attached families[6] of butterfly fish, damsel fish and wrass species.

[6] **Site attached fish** refer to those fish groups that do not roam or move around the reef but remain within a small area for all or most of their lives.

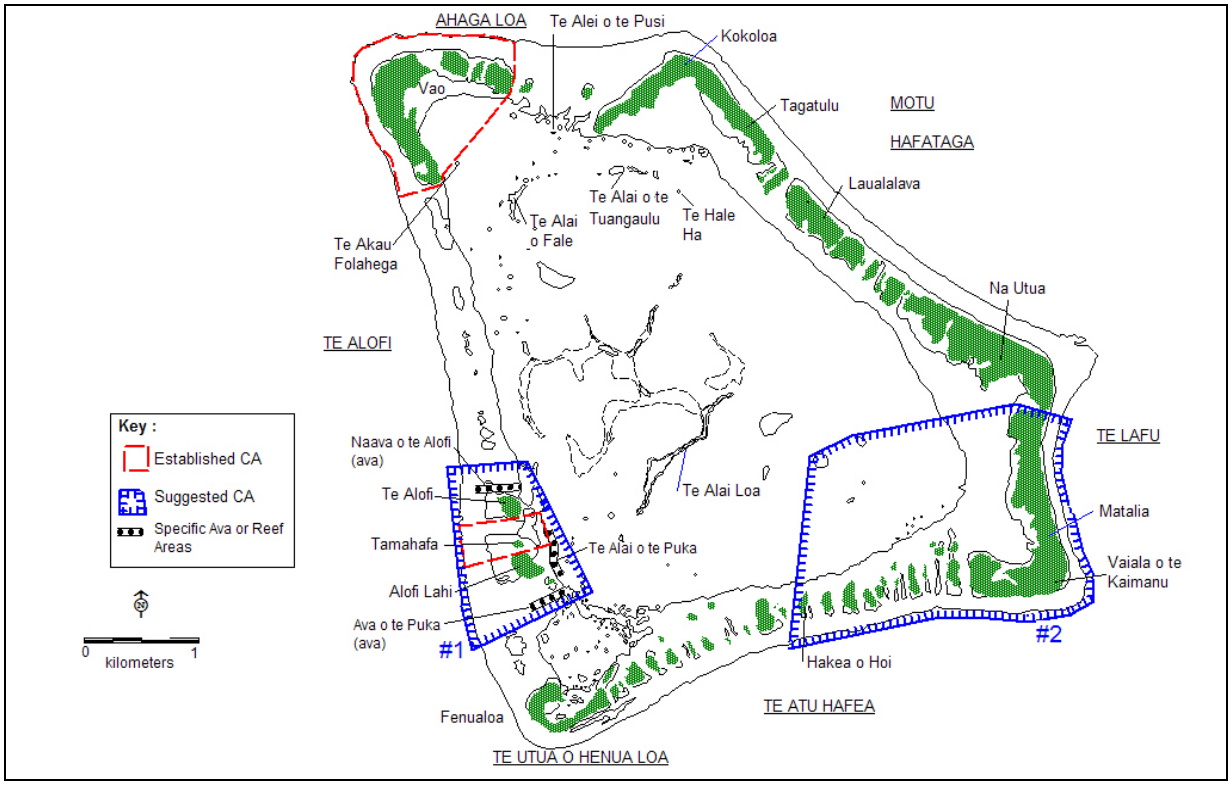

Figure 3. Existing Conservation Areas on Atafu Atoll and suggested new Conservation Area. A number of the more prominent landmarks that carry local names are also shown.

Photo 3. Motu and exposed reef flat with lagoon in the background and a number of distant motus. The reef flat is exposed at low tides and forms a barrier to the influx of ocean water during the low tide period.

Photo: Gordon Lapraik

Reef Flat

The reef flat is generally smooth with shallow pools and very little heterogeneity so does not provide good habitat (shelter) for reef animals. Portions of the east coast reef flat in particular have exposed hard rock surfaces that may represent former reef levels that have been uplifted and weathered smooth. The average height of the reef flat around the whole perimeter of the atoll is slightly above the normal minimum low sea level, providing an effective seal against the open ocean at low tide (see Photo 3).

The reef flat habitat typically shows a narrow set of zones commencing with the pink encrusting coralline algae zone on the crest and the outer flat area where the wave break occurs. A zone of encrusting turf and macro algae with some wave adapted coral growth forms is present behind the coralline algae zone moving inwards on the reef flat towards the lagoon. Some shallow depressions also occur in this zone but few are deeper than 20 cm depth. In places, these depressions also have short overhangs that extend up to 30 cm, offering some shelter for invertebrates (octopus, crabs, and crayfish) and fish.

The reef flat is frequently visited by schools of herbivorous fish and their predators including sharks, at high tide. The herbivorous fish exploit the abundant algal growth that is present here. These fish are forced to retreat down the slope or into the lagoon during the low tide periods because of insufficient water depth on the reef.

Reef Slope

The reef slope varies in steepness and therefore in the extent of shallow (<40 m depth) shelf area. Spur and groove formations are common in the upper 10 m depth range. The grooves are smooth and devoid of reef organisms except for turf algae. The upper surfaces of the grooves are well covered with robust coral colonies in particular. The highest fish densities are usually observed in the spur and groove zone where herbivorous fish are commonly feeding (especially at low tide). Strong wave action is common on the outer edge of the reef on all sides of the atoll. The dominant reef benthos on the slopes is very similar to what was described by Laboute in 1987. There is a dominance of branching *Pocillopora* spp and *Porites* spp with relatively less cover of encrusting and foliaceous *Montipora* spp and low cover of *Acropora* spp, *Hydnophora* spp, *Pavona* spp, and *Millepora* spp (Photo 5). All species present are resistant to strong wave action even though they present very different growth forms.

The overall profile of the reef slope is smooth and undulating with frequent depressions running perpendicular to the reef edge. The calcareous macro algae *Halimeda* spp is the most common algae in crevices and cracks on the shallower slope areas. Fish densities can vary greatly in the mid slope zone but commonly the site attached fish groups are most abundant such as butterfly fish, damsel fish, angel fish, wrass, and (fewer) grouper species. Large schools of predators are occasionally encountered, particularly on the acute angles or corners of the atoll perimeter. These corners were also where many sharks and large predators such as barracuda were found. The corners of the atoll are probably attracting these predators because they are zones of tidal convergence and therefore places where food supplies converge, setting up a food chain that attracts the predators in high numbers. The timing of the survey team's visit also coincided with the annual early summer fish spawning period and spawning aggregations were sometimes observed at these corner locations.

Photo 4. Typical spur and groove formation on the upper slope crest wave break zone. Grooves are used by many fish as feeding locations as well as refuges, and as entrances to the reef flat. The grooves are where large boulders and broken coral move out to deeper water in high wave conditions, making the walls of the grooves smooth from constant erosion, which in turn is good habitat for turf algae on which the herbivorous fish feed.

Photo: Gordon LaPraik

The outer slope tends to drop away very steeply to deep water at approximately 30-40m depth. At the edge of the drop off, the dominant coral form was planular, with massive plates of *Porites* spp that occurs as large hemispherical colonies in other habitats.

Photo 5. Mid slope scene on Atafu Atoll with a mixture of dead coral and live coral forms. Most dead coral are *Pocillopora* spp with live flat *Porites* spp and foliose *Montipora* spp that is rapidly growing and starting to take over the areas where dead coral is present.

Photo: Gordon LaPraik

2.3 Resource and Habitat Accessibility

The relationship between the coral reef and the people who depend on its resources is complex. It is a relationship highly dependent on (safe) weather conditions, the level of technology available and the knowledge of the community regarding the cycle of availability of various species. For example, access to outer reef resources is extremely weather dependent as, due to steep drop-off, reef species can only be harvested close in to the reef edge where the strong oceanic swells impact. In contrast, while offshore pelagic[7] fishing is also weather dependent, this restriction can be partially overcome if relatively large seaworthy boats are used. There is a limitation however to the use of large modern boats in Atafu and Tokelau generally, because they cannot be safely moored or launched from the shore due to the exposed position and the lack of access to a safe lagoon anchorage.

In contrast, lagoon resources are accessible all year round. However, sectors of the lagoon distant from the centralised village still require special effort and / or mechanized boats, increasing the costs of accessing the resources and generally limiting resource harvesting. The effect is evident in the distribution of many fishery species within the Atafu lagoon (see Ecosystems and Resources below).

The internal structures of Atafu lagoon also restrict access to sections of the lagoon. These internal walls effectively partially seal off portions of the lagoon at low tide (particularly in the central and southern areas). The effect of these structures is to restrict boat access to some sectors to high tide periods. Walking around the exposed reef flat at low tide can be an alternative way of accessing distant locations, but this will be controlled by the tidal cycle that will restrict the distance that can be travelled in a single low tide period or will require temporary stays on distant island.

Reef flat resources are readily accessible at low tides (with the limitation of tidal periods mentioned above) but the extent of target resources here is limited due to degree of tidal exposure to air and the shallow depth characteristics of most of the depressions in the reef flat.

Mobile species move in and out of the lagoon and on and off the reef flat through shallow channels, but this concentration of mobile species to well defined and accessible areas make them extremely vulnerable to harvesting. Obviously the people of Atafu have a wealth of traditional knowledge of the seasonal movements of fish in particular and also where the different species tend to be most prevalent when utilizing the channels.

2.4 Resource Management

The limited land area of Atafu has meant the community is highly dependent on the marine resources of their lagoon and the surrounding ocean. Despite Tokelau being an associated territory of New Zealand[8] and having regular transport to Samoa, Atafuans remain highly dependent on their marine resources for subsistence.

[7] **Pelagic** fishing targets fish species that live in the mid water away from the shallow reef areas, though the presence of a reef often provides a reference point and water movements that create food chains that are attracted to the food that is brought to the surface from these currents.

[8] Tokelau became a British protectorate is 1877 when Britain included Tokelau in the boundaries of the Gillbert and Ellice Island colony. In 1925 the British government transferred administrative control of Tokelau to New Zealand. Formal sovereignty was transferred to New Zealand under the 1948 Tokelau Act. (Statistics NZ 1993).

Marine resources in Atafu are open to access to by all. Traditionally the management of atoll resources lies in the hands of the *taupulega*, the atoll Council. Restrictions on resource harvesting are put in place at certain times depending on the ruling of the *taupulega* (usually related to drought, bad weather and special occasions) and post-harvest rules exist for sacred species (i.e. turtles must be shared with the whole village). Permanent harvesting bans however did not traditionally exist.

Traditionally the isolated conditions of the Tokelauan society, the limited land for population growth and warfare probably negated the need for restrictions on harvesting marine resources due to functionally unlimited marine fisheries (Johannes 2002). It appears traditional fishing gear, lack of freezers, no regular transport to Samoa along with the *inati*[9] system and the *taupulegas*' rule, enabled to a certain degree the sustainable use and management of the atolls limited resources.

Growing individual expectations are increasing the pressure on Fakaofoans to accumulate possessions and therefore cash. This factor, coupled with the introduction of freezers, regular transport to Samoa and modern fishing gear, has increased the pressure on fisheries resources. Motorised boats, (removing the restriction of wind or weather factors to some extent), have enabled villagers to fish when it is convenient, more frequently and over greater distances thereby increasing fishing pressure. Local opinion on the status of marine species indicates that the impact of the motorised boat in Tokelau has had a large socio-economic, cultural and environmental impact.

Current and historical resource management practices based on (traditional/living) ecological knowledge:

- *Lafu:* a temporal restriction on harvesting. According to respondents it was mainly a terrestrial-based management strategy, imposed by the *taupulega* and something generally that people has not been practiced for some time;

- *Fakahao* (no-take area): this interpretation of the 'western' conservation area concept represents a modern approach to resource management. Site selection is not necessarily aimed at protecting specific habitats or species, but at increasing resources for future harvest;

- Targeting older individuals of a particular species and leaving the young: according to community members this is not a rule but a general practice, however it depends on the individual and is often not followed;

- Protection of vulnerable life history stages: no respondents mentioned this as a currently practiced management system;

[9] Traditional institutionalised sharing, where every member of the village (infant, child, adult and elder) receives and equal portion of harvested resource i.e. fish, coconut etc.

- Territoriality[10]: marine ownership and resource rights (offshore and lagoon) are restricted to Atafuans, outsiders must gain permission from the *taupulega* to harvest resources;

- Traditional knowledge and expertise: Master fishermen (*tautai*) and *toeigas* once possessed in-depth detail knowledge of the relationship between specific marine species (their lifecycle and behaviour) and the lunar cycle. This knowledge was essential to successful fishing. These days however this knowledge is not as vital due to new fishing technology, cash economy and improved transportation; and

- Communal ownership of land: a few pieces of land are set aside as communal land. This land is used as a reserve area and probably formed an important component of the atolls resource management.

The main form of 'conservation' referred to in text and by practitioners is the '*lafu*' system. This is a restriction imposed by the *taupulega* over a particular spatial area for a short-time period (i.e. 4-6 months). All resource harvesting is prohibited within the lafu area unless otherwise specified by the *taupulega*. Toloa, Gillet et al (1993) describe the lafu system as a management prescription that bans all types of fishing in a specific area of the reef. However, in our recent investigation participants felt that *lafu* was something only ever applied to the terrestrial environment[11]. *Lafu* was imposed on land when resources were scarce such as post-cyclone, or in preparation for a special occasion when bulk resources would be needed (therefore the *lafu* acts as a larder) and at other times when there was a reduced abundance in a particular resource. In the past it appears this system was extremely important, now however according to Atafuan, it is something that is considered an 'old way', recalled from childhood and something that was land-based.

It has been asserted in the past that offshore fishing is encouraged in Tokelau, subsequently protecting inshore (lagoon) fisheries (Toloa, Gillet *et al* 1993). We found lagoon fisheries were preferred by community members in Atafu, and fishing effort was relatively evenly distributed (between offshore and the lagoon) according to workshop participants and respondents. This could however reflect the time of year in which the investigation was conducted. It may also however be the result of a change in practices and new technology. For example, according to participants there is a reduced reliance on fisheries resources due to the availability of imported goods. It may also reflect the reduced emphasis on the '*tautai*' and the previously elevated status in tuna fishing. In Tokelau social status was gained through the possession of this knowledge as well as through demonstrated skill in utilising this knowledge. In a traditional Tokelauan society, a tautai was highly respected and needed[12].

Conservation Areas

Currently there are two "no-take" or '*fakahao'* (conservation) areas in Atafu. The main one is a marine no-take area surrounding the village islet (with the exception of the islet shoulders). All

[10] The traditional community-based fisheries management system in Tokelau is similar to other parts of the pacific, defined by common property regimes where access to a particular territory is limited to a defined user-group and control of resource use and access resides in traditional local authorities (Ruddle 1998).

[11] i.e. "just on the land not sure about the sea… I remember in the old days the toeiga put a stop to going to that area for a period of time, just like conserving for sometimes… *"* (FI12).

[12] The deterioration of traditional fishing skills and the lack of emphasis placed on the development of a fisherman into a tautai has had a negative impact on marine conservation in Tokelau according to Toloa, Gillet et al. (1993).

resource harvesting activities are prohibited in this area unless otherwise directed by the *taupulega*, with the exception of shark harvesting for safety reasons. The other *fakahao,* Matiti School Marine Conservation Monitoring Project, is situated in the mid western atoll margin between the motu's of Te Alofi, Tamahaka and Alofi Lahi. This no-take area is specifically for clams and is managed by the school for educational purposes. See Map 2.

Based on data from interviews and meetings, the main purpose of the Conservation Areas from the community's perspective, is to improve the marine resources of each atolls lagoon as opposed to (a western protected area aim of) improving biodiversity and ecosystem function. This does not necessarily inhibit the effectiveness of the Conservation Areas. A no-take conservation area of the right design and management can contribute to both sustainable fisheries and protection of the area's biodiversity and ecosystem function. However the Atafu Conservation Areas lack effective management in the form of clear vision, appropriate design and position, management, community commitment and a concerted attempt at compliance and enforcement,. It appears the general community has not been able to conceptualise the conservation area ideal beyond a communal fish larder.

2.5 Ecosystem and Resource Status

2.5.1 Habitat Characteristics

Underwater visibility is an indicator of relative turbidity or the amount of material that is suspended in the water. At Atafu, the outer slope manata-tows all generally recorded good visibility (defined as 13 to 18m of vertical clarity), compared to the lagoon where visibility was generally good to medium (6m to less than 12m vertical clarity). The variation in the clarity of the lagoon water is due to the relative degree of flushing of lagoon waters as is outlined in the sire description above. In some sections of the lagoon, the visibility was much less than 6m, especially on the lagoon perimeter adjacent to the larger motu where the turbidity levels can be very high, with a dense suspension of fine mud or clay occurring naturally in the water.

Photo 6. Sponges (like this very common yellow-orange coloured species) are a very common feature of the lagoon which is indicative of abundant microscopic food for these filter feeders, despite the absence of strong water flows.

Photo: Gordon LaPraik

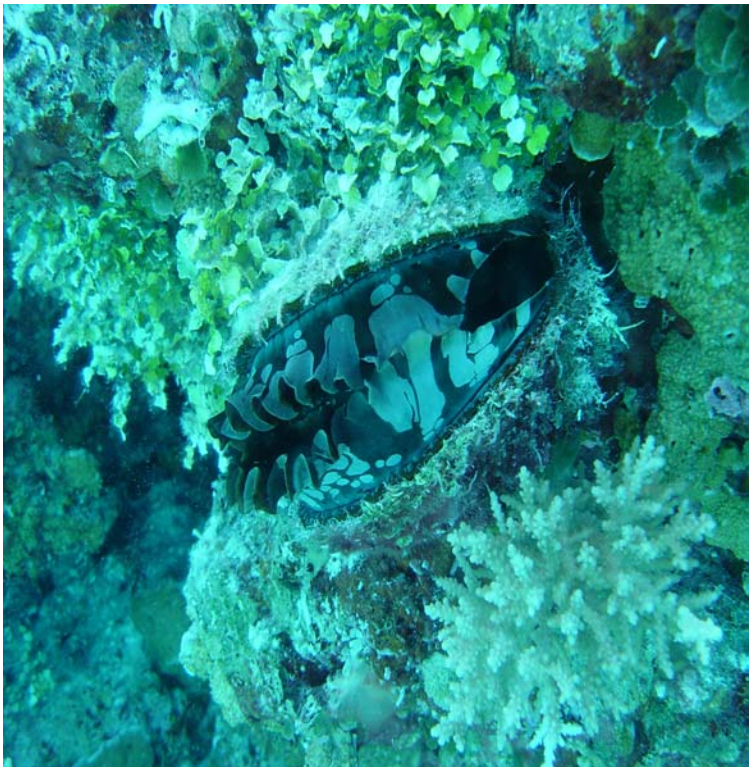

Photo 7. The spiny oyster *Spondylus* spp, is very common on the lagoon patch reefs. Here a common lagoon macro algae, *Halimeda* spp surrounds the oyster on a patch reefs that has relatively clear water turbidity.

Photo: Gordon LaPraik

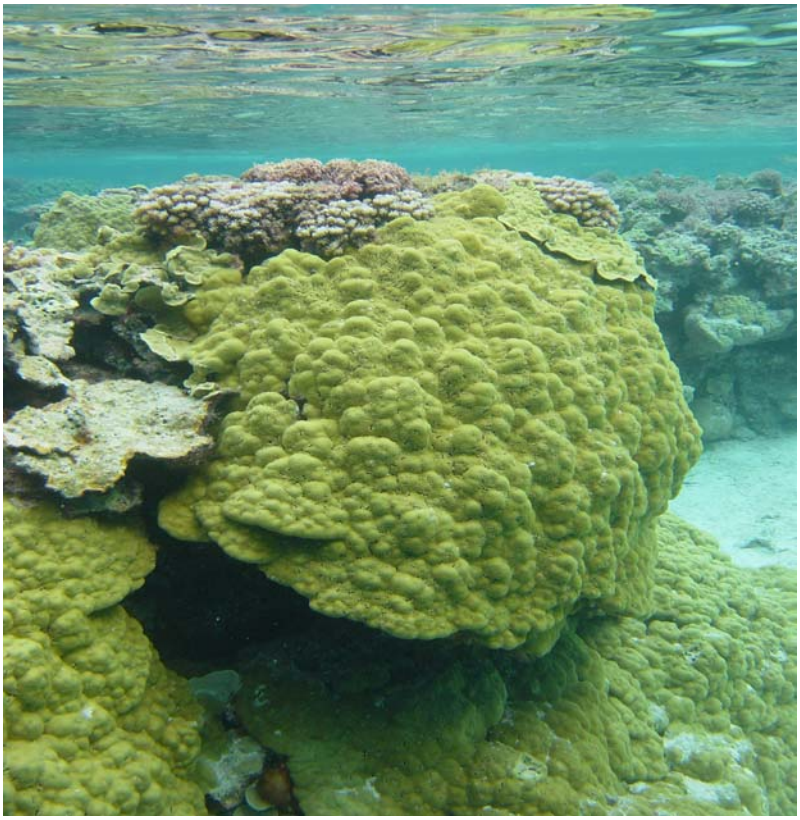

Photo 8. A *Porites* spp coral dominated patch reef showing a multitude of small holes which are the entrances to live boring date mussels (*Lithophaga* spp). The date mussels are extremely abundant throughout most of the lagoon except for the most turbid areas.

Photo: Gordon LaPraik

The broad assessment of the type of live organisms (Table 1) that were present in the lagoon and outer slope showed that live coral was dominant in approximately 72% of all tows from both habitats, with 100% of tows in the lagoon and 55% of tows on the outer slope dominated by live coral. The lagoon habitat also has a benthos composed of filter feeding invertebrates, sponges, bivalves, and ascidians[13](Photo 6). Significant filter feeding organisms other than sponges include the spiny oyster (*Spondylus* spp, Photo 7) and other bivalves (especially the boring date mussel, *Lithophaga* spp).

Habitat	Benthos					# Tows
	ASC	CA	LC	MA	SP	
Lagoon	0.0	0.0	100.0	0.0	0.0	17
Slope	0.0	37.9	55.2	6.9	0.0	29
Combined	0.0	23.9	71.7	4.3	0.0	46

Table 1. Summary of habitat dominance in terms of percentage of tows for broad scale tows in the lagoon and outer slope habitats of Atafu Atoll. ASC = Ascidian, CA= Coralline algae, LC = Live Coral, MA – Macro algae, SP = Sponge.

Tows from the slope habitat also recorded high numbers of sites with a dominance of either coralline algae (38 % of tows) or macro algae (7 % of tows). The dominance of coralline algae was a consequence of the widespread death of the previously dominant live coral which has subsequently been colonized by coralline algae. Macro algae were also very common in places, with *Halimeda* spp the most dominant species (Photo 7).

2.5.2 Biotic Characteristics

Hard Coral

There are approximately 70 to 80 species of hard coral species present on Atafu shows that. Within this suite of species there is a clear dominance of a small number of species. A few species of *Pocillopora* spp dominate the outer slope, with less than six species of *Montipora* spp (Photo 9) present, in addition to 2-3 species of *Porites* spp. In the lagoon, where coral diversity is higher than the outer slope and reef flat, similar *Porites* spp to those present on the slope are dominant (Photo 8), followed in relative abundance by *Acropora* spp, *Cyphastrea* spp, and *Echinopora pacificus*. There is also the likelihood that a number of rare species are present that have not previously been recorded from the Pacific Ocean or from the Central Pacific Ocean, and that there may be one or two coral species new to science. These records are awaiting confirmation of their identities from experts in coral taxonomy and so these conclusions should be treated as preliminary findings at this time.

[13] **Filter feeding invertebrates** are animals that attach to the substrate and feed exclusively by drawing water through their gills and filtering out edible particles that are floating in the water. Live corals can also utilize this food source though most energy requirements are obtained by the corals living in association with microscopic algae.

Photo 9. A typical slope coral community with mostly dead *Pocillopora* spp (branching coral in photo) and live foliose *Montipora* spp (foreground, mid right hand side and background). A representative number of slope fish species (black surgeon and butterfly fish) are also shown in the photo. Photo: Gordon LaPraik

Dominant live coral growth form was assessed as an indicator of the type of habitat that was present for other reef organisms that associate with different coral forms (Table 2). Growth form is also an indicator of natural environmental conditions that occur in a particular area[14]. The results indicate that in the lagoon, encrusting and massive coral growth forms are clearly dominant, whereas on the outer slope, foliose and branching forms dominate. In addition, the lagoon coral community is made up of branching (corymbose) *Acropora* spp forms which dominate the upper sections of patch and wall reefs. The massive growth form was relatively low in abundance on the slope compared to other more dominant forms, however, it was very conspicuous especially on the mid to lower slopes. The massive growth form on the outer slope is probably more accurately described as a flat or plate like form whereas the lagoon massive form is the more typical hemispherical form. The domination of massive and encrusting forms in the lagoon indicate that relatively high sedimentation (or turbidity) is occurring compared to the outside slope, where strong wave action and water flows are normal.

[14] Different **coral growth types** can indicate the degree of turbidity (therefore light conditions) or sedimentation, wave action, and water flow as their growth rates and ability to survive in varying conditions are influenced by the natural environmental conditions.

Habitat	Coral Form								
	ACB	ACC	BRA	ENC	FOL	MAS	POR FLAT	SUB	Total
Lagoon	0.0	17.6	0.0	41.2	0.0	41.2	0.0	0.0	17
Slope	0.0	0.0	51.7	0.0	41.4	3.4	3.4	0.0	29
Combined	0.0	6.5	32.6	15.2	26.1	17.4	2.2	0.0	46

Table 2. Summary of dominant growth forms from manta tows conducted in the lagoon and outer slope habitat. ACB = *Acropora* branching; ACC =*Acropora* corymbose (thick pillow shape); BRA = Other branching corals; ENC = Encrusting; FOL = Foliose; POR FLAT = Flat plate *Porites*; SUB = Submassive.

The mortality index for coral was far higher on the slope, 0.44 per cent, than in the lagoon, 0.13 percent indicating that thee has been a much higher occurrence of recent coral mortality on the slope. Estimates of coral cover and a mortality index (or health index) from manta tows (Table 3) show low live coral cover in the lagoon (23 %) compared to the slope (42 %), and dead coral cover of 3 % in the lagoon compared to 42% on the slope. Soft coral was extremely rare in all habitats and was not recorded from any of the survey sites, though incidental observations were made of the presence of small colonies in a few slope sites.

TOWS	%LC	%DC	%SC	MI
Lagoon	22.7 (9.0)	3.0 (0.1)	0.0 (0.0)	0.13 (0.14)
Slope	42.2 (28.5)	41.6 (36.3)	0.0 (0.0)	0.44 (0.34)
Combined	35.0 (25)	27.3 (34.3)	0.0 (0.0)	0.33 (0.32)
SWIMS	**%LC**	**%DC**	**%SC**	**MI**
Lagoon	14 (10)	4 (2.6)	0.0 (0.0)	0.23 (0.1)
Slope	60 (26)	22 (15)	0.0 (0.0)	0.29 (0.16)
Combined	37 (30)	13 (14)	0.0 (0.0)	0.26 (0.13)

Table 3. Summary of manta tow and timed swim mean (and standard deviation) estimates of live coral (LC) cover, dead coral (DC) cover, soft coral (SC) cover, and a calculated mortality index (MI) based on the dead to live coral cover ratio. Number of lagoon manta tows = 17 and slope tows = 29. Number of lagoon swims = 5 and slope swims = 5.

Estimates of coral cover from timed swims (20 mins / swim) in both lagoon and slope habitats are also included in Table 3. Mean estimates for the percent cover of live coral for the lagoon sites differ between tow and swim methods. This difference is probably due to the fact that the swim surveys resulted in a better view of the sides of the patch and wall reefs that were not as visible from the surface during tows. Towing with a boat also required that the boat avoid very shallow areas so the tows tended to be undertaken in relatively deeper water than the swims, and as there was a rapid diminution of coral cover with depth in the lagoon, the two methods would be expected to differ.

Macro Invertebrates

Macro invertebrate distributions showed a relatively low presence of clams and selected filter feeding invertebrates (restricted in this survey to filter feeding bivalves, (*Spondylus* spp, spiny oyster, sponges and ascidians). Clams are discussed in more detail below but as was the case from the manta tows, most clams were observed inside the lagoon with 42.9 % of timed swims (total of 14) recording the presence of clams. Sea urchins were not recorded in either the lagoon or slope tows. Other invertebrates, especially Asteroids (starfish), were extremely rare in the lagoon and on the outer slope. Very low densities of crinoid starfish were observed on overhangs of lagoon patch reefs while none were observed on outer slope sites.

Holothurians were recorded in approximately 76 % of tows in the lagoon (65 % with high abundances, and 12 % with low abundances, number of tows = 17). None of the slope tows recorded the presence of holothurians (number of tows = 29). Most of the holothurians observed in the lagoon tows (Table 4) were from a single species *Holothuria atra*. Very low abundances of *Bohadschia argus* were also observed in the lagoon, but not the green-black holothurian, *Stichopus chloronotus*, which was recorded to be common in a previous survey in 1987 (Laboute, 1987).

The small number of slope habitats surveyed by timed swims (N = 5) confirmed the general pattern from the more broad scale manta tows, with no clams, large sponges, or ascidians present, and with a very low frequency of holothurians. The holothurians observed in swims on the slope were relatively uncommon and in very low densities and were different species to those observed in the lagoon, namely, *Holothuria atra* was exclusively observed in the lagoon compared to *Actinopyga mauritiana* observed only on the slope (or outer reef flat).

HABITAT	MACRO INVERTEBRATE	No (% Tows)	TOTAL SITES
Lagoon	CLAMS	27 (87 %)	31
	HOLOTHURIANS	13 (76.5 %)	17
Slope	CLAMS	0 (0 %)	29
	HOLOTHURIANS	0 (0 %)	29
Combined Atoll	CLAMS	27 (45 %)	60
	HOLOTHURIANS	13 (21 %)	46

Table 4. Summary of manta tow data recording the presence of selected macro invertebrates. Number of lagoon swims = 15 and slope swims = 16.

Giant clams were present in 87 % of lagoon tows and in none of the slope tows. Giant clams (mainly *Tridacna maxima* were observed) were generally in low to moderate numbers and were mainly observed in the lagoon of Atafu during manta tow surveys (Table 5). The only other species of clam observed on Atafu were an occasional individual of *Tridacna squamosa*. Caution should be taken when interpreting these results for fishery potential as there is a very high standard deviation associated with the mean value, which means that the distribution of clams is highly variable (they are absent from large areas) over the whole lagoon. Clam densities per hectare are also highly dependent on the proportion of suitable hard substrate (comprised of shallow patch reefs) within the area.

	MEAN # INDIV. (SD)
Lagoon:	
Clams / Tow (SD)	12 (13)
Clams./Ha (SD)	96 (107)
Slope:	
Clams / Tow (SD)	0
Clams./Ha (SD)	0
Combined Atoll:	
Clams / Tow (SD)	6 (11)
Clams./Ha (SD)	50 (91)

Table 5 . The mean numbers of clams per manta tow and per hectare for the lagoon and slope habitats on Atafu Atoll. Number of lagoon manta tows = 31 and slope tows = 29.

Within the lagoon, densities of clams tended to increase further away from the principal settlement on the west side of the atoll. Estimates of densities were taken from a representative sample of 60 manta tows within the lagoon, which included a number of tows undertaken for the sole purpose of recording clam densities. Table 5 shows the clam density estimates from manta tows in the lagoon which averaged 12 individuals per tow (each tow covered approximately 3000m^2). The conversion of these densities to numbers of individuals per hectare is also presented in the table. It was estimated that the lagoon has overall densities of 96 clams per hectare but this scaling up needs to be treated with caution due to the aggregated nature of the resource.

Trochus (*Trochus niloticus*) was introduced to Atafu in the 1980's at one site on the south east reef flat (opposite the motu of Matalia). Extensive surveys of these two sites at very low tide revealed no individuals at the southern site though there were observations from villagers of a number of small trochus washed up on the beach in the area where the adults were introduced.

Fish Communities

The status of fish recorded in manta tow surveys (Table 6) did not vary in the lagoon with 100 % of tows with low abundances (less than a total of 100 fish per 3 min tow). On the slope, 93 % of tows recorded low fish abundances, and 3.4 % of tows each recorded medium (100-500 fish per 3 min tow), and high fish abundances (> 500 fish per 3 min tow).

Damsel fish are the most dominant family in the lagoon (65 % of tows) and surgeon fish the most dominant in the slope habitat (41 % of tows). The slope and lagoon communities showed a different range of species beyond the dominant family groups. In the lagoon, mixed families, usually a combination of parrot fish, surgeon fish and snapper, were equally the second most abundant (12 % of tows). This compares to the slope where trigger fish (38 % of tows) and parrot fish (10 % of tows) were the second and third most dominant families (respectively).

DOMINANT FISH GROUP:	Lagoon	Slope	Total
Butterfly fish	0	0.0	0.0
Damsel fish	64.7	0.0	23.9
Grouper	0.0	0.0	0.0
Mixed Families	11.8	0.0	4.3
Paddletail	0.0	6.9	4.3
Parrot fish	11.8	10.3	10.9
Rabbit fish	0.0	0.0	0.0
Snapper	11.8	3.4	6.5
Surgeon fish	0.0	41.4	26.1
Trevally	0.0	0.0	0.0
Trigger fish	0.0	37.9	23.9
Wrass	0.0	0.0	0.0
ABUNDANCE:	**Lagoon**	**Slope**	**Total**
High	0.0	3.4	2.2
Medium	0.0	3.4	2.2
Low	100.0	93.1	95.7
NUMBER OF TOWS	17	29	46

Table 6. The percentage of manta tows recording the dominant fish families and abundance categories in lagoon and slope habitats.

Photo 10. Solitary individuals or pairs of blue fin trevally (*Caranx melampygus*) were commonly observed on the slope.

Photo: Gordon LaPraik

Larger species (fish, turtles, sharks and dolphins) were also recorded (Table 7). Only very low numbers of black-tip sharks were recorded (3 % of all tows). Green turtles were occasionally observed, both in the lagoon and on the slope, but not during actual surveys. Most turtles were relatively small in size No other large species were observed during surveys.

SPECIES	LAGOON	SLOPE	TOTAL
Green Turtles	0	0	0
Black-Tip Shark	0	3 %	2 %0
Big-Eye Trevally School	0	0	0
Spinner Dolphin School	0	0	0
Barred Barracuda	0	0	0
Hump headed Wrass	0	3 %	2 %
NUMBER Of TOWS	17	29	46

Table 7. Percentage of tows from the lagoon and slope where large indicator species were observed.

Photo 11. A juvenile green turtle observed on the western slope among typical coral communities.

Photo: Gordon LaPraik

A checklist of fish species observed is presented in Annex 1. Some general information is included on habitats where each species were observed, their relative abundance, and their behaviour with respect to groupings. The fish species list indicates the relative paucity of predator fish species and the dominance of herbivorous fish, particularly, surgeon and parrot fish.

Specific fish species that were once abundant but are no longer commonly seen are the coral trout (*Plectropomus areolatus*) and the black trevally (*Caranx lugubris*). Both species were rarely seen during the surveys and the few observations were confined to isolated individuals in deep water on the lower slope (in >30m depths).

2.5.3 Disturbance and Health Indices

Mortality indices from the manta tow data show that there is a high proportion of dead coral in the slope habitat (MI = 0.44, Table 3). The lagoon surveys showed a relatively lower mortality index of 0.13. Much of the dead coral in the lagoon were either from the genus *Acropora* spp (corymbose or thick 'pillow' forms), *Stylophora* spp, or *Millepora* spp (branching forms). This selective mortality is consistent with mortality due to bleaching, and this correlates with information given to the survey team by villagers. Similarly, a high ratio of dead coral on the slope is most likely due to bleaching impacts in the recent past. In contrast to the lagoon, mortality on the slope was most pronounced in the dominant *Pocillopora* spp (particularly *Pocillopora eydouxi* and *P. cf indiana* or *P. cf zelli*), and has been very severe on *Acropora* spp plate colonies which are not present in the lagoon. Massive colonies of *Millepora* spp also were severely affected by the bleaching event and this species, along with *Acropora* spp, has been almost totally eliminated from the slope. Due to the drop in cover of the above dominant species, foliose *Montipora* spp are rapidly increasing in cover and are growing over dead colonies.

Photo 12. A colony of *Acropora* spp with crown of thorns feeding scar (pale section). A live colony of *Porites* spp is surrounding the recently eaten *Acropora*..

Photo: Gordon Lapraik

Natural disturbances to the coral reef (Table 8) of Atafu also are occurring from other factors in addition to bleaching, and include coral disease and feeding activities from a gastropod (*Drupella* spp) and from crown of thorns starfish (COTS, *Acanthaster planci*).

	BLEACHED	DISEASE	SCARS	DAMAGE	ALL	NO. TOWS
Lagoon	0	0.0	17.6	0.0	17.6	17
Slope	20.7	24.1	10.3	0.0	55.2	29
Combined	13.0	15.2	13.0	0.0	41.3	46

Table 8. Disturbance indices recorded from mant tows (% of tows) from the lagoon and the slope. ALL refers to all tows with one or more disturbances recorded.

A higher incidence of disturbances was observed on the slope (55% of tows, compared to 18 % of tows in the lagoon) and some tows were observed with more than one disturbance type present. Coral disease was observed on a small percentage of corals in the lagoon but it was widespread in the slope (24 % of tows from the slope). Disease is often a secondary effect from a previous disturbance or stress. In this case the disease was probably a consequence of the stress from the prior bleaching event(s).

Feeding scars were observed in both the lagoon (18 % of tows) and the slope (10 % of tows) and were a result of both *Drupella* spp and/or crown of thorns starfish (COTS) activities. The feeding characteristics of either organism are quite different so it is relatively easy to distinguish between the two types of scars. COTS feeding scars were infrequently observed on corymbose *Acropora* spp. though no individual starfish were directly observed due to their cryptic nature. Scars observed in the current survey were mainly observed on foliose *Montipora* spp `and *Pocillopora* spp, and were probably due to the feeding activities of the gastropod *Drupella* spp in most cases. In a few sites, the scars were moderately severe and are impacting on the coral cover at those places on the lower slope drop off.

Photo 13.

Typical slope scene where a permanent monitoring site was established. The plate colony in the foreground, *Acropora listeri*, is exhibiting a white feeding scar most likely from the gastropod *Drupella* spp.

Photo Gordon Lapraik

COTS were noted during consultations to be present in the atoll and on the northern slope margin (Ahaga Loa). However, during the current survey, feeding scars were confined to the south lagoon margin and to the north west slope (though the north east and east coast slope was not surveyed). Overall, the effect of these feeding scars was minor as they were low in abundance within most sites.

The previous existence of the wreck on the north to north-west reef flat (wrecked in 1979 and blown up in 1981) as had a significant impact on the surrounding reefs with up to 100 % mortality to corals around the site. Coral reef recovery was still very low in 1987 when the site was last inspected (Laboute, 1987). The current survey reported live coral cover on the slope at relatively low to moderate levels (from 10 to 20 % cover). Villagers reported higher incidences of fish poisoning (ciguatera) from fish caught in this sector of the atoll which is most likely was associated with the presence of the wreck[15].

Major disturbances in the past were noted during consultations. These include unusually low water levels in the lagoon in conjunction with clear calm weather that persisted for some time (in 1982-83), which was considered to have lead to high mortality of lagoon organisms (corals, fish and turtles). A ndrop in the lagoon sea level is thought to have been associated with an abnormal El Nino episode that affected much of the Pacific during this period.

There was also an incident some time in the 1970's when people from a research boat (possibly American) introduced a white powder into the lagoon in several places during incoming tides. Fish and eels apparently quickly died and the coral died soon after. There was concern that this has had a long term effect on the lagoon resources, which could not be substantiated from this survey due to the lack of data on resources before the incident.

2.6 Conclusions

The survey results show that there are specific characteristics of the habitats and biotic communities on Atafu Atoll that should be taken into account when considering sustainable management of marine resources. These characteristics are:

1. The relative **geographical isolation** of Atafu Atoll from other Tokelau atolls, and from other regional reef systems means that marine resources on Atafu are effectively isolated from all other sources of marine species replenishment. From a biological perspective, the geographic isolation factor is of great significance. This isolation means that Tokelau in general, and possibly each individual atoll, is in effect "closed" biological system, i.e. it should be assumed that there is little or no regular or continuous contribution of species to the atoll from outside its boundaries. Any biological inputs (fish, fish eggs, coral eggs, clam eggs etc) other than from highly mobile species like tuna and birds, are likely to be rare events associated with rare favourable oceanic conditions. This means that each atoll ecosystem has to be self-sustaining. Replenishment of reef fish, corals, clams and other stocks of marine species must occur from within each atoll's marine ecosystem. For this to happen there must be viable (or reproductively successful) populations of adults of each species within

[15] Ciguatera is a fish poison that accumulates in the food chain via a microscopic dinoflagellate that is ingested by algae eating fish in particular. Major disturbances (such as iron poisoning from ship wrecks) that result in large areas of reef surfaces that are available for algal growth can lead to outbreaks of ciguatera.

each atoll. Even when healthy populations of breeding species are present on an atoll, the year by year differences in successful replenishment of different species will vary greatly because of this isolation.

2. When compared to an atoll with deep wide channels to the open ocean, the **passageways or channels where ocean and lagoon waters transfer are few and they are generally extremely shallow**.

3. The **lagoon has a partitioned internal structure** where water is exchanged with the open ocean or moves within the lagoon at very low rates. This is significant when waste and pollution from the village are added to the lagoon waters, as they may remain in the lagoon system (including in the food chain) for long periods.

4. The **western end of the lagoon is relatively the most open sector of the lagoon with respect to water exchange with the open ocean**, but even in this area, flow patterns are significantly different to the open ocean due to the presence of wall reef systems.

5. The significantly low rate of water flushing from and within the lagoon **will have major implications for the potential to develop mariculture** activities and also for mitigation of pollution in the lagoon.

6. Atafu has very shallow reef flats that are regularly exposed at low tide periods which limit the development of many coral reef components. Therefore, no permanent habitat is available for many fish and other species in these areas. The reef flat can be a high energy habitat due to the constant wave and tidal movements over the area, which further restricts the development of complex reef communities. Many fish and other animals utilize the reef flat for feeding purposes, but have to return to the adjacent deeper reef slopes during low tide periods. That is, the **reef flat and adjacent slopes are effectively one habitat** in Atafu and therefore they should be managed as a single area.

7. The overall status of marine resources on Atafu is one of **general depletion of many traditionally harvested species**. The reasons for these depletions are not always easy to determine but they no doubt include natural fluctuations and natural disturbance events as well as human factors including the use of highly efficient fishing tools, food preserving fridges and freezers, and a cash society that encourages more harvesting than might have been carried out in the past.

8. The passageways or channels over the reef flat are **highly efficient fishing locations** because of the predictability of the periodic fish migrations, and because of the restriction of room for the fish to move through. The introduction of highly efficient gill nets into these sites has meant that the catch of fish for the effort is far higher than it ever has been in the past.

9. The current reef system and its biological components on Atafu is not complex relative to other reef systems though it probably is typical for atoll systems in the Central Pacific. This lack of complexity is demonstrated by the **relatively low diversity the low abundance of many of the species**. There also is a noticeable lack of representation of some major reef species groups, such as the Echinoderms (starfish,

holothurians, etc), Molluscs (gastropods and bivalves), and Crustaceans (crabs, shrimps, etc).

10. There is clear evidence that **significant impacts have occurred from recent bleaching events** and major components of the reef have been affected, particularly on the outer slope and less so in the lagoon.

11. **There are additional indicators of stress** in the reef system, observed both inside the lagoon and outside the reef on the slope. Stress indicators from the slope include the presence of low levels of coral disease, and the presence of higher than normal levels of feeding scars on some corals from (mainly) coral eating gastropods (*Drupella* spp) and (lower frequencies) crown of thorns starfish.

12. There is a representative suite of species from the major fish groups (ie, there are reasonable representations of herbivores (plant eating fish), planktivores (plankton eating fish), detritivores (fish that eat detritus or waste particles) and predators (fish that eat other fish and reef animals). The **fish communities are generally low in diversity and in many areas are also low in abundance** and there appears to have been **major reduction**s in some of the more desirable predator fish species such as black trevalley, and coral trout, that were apparently once quite abundant.

13. The **abundance of many species important to fisheries varies from low to high according to the distance away from the main settlements**. This characteristic is demonstrated in a number of different species and the pattern is similar on the outer slope as well as in the lagoon.

14. The one exception to the lack of abundance of fishery species is the **low to moderate densities of giant clams** (*Tridacna maxima*) in certain sectors of the lagoon. The highest densities of clams are found on patch reefs in depths of more than 5m. However, the average size of clams is quite small, with the median size of most clams averaging less than 12cm, which are slightly above the minimum breeding size. There were very low densities of *Tridacna squamosa* in all habitats.

3. COMMUNITY PERCEPTIONS ON RESOURCES AND RESOURCE MANAGEMENT

3.1 Rationale for Investigation into community perceptions

It is now widely accepted that local knowledge, concerns and priorities should be incorporated into a resource management strategy. In addition, addressing social concerns deemed important and a priority by the focus community is essential for the success of any resource management and conservation initiative. This is especially relevant and necessary in Tokelau where the *taupulega* (local council) is the community voice, and the main body responsible for the management of the local community and atoll environment, including resource use and conservation

The following is a general summary of the main issues and themes that were raised during community meetings and interviews in Atafu. Ten semi-structured interviews were conducted with a cross-section of community members (male and female) over the age of eighteen. In addition community workshops with the *fatupaepae, aumaga* and *taupulega* were conducted, as well as resource mapping and story telling sessions with *toeigas* and casual discussions with community members. The opinions expressed in the following sections are therefore those of the community members of Atafu, not the author.

Note the in-text italics are statements taken directly from interviews.

3.2 Socio-cultural setting of Atafu Atoll

The central governing authority on each of the atolls is the *taupulega* (local government council). This is the central body responsible for village matters and the atoll's environment and resources. The *taupulega* has formal legal power under the Tokelau Village Incorporation Regulations 1986 to pass village regulations including resource management controls (Tokelau Government 1995, 13). Atafu's *taupulega* is made up of descent group representatives, all members are male matai's (chiefs – head of the extended family) of varying age, with representation from the *faipule* (administrative officer, village representative to the National Government) and *pulenuku* (mayor, charged with the oversight of internal affairs). According to Huntsman and Hooper (1996, 3) Atafu's *taupulega* is distinct from the other Tokelauan *taupulega's* in that "*its role is more often one of surveillance, monitoring and overseeing the activities of other semi-autonomous village organisations that initiate and plan their own activities, but nonetheless characteristically include the whole village".* The introduction of younger matais is in part due to the loss of elders to New Zealand and the recognition of the knowledge that younger educated matais can bring to the council.

In recent times, the *taupulega's* power has eroded due to the presence of the external administrative body. However, according to the Tokelau Office in Apia, this is currently being reinvigorated. The strength of the *taupulega* and the community's reliance on them was still strongly evident in Atafu atoll. A member of Atafu's *aumaga* commented, *"We have no power, it's all with the elders*" and another *aumaga* stated, *"The elders are the leaders, they're the ones that make the decisions… we do whatever they say".*

New traditions in Tokelau came with colonialisation. Christianity and the church now play a dominant role in village life on all three atolls in Tokelau. Atafu has only one church, the Christian Congregation Church, no other faith other than this is allowed to be publicly practiced or discussed.

3.3 Important Qualities of Atafu

Community members identified a number of Atafu's qualities and resources that are especially important to them. Most qualities are related to daily subsistence needs and the Atafu lifestyle including the atolls socio-cultural environment.

The members of Atafu community that were interviewed expressed a strong connection and love for their Atoll and concern for its future. Participants commented, "*Atafu is unique, there's nowhere else like our island*". They identified places of significance to them such as the *pua tree at lalopua where the men met to carve, weave nets, share stories and watch the fish in the lagoon*. Other people commented on the importance of the people that form the community of Atafu, their well-being and happiness.

Environmentally respondents had varying opinions as to what the most important natural qualities of the atoll were. Some felt it is the whole environment, the land and water together. A few felt it is the land, which is extremely limited on Atafu and its precious resources. Most however felt that the marine environment of Atafu, especially the lagoon and its reef form the most important natural quality. "*This is our main source of subsistence, it is our life*"

The important resources of Atafu atoll according to respondents are those resources found in the marine environment, especially fish. Other significant resources identified include, the coral reefs which provide protection for the village and food and protection for fish. Seashells are important for aesthetic reasons, they make the beach look attractive and in addition they are important to women for use in handicrafts and decorations. Coconut crabs, clams and pigs were identified as very important delicacies and favoured foods.

3.4 General issues raised by respondents

Atafu is the smallest atoll of the Tokelaus, this is a fact that all Atafuans are starkly aware of. They understand that this means their lagoon and reef fisheries and land resources are more limited than the other atolls. The concept of the need to care for their 'small atoll' and be careful with its limited resources was more apparent here then on the other atolls. Some issues related to Atafu's marine and terrestrial environment noted by community members are outlined below.

1. *Resources harvesting*

Respondents noted a decrease in the coconut crab population in the past few years. Respondents noted that there has been as increase in harvesting of coconut crabs over the past few years for relatives overseas. Some respondents expressed a belief that the increase in harvesting for overseas consumption and the decrease in populations are linkedCoconut crabs are currently banned from harvest on Atafu. This ban is temporary. According to some respondents this is the way it has always been "*we had a traditional system if banning people*

from taking uga'uga, right now we are not allowed, we've always done it like that not allowed and then allowed"

It was noted that there continues to be some harvesting of birds and bird eggs for subsistence, this however is not a staple but an occasional dietary preference. *Takupu* (red footed booby) and *gogo* (noddies) were identified as favoured bird species.

2. *Species knowledge*

There was some confusion over the lifecycle and habits of some species, in particular coconut crabs and turtles. Respondents queried, "*How big should they grow before we can eat them?*" and "*How can we ensure there is enough for the future*?"

3. *Resource preference*

A preference for reef fish found in the lagoon over pelagic fish was indicated by most respondents. Parrot fish and black trevally were noted by respondents in interviews and meetings as favoured consumption fish within the village. Concern was also expressed as these species have not been seen for some time as they once were.

4. New practices

The community has started dumping rubbish at sea in the deep in an attempt to address the ever pressing waste problems facing the atoll.

4.1 Changes

A number of changes in the environment and resources of Atafu Atoll were noted by community members. The following were identified as changes in recent years.

- Coral has decreased;
- Cowry shells and octopus have declined;
- the fish are smaller in size and in quantity;
- the diversity of fish has declined, there are some fish that we no longer see;
- bait fish are slowly disappearing;
- Crayfish been completely depleted;
- the number of coconut crabs have declined;
- atoll is being ruined by rubbish;
- there has been an increase of black algae in the lagoon, especially near the rubbish islet;
- there has been a loss of seaweed within the lagoon;
- water clarity of the lagoon near the village is now poor, it was once clear;
- the shoreline on the village islet has changed as erosion has increased; and
- the number of clams has decreased dramatically.

Reasons for environmental changes and resource declines:

Participants commented that these changes and declines were for a variety of reasons, including the following:

1. New fishing technology
   - new fishing gear, especially the use of fine mesh nets
2. Natural conditions and events
   - El Nino, "*Why isn't yellow fin as abundant as it is use to be, is it connected with El Nino?*";
   - the temperature of the water in the lagoon has increased causing a decline in clams and coral;
   - 'we have a smaller reef and lagoon than the other atolls, I think that's why we're running out'; and
   - some respondents however believed that there had not been any declines in resources, however some fish had gone elsewhere or were perhaps hiding in a new place.
3. Development
   - coral disturbance when the channel was blasted
4. Pollution
   - "*pollution from petrol, cleaning agents (i.e. chlorox) and rubbish in the lagoon"*
5. Behavioural and resource changes
   - an increased harvesting of clams and coconut crabs for relatives overseas;
   - community members harvesting resources beyond their needs because of: freezers, improved fish gear, motorised boats, and for family overseas; and
   - because, "*sometimes people aren't obedient and don't treat the environment in the right way"*.

Photo – Discussing resource use, status and special locations with the aumaga

Photo Gordon LaPraik

4.2 Atafu village concerns:

The concerns identified by participants are mainly related to the actions of community members. Respondents are concerned about in the ever increasing amount of goods introduced from outside. They fear this is affecting the health of village members, the culture of the atoll, and the condition of the environment. The amount of rubbish on Atafu is constantly increasing and community members are at a loss to address this concern. "Issue of *rubbish, drop in the ocean*, contemplating taking it out to the moana because the *atoll is being ruined by rubbish*". Some feel that village members are not looking after the place and subsequently people are throwing rubbish into the lagoon.

These concerns according to participants should be addressed by the elders imposing greater controls on the import of goods coming to the atoll from outside. However it is felt that greater care should be taken by all community members, '*we should look at ways of getting what we need that suit the environment as well'*. It is important that community members' work together to address these concerns and improve future prospects of the village and atoll environment.

At the final village meeting during the teams visit to Atafu, Dr Dave Fisk gave the community an overview of what had been found during the rapid marine assessment. A community member raised the concern that people may abuse this new knowledge, "*I hope people don't abuse those species now we have more information on them*". Pulenuku's closing comments, "*I am still thinking about the issues you have raised today, these are things we don't think about but then end up crying…*"

4.3 Traditional conservation ethic and practices

Many respondents felt that conservation was a new idea. However some drew a comparison to traditional resource management practices, such as *te lafu (faka-lafu)* which respondents noted was only ever implemented on land. Many were unaware of the concept and practice of lafu areas or felt that it was an old way that was no longer practiced, "*lafu? I wonder what lafu means…faka-lafu, there's no more of that*".

A few of the older respondents talked about a traditional conservation ethic. This belief included being wise in the use of resources, letting the young species go, not taking more than was needed, planting coconuts and restricting the harvesting of resources found on a designated motu on occasions. "*that's what our ancestors taught us, always grow coconut trees and let the small fish go*". Whether long-term taboo (tabu) areas were once part of the management approach to Atafu's resources is unclear. A *toeiga* noted however, that there have been no tabu areas on Atafu since the arrival of the 'good news' (Christianity).

Photo

Resource Mapping at the carving shed with the toeinga

Photo Joanna Axford

4.4 *Fakahao* (Conservation)

"Conservation means a lot…Atafu is the smallest of the atolls…and it's very important to try and be careful in how we use the resources like fish".

There were varying opinions of what conservation meant to individuals. Most respondents however felt that it meant 'wise use', being careful with the atolls resources. Careful and wise use according to respondents, includes leaving the young of various marine and terrestrial species, especially fish.

It was generally felt that conservation is a new idea and when practised it provides a back-up source for village required resources, which can be accessed when conditions are bad and resources are low in other areas. It is hoped that conservation will help bring resources back, "*like in the old days when the fish were plentiful*". Respondents commented that because of these reasons, conservation is a good idea that allows them to hope for better times in the future.

4.4.1 *Te fakahao* (the Conservation Area)

Although there are two *fakahao* areas in Atafu, this next section will focus on the main Conservation Area around the village motu. According to respondents the *fakahao* area started as a small program on target species of fish, the atoll, a few years ago. However this species disappeared and the taupulega extended the *fakahao* area to encompass all marine resources, with the exception of sharks and seashells.

The taupulega, it is thought, established the *fakahao* area in recognition that the diversity and quantity of fish had declined. The aim of the *fakahao* area is to increase fish stocks for the

future. Some feel that the purpose of the *fakahao* area is to provide a food reserve in times of need such as bad weather.

The *fakahao* area is located around the village islet and encompasses a narrow patch of marine area on the ocean and lagoon side. The sides of the islet are not however considered part of the Conservation Area.

The *fakahao* area was located here because it is easy to access, it thought to be an area of comparatively high fish stocks and it is close to the village. For these reasons the location of the *fakahao* area means it is easy to manage and easy to enforce the rules because the whole village can see the area. An additional benefit of this location is that community members are able to see the effects of the *fakahao* area.

Fakahao area perceptions

Respondents felt that the *fakahao* area provided both advantages and disadvantages. The perceived advantages included improved resources, especially an increase in fish numbers (schools) and in individual fish sizes. '*Its working, we're getting a lot of fish'*. It was noted by some that some fish species that were thought to have disappeared are now returning, "*we are now getting new fish*". Some participants noted an increase in coral growth inside the Conservation Area on the lagoon side. A few respondents commented that the Conservation Area was important because it acted as a back up fishing area or a fish larder, therefore, '*there is always a place to go fishing when there is a shortage of fish*'. In addition some community members felt there has been an increase in mullet and turtle numbers.

Disadvantages of the Conservation Area according to participants include a perception of disparity in costs amongst village members. One side of the village is not bounded by the Conservation Area therefore their fishing area is not restricted, "*people joke and complain that we conserve the fish until they are big and then the fish go to the other side of the motu for the other side of the village to catch and eat*". Some respondents commented that they now have to go further to fish. Others felt that the Conservation Area is not opened for fishing often enough and shark numbers had increased posing a safety concern (although others felt that shark numbers had always been high in this area). In addition some community members commented the the Conservation Area meant they could not eat reef fish as often and during the windy storm season (*laki*) when they traditional have had to rely more heavily on reef fish out of necessity this was a major disadvantage. The *fakahao* area is "*good for this time of year because we get a lot of fish from the ocean*" but "*it is a disadvantage during the laki season*".

Fakahao Management

It is generally felt that while the whole village is responsible for the *fakahao* area, it is managed directly by the village *toeiga* (elders). Community members are responsible to respect the MPA rules and ensure no-one breaks the rules, thereby they act as watch dogs for the *fakahao* area. The elder however are the decision-makers, they decide when the community can fish in the MPA and they punish those who do not comply with the *fakahao* area rules.

According to respondents and workshop participants all fishing is banned within the *fakahao* area, with the sole exception of sharks. Shark fishing is not prohibited because of their high numbers and the threat that they pose. The collection of shells and other resources along the

beach of the *fakahao* area is allowed, but there is a strict rule prohibiting the dumping of rubbish within the lagoon side of the Conservation Area.

Compliance with the Conservation Areas rules was felt to be high because of the strong leadership and management of the elders. Generally respondents felt that community members respect the authority of the elders. While a few participants commented that '*no one ever breaks the rules'*, the majority of respondents however commented that occasionally village members do break the rules and fish or throw rubbish in the *fakahao* area.

The participants that commented on people breaking the rules felt it was because, they don't respect the authority of the elders, they only break the rules when there is not enough fish elsewhere or they don't have time to go fishing further away.

There was no consistency in perceptions of how rule violators were punished. The only thing that all participants agreed on is that the elders enforce the rules and punish violators. Perceptions on how the elder's punished violators varied greatly from a fine of $20, to a fine of around $200, others believed the punishment was house arrest and some felt that violators were only punished by being scolded by the elders.

Success in Atafu *fakahao* area

Success in the *fakahao* area is considered to be an increase in fish numbers (schools), diversity and individual fish size. Some therefore believe that success will be realised when the Conservation Area is opened up for the village to fish.

Success will be reached if community members abide by the *fakahao* area rules and respect the elder's authority. It is important therefore for the *taupulega* and the community to work together to achieve a successful *fakahao* area. Some respondents also noted that success will also require awareness and education opportunities for community members to increase understanding of conservation and skills in effective conservation practices. Other respondents noted that success would come from the strong and wise leadership of the elders, it is important therefore that the elders lead by example.

There is a need according to some community members to clearly mark the boundary of the *fakahao* area, "*to keep little hands out*".

4.5 Future vision for the atoll

"*We need to think seriously about the future…in terms of economic development, at this stage, it's not something we can say we won't do*".

Participants hoped that there will be improvements in Atafu in the future. Improvements included, good land and marine condition, better village planning, less rubbish, corals growing, an increase in reef fish and improved village well-being and happiness. In addition some respondents commented that they would like to see some the atoll community and environment to return "to the way it use to be".

Participants felt this vision will be attained through cultural strengthening and because people in the village have the 'right attitude' and listen to the elders and respect their authority. Others

felt it would be attained through education and training of community members. A few respondents however felt that it is up to the will of god, therefore they, '*pray to god to look after our small place'*.

Photo – Full Community meeting to discuss findings of the surveys

Photo Gordon LaPraik

5. RECOMMENDATIONS

Considering the findings of the resource surveys and the interaction with the all groups of the community the following recommendations are put forward as a way to improve resource management on Atafu.

The recommendations are for management actions aimed at contributing to the conservation and preservation of the atoll by providing a framework for achieving sustainable resource management of human activities. The goals address the major management issues and encompass the following principles:

1. ***Conservation***

Protect, conserve and, where possible, restore the natural biodiversity and cultural values of the atoll.

2. ***Community involvement and support***

Develop community awareness, understanding and appreciation of the biological and physical diversity of the atoll, and promote community involvement in, and support for, its protection, conservation, and restoration.

Incorporate traditional and modern resource management practices to form a comprehensive and integrated community-based Resource Management Plan.

3. ***Commercial and other uses***

Manage commercial and other uses in an ecologically sustainable way.

4. ***Research and Monitoring***

Implement a data collection and analysis program that provides for a much greater understanding of the impacts of use and management activities within the atoll to better understand the potential and real impacts resulting from resource use.

4.1. Specific High Value Areas (incl Target Species/Objectives)

Fish Aggregation Sites

Effective management of specific high value areas, which are mostly related to seasonally occurring phenomena, could significantly benefit long term sustainable fisheries. These include the well known fish aggregation sites spread around the lagoon. Aggregation sites are probably of two types: sites where fish congregate (waiting for high tide to access the outer slope) on their way to spawning or feeding locations, and sites where spawning occurs, which are usually located on the outer slope or in areas that provide direct access / strong water flows to the open ocean. Aggregation sites near passes and channels will have to be effectively protected so as to allow the aggregating fish to spawn before too many breeding adults are taken from the population, leaving inadequate numbers of those species for future generations. It has been noted that fish on their way out of the lagoon through the shallow channels are often full of eggs whereas the same fish species returning from the outer slope into the lagoon,

do not have eggs. This strongly supports the understanding that many fish may move to outer slope aggregation sites for spawning, then return to their lagoon habitat.

It is apparent that some aggregation sites are mostly used by specific species or a small group of species. Seasonal protection for these aggregations, especially from the very effective netting practices currently being used, would be a very significant step forward for long term sustainable management of finfish stocks of importance to subsistence livelihoods. It is also wise to nominate for protection more than one such species-related aggregation site for each species, so that annual variation is taken into account.

RECOMMENDATION 1:
It is highly recommended that more than one species-specific site, known for seasonal fish aggregations, be protected from harvest activities during these critical phases. This should be applied to sufficient sites so that all the major target fish species included.

Giant Clams

Giant clams populations comprised predominantly *Tridacna maxima*, as only a few individuals of *T.squamosa* were observed during the whole period of the survey. The reef flat habitat along the western margin of the atoll (Te Alofi) is probably the most suitable habitat for clams as it is more regularly flushed by clean clear oceanic water. This includes the adjacent shallow lagoon area where large *Porites* spp patch reefs and other composite types of patch reefs are located. To improve clam stocks, natural replenishment of depleted areas would be most favoured by establishing a clam protection area (CA) within the western atoll margin and within the southern margin channel system. A suggested suitable area would be the current CA extending between the motus of Te Alofi and Alofi Lahi, and also within a suggested CA area adjacent to the motu of Matalia (see Figure 4).

The success of natural replenishment of clam stocks will also be dependent on effective management of the total clam harvest from outside the CA areas. These measures will have to include limits on the number and size of clams that are harvested. In particular, the harvesting of clams that are smaller the size for reproductive maturity will have to be minimised.

RECOMMENDATION 2:
It is recommended that relatively large areas of reef flat and adjacent shallow lagoon area on the western and southern margins, on the scale of 500m - 1 km, be set aside as long term refuges for giant clams, to as sources of clam larvae for other parts of the atoll.

4.2 Permanent and Temporary Closures

Current fisheries knowledge recognizes that the periodic opening and closing of specific areas for harvest activities is not very effective in the long term for maintaining sustainable fisheries, particularly when resources have been significantly depleted and the aim of the conservation areas is to improve the resource stock. This system of management has been traditionally

practised by Tokelauans for a very long time and it obviously has contributed to the long term viability of the society on these atolls. However, current understanding of fisheries viability indicates that the ability of specific fisheries to supply resources is limited and that this is particularly the case in isolated reef systems like the atolls of Tokelau.

While there is a role for traditional temporary closures of areas it must be recognised thatthis strategy has limited effectiveness to sustain long term fisheries if that is the only management technique that is adopted. The choice of areas for periodic closure should be targeted towards the most productive areas and temporary closures should be rotated between a number of similar habitat areas that are important for the aims of the resource conservation measure or species of concern.

RECOMMENDATION 3:
It is recommended that both temporary and permanent closure systems be employed to enhance overall fisheries yields for Atafu. Also, a clear distinction should be made between areas that are intended to be permanently closed to harvest activities and those that are to be more temporary (in terms of a number of years or on a seasonal basis).

RECOMMENDATION 4:
Where harvesting is to be periodically allowed following temporary closures, there should be a systematic rotation of open and closed areas that are easily applied and the boundaries readily understood with reference to reef features.

4.3 Conservation Areas

The current Conservation Areas (Figure 4) includes the northern lagoon edge and the seaward reef flat surrounding the Atafu village on Vao Island (Te Kakai) AND an area situated in the mid western atoll margin in a channel between Te Alofi motu and Alofi Lahi motu, and includes the motu of Tamahaka. The principal aim of the Vao Island Conservation Area is to allow the build up of giant clams. The second Conservation Area was established following a school project for the same purpose.

An alternative or additional area suggested for consideration as a CA includes a substantial portion of Matalia motu and the surrounding reef flat including a few of the more distant patch reefs, and west to include a number of motus along the southern edge and the outer slope. In total, this suggested CA would include major habitat for coconut crabs, giant clams, and a number of fish aggregation sites and would therefore address a number of major concerns that the people of Atafu have highlighted during consultations.

RECOMMENDATION 5:
It is recommended that the two current Conservation Areas be maintained as specific clam recovery areas. To be effective, the boundaries should be extended to the lower slope and further into the lagoon to maximize benefits of a Conservation Area. The closures should be permanent.

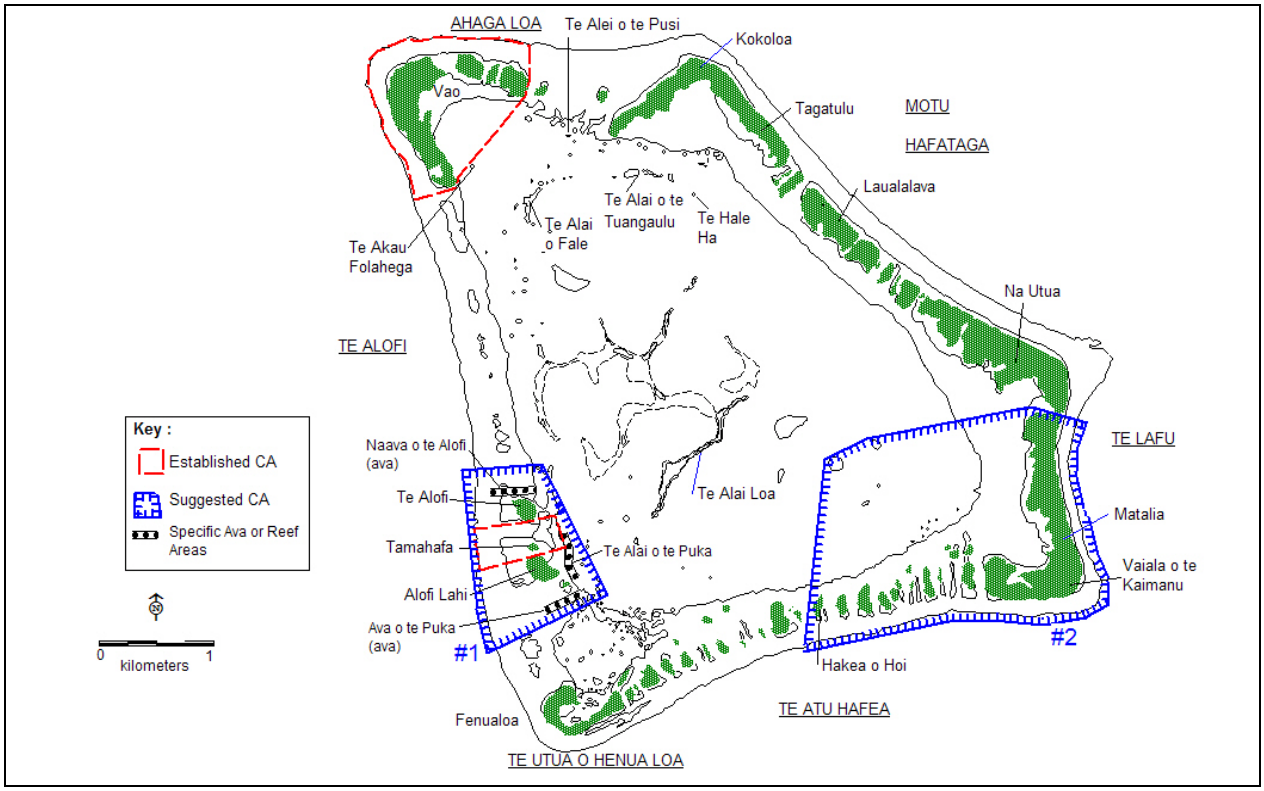

Figure I: **Map of Atafu Atoll showing the existing Conservation Areas, including an extension of the boundaries to CA #1, and an additional suggested Conservation Area (CA #2).**

RECOMMENDATION 6:
It is recommended that consideration be given to setting aside a section of the south eastern margin and Matalia Island, as a major Conservation Area. The reef slope, reef flat, and a portion of the adjacent lagoon (to approximately 20 m depth) should be included in an area that excludes the harvesting of any species.

4.4 Control on Current Harvest Practices.

Current harvest activities on Atafu have several characteristics that are significantly contributing to the over harvesting of resources. These include: the widespread use of fish gill nets in the shallow and narrow channels that dissect the reef flat; the targeting of fish

aggregation areas, contributing to over fishing and depleting the breeding population of each species when they are at their most vulnerable; the taking of all fish of any size is a further fishing practice that should be controlled if sustainable fisheries are to be maintained.

RECOMMENDATION 7:
Good practice fisheries regulations need to be adopted that address the common causes of over fishing like small mesh net sizes, the targeting of most fish aggregation sites in any one year, and the taking of small fish sizes. These regulations have to be understood by all members of the community and have to be adequately.

4.5 Policy on Export Activities

The practice of exporting marine products for either family reasons or for income needs to be carefully managed so that over exploitation of limited resources does not occur. A careful policy in relation to commercial export industries will have to be developed before any scheme is approved.

RECOMMENDATION 8:
It is recommended that the export of marine resources be either significantly controlled and monitored, or prohibited. It is essential to obtain figures on the amount of product leaving the atoll.

4.6 Waste Management Plan

There is obviously an issue on Atafu relating to the treatment of solid rubbish and this includes the issue of the importation of plastics. Waste management plans should also address the potential important issues of effluent and chemical use. An important option for the leaders to consider is to control the types and quantities of certain materials onto the atoll. This is because there is very poor circulation in the lagoon which means that any introduction of nutrients or chemicals can be very damaging due to the time that these chemicals can spend in the lagoon system.

RECOMMENDATION 10:

It is recommended that a wide ranging management plan for waste in all its forms be developed as a matter of urgency and that it be implemented as soon as is practical. Immediate measures may include restrictions on the import of certain material (like plastics) onto the atoll.

4.7 Atoll Wide Issues

Islands that supported large colonies of seabirds no longer do so and no substantial colonies of sea birds were observed on any motu. A combination of natural disturbances (direct and indirect cyclone effects), and changes to the vegetation structure of the motus due to the expansion of coconut plantations, has probably contributed to the reduction in sea bird numbers.

Similarly, the disturbance of the few turtle nests that are currently present on Atafu will restrict the potential for long term increases in turtle numbers, particularly during turtle breeding seasons.

RECOMMENDATION 11:
It is strongly recommended that an atoll wide ban on the harvesting of turtles and sea birds be put in place.

4.8 Biological Monitoring

Biological Monitoring provides ongoing data on the health and status of resource stocks. This data is essential for re-assessing and reviewing management issues with regards to specific animals and resources. This information is essential to provide the community with regular status reports of the marine environment (in particular specific resources of concern), and to highlight management actions that may need to be taken to ensure sustainable management of these resources.

RECOMMENDATION 12:

It is strongly recommended that a Biological Monitoring Program be established once the final decisions are made on a sustainable management approach, so that information can be provided to the decision makers on the effectiveness of their decisions. Alterations and improvements to the rules governing the management of resources can also be made using the information obtained from monitoring efforts.

See Appendix 2 for the outline suggest approach for the Biological Monitoring Program.

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Annexes

Annex 1 Atafu Fish List from Observations during Field Surveys 2003:

Scientific Family	Common Name	Scientific Name	Tokelau Name	Habitat	Abundance	Notes
Acanthuridae	Orangebar Surgeon fish	Acanthurus olivaceus		Slope	Very common	Schools
Acanthuridae	Convict Surgeon	Acanthurus triostegus		Slope	Very common	Schools
Acanthuridae	Striped Bristletooth	Ctenochaetus striatus		Slope	Very common	Schools
Acanthuridae	Yellow Tang	Zebrasoma flavescens		Slope	Very common	Schools
Balistidae	Titan Triggerfish	Balistoides viridescens		Lagoon&Slope	Very Common	Individuals
Balistidae	Black Triggerfish	Melichthys niger		Slope	Very Common	Large Schools
Balistidae	Pinktail Triggerfish	Melichthys vidua		Shallow Slope	Common	Individuals
Carangidae	Black Trevally	Caranx lugubris	Tafauli	Deep Slope	Uncommon	Individuals
Carangidae	Blue Fin Trevally	Caranx melampygus	Aheu	Slope	Common	Small schools of relatively small individuals; Occasional larger individuals
Carangidae	Big Eye Trevally	Caranx sexfasciatus	Komulo	Slope	Common	Large Schools
Carcharhinidae	Reef Blacktip Shark	Carchhinus melanopterus	Malu	Slope&Lagoon	Common	
Carcharhinidae	Reef Whitetip Shark	Triaenodon obesus	Kili	Slope&Lagoon	Uncommon	
Chaetodontidae	Ornate Butterfly	Chaetodon ornatissimus	Tifitifi	Slope&Lagoon	Common	
Chaetodontidae	Spotnape Butterfly	Chaetodon oxycephalus		Slope&Lagoon		
Chaetodontidae	Fourspot Butterfly	Chaetodon quadrimaculatus		Slope		
Chaetodontidae	Reticulated Butterfly	Chaetodon reticulatus	Tifitifi	Slope	Very Common	
Chaetodontidae	Pacific Doublesaddle Butterfly	Chaetodon ulitensis		Slope&Lagoon	Common	Pairs
Chanidae	Milkfish	Chanos chanos	Ava	Deep water	Common	
Cirrhitidae	Halfspotted Hawkfish	Paracirrhites hemistictus	Patukilaufala	Slope	Very Common	Juveniles in passes
Holocentridae	Scarlet Solderfish	Myripristis pralinius	Talatala	Slope&Lagoon	Common	Migrate between slope and lagoon
Labridae	Red Brested Wrass	Cheilinus fasciatus	Papo	Slope	Common	Individuals
Labridae	Maori Wrass	Cheilinus undulatus	Malatea	Slope	Common	Usually large individuals
Labridae	Harlequin Tuskfish	Choerodon fasciatus		Slope	Common	Usually individuals
Labridae	Sling jaw Wrass	Epibulus insidiator		Slope	Common	Usually individuals
Labridae	Bird Wrass	Gomphosus varius	Mutuhiko	Slope	Common	Individuals
Labridae	Bicolour Cleaner Wrass	Labroides bicolor		Slope&Lagoon	Common	
Labridae	Bluestreak Cleaner Wrass	Labroides dimidiatus		Slope&Lagoon	Common	

Scientific Family	Common Name	Scientific Name	Tokelau Name	Habitat	Abundance	Notes
Labridae	Six Bar Wrass	Thalassoma hardwicke	Sugale	Slope	Common	Schools
Lethrinidae	Goldlined Seabream	Gnathodentex aureolineatus		Slope	Common	Schools
Lethrinidae	Orangefin Emperor	Lethrinus erythracanthus	Hapute	Deep slope	Uncommon	Individuals
Lethrinidae	Thumbprint Emperor	Lethrinus harak	Filoa	Lagoon	Common	
Lethrinidae	Bigeye emperor	Monotaxis grandoculis	Mu	Slope	Common	Schools and individuals
Lutjanidae	Red Bass	Lutjanus bohar	Fagamea	Slope	Common	Individuals & occasionally large
Lutjanidae	Longspot Snapper	Lutjanus fulviflamma	Taiva	Slope	Common	Schools
Lutjanidae	Yellow margin Seapearch	Lutjanus fulvus	Tagau	Slope&Lagoon	Common	Schools
Lutjanidae	Paddletail	Lutjanus gibbus	Taea	Slope	Common	Schools
Lutjanidae	Five lined Seaperch	Lutjanus kasmira	Havane	Slope	Common	Schools
Lutjanidae	Scribble Snapper	Lutjanus rivulatus		Deep slope	Uncommon	Individuals
Lutjanidae	Black Snapper	Macolor marcuaris	Mu mea	Corner slope	Common	Aggregations
Lutjanidae	Black&White Snapper	Macolor niger	Mu mea	Deep slope	Common	Associated with caves
Monodactylidae	Teira Batfish	Platax teira		Lagoon	Uncommon	
Mullidae	Yellow Goatfish	Mulloides varicolensis	Memea	Slope	Common	Schools
Mullidae	Dash-dot Goatfish	Parapensis barberinus	Tuita	Slope	Common	Individulas
Mullidae	Manybar Goatfish	Parupenus multifasciatus	Hulu	Slope	Common	Individulas
Muraenidae	Peppered Moray Eel	Siderea picta	Puhitea	Lagoon	Very Common	
Pomacantridae	Lemonpeel Angelfish	Centropyge flavissimus		Slope	Very Common	Small Groups
Pomacantridae	Flame Angelfish	Centropyge loriculus		Slope	Very Common	Individuals
Pomacantridae	Regal Angelfish	Pygoplites diacanthus		Slope & Lagoon	Common	Individuals
Pomacentridae	Blue green Chromis	Chromus	Palulaufala	Slope&Lagoon	Very Common	Schools
Pomacentridae	Dicks Damsel	Dascillus		Slope	Very Common	
Pomacentridae	Three spot Dascillus	Dascillus		Slope	Common	
Scaridae	Bullethead Parrot	Chlorurus sordidus	Uhu	Slope	Common	Schools
Scaridae	Pacific Long nose Parrot	Hipposcarus longiceps	Ulafi	Slope	Common	Large schools
Scaridae	Reefcrest Parrot	Scarus frontalis	Kamautu	Shallow Slope	Common	Schools
Scaridae	Schlegels Parrot	Scarus schlegi	Koti	Slope	Common	Individuals
Serranidae	Slender Grouper	Anyperodon leucogrammicus	Faloa	Slope	Uncommon	
Serranidae	Peacock Grouper	Cephalopholis argus	Loi	Slope	Very Common	Individuals
Serranidae	Flagtail Grouper	Cephalopholis urodeta	Matele	Slope		
Serranidae	Brown-marbled Grouper	Epinephelus fuscoguttatus	Fapuku	Slope	Uncommon	
Serranidae	Hexagon Grouper	Epinephelus hexagonatus	Eve	Lagoon	Common	

Scientific Family	Common Name	Scientific Name	Tokelau Name	Habitat	Abundance	Notes
Serranidae	Honycomb Grouper	Epinephelus merra	Gatala	Lagoon	Common	
Serranidae	Lowfin Rudderfish	Kyphosus vaigiensis	Nue	Slope&Surf zone	Common	Schools
Sphyraenidae	Great Barracuda	Sphyraena barracuda	Pananua	Slope	Common	
Sphyraenidae	Chevron Barracuda	Sphyraena qenie	Ono	Slope corners	Common	Large Schools
Zanclidae	Moorish Idol	Zanclus candescens	Laulaufoau	Lagoon&Slope	Very Common	Targeted in passes

Annex 2 Biological Monitoring Program

There are five main elements to the Biological Monitoring Program. They are listed below in order of greatest priority.

Element 1. Atoll Wide Marine Assessment

An atoll-wide rapid assessment should be every 3-5 years to provide a general assessment of the health of all marine habitats and stock populations of selected indicator species within the atoll. This assessment should duplicate the original marine assessment undertaken in this exercise using all techniques and organisms targeted (as described in detail in the Technical Report). Capacity building, training and community awareness programs on all aspects of this program should be included in these activities. Community based monitoring should be an integral component of the long term monitoring as it serves to maintain local awareness of the trends in the atoll's resources, and also provides a mechanism for the trends to be directly passed on to the community (ie, the information stays with the village).

These data then need to be analysed to provide information on the success of the management actions. This information is extremely important to provide direct scientific evidence that the management actions are conserving and protecting marine species and habitats. The permanent monitoring sites should used to provide long-term repeatable data sets. The permanent long term monitoring activities are more technical and probably will have to be carried out with the help of specialists.

It is expected that the conservation areas will provide a habitat that is free from human interference, thus allowing the natural processes of reproduction and recruitment to occur resulting in stock population increases of previously targeted species. These conservation areas are an essential component to the management of the marine resources of the atoll and must be maintained and monitored.

Element 2. Monitoring Effects of Atoll Wide Bans

The atoll-wide bans on selected species must be reviewed through data assessment to determine if and when stock populations have recovered enough to allow subsistence and/or commercial activities to recommence. Suggested species include: turtles (particularly turtle nesting), coconut crab numbers and sizes, and sea bird colonies on remote motus.

The monitoring of species such as these will be very important if there is any action taken to attempt to remove some of the threats to these species. Threats to these species include: wild pigs, cats, and rats, that are affecting population numbers and disturbing motu habitats.

Element 3. Monitoring Spawning Aggregation Sites

It is recommended that there be an investigation into the exact reef locations and timing of spawning aggregations within the atoll. This will have to be carried out so that the most effective decisions can be made on protecting this vital aspect of an atoll's fishery. This is because there has to be a decision on which aggregation sites are most worthy of protection from harvesting so that the maximum number of important fish species can be afforded

protection to complete their reproduction functions and so help to reverse the trend towards depletion of stocks.

Information gained from the SPREP 2003 marine assessment and anecdotal information gleaned during the community discussions have provided valuable information on the locations of fish spawning aggregation sites.

However, verification of these and other sites within the lagoon is required to allow the successful management of these important resources to be achieved.

Element 4. Evaluating Specific Species

A resource evaluation should be undertaken to assess the existence, locations, and abundance and population size of coconut crab and turtle populations within the atoll.

Element 5. Capacity Building

There is an urgent need to run an extensive training program on resource management and monitoring protocols. This training program must include data collection techniques for both terrestrial and marine environments, data recording and analysis. An urgent requirement is to include clear demonstrations of the life cycle of many important species so that the community understands what is required to be addressed with respect to the management of those species.

It is recommended that the Conservation Projects seek the participation of a local science graduate (and perhaps an overseas volunteer in the first instant) to assist in all aspects of the program.

In the short term many aspects associated with the marine monitoring program may require external technical support.