1 INTRODUCTION

The Government of the Kingdom of Tonga has formally proposed the designation of the entire Ha'apai Group, the 62 central islands of Tonga (see maps below), as a Conservation Area (CA) under the South Pacific Regional Environment Programme (SPREP)'s South Pacific Biodiversity Conservation Programme (SPBCP). The proposal to SPBCP for the funding of a "Ha'apai Conservation Area Project" (HCAP) has been subsequently approved by SPBCP as Tonga's project under SPBCP, subject to the completion of a detailed Project Preparation Document (PPD) by the Kingdom of Tonga. This document constitutes the PPD for the Ha'apai Conservation Area Project.

The main objectives of this Project Preparation Document are to:

1. Provide relevant background information on the proposed Ha'apai Conservation Area (HCA);

2. Draw attention to issues of concern relevant to biodiversity conservation within the HCA;

3. Identify desirable objectives, activities, strategies and an organisational or management structure of the HCAP; and,

4. Provide a detailed Work Plan of activities for the implementation of the HCAP under Phase 1 (the first year) of the HCAP.

For the preparation of this PPD a mission was undertaken to Tongatapu and Ha'apai in January 1995 by SPREP/SPBCP consultants, Dr. Randy Thaman and Mr. Robert Gillett, officials from the Land and Environmental Planning Unit (LEPU) of the Ministry of Lands, Survey and Natural Resources (MLSNR), and data collection staff. The objectives of the PPD mission were:

1. To determine the degree of community interest in and willingness to become active participants in the Project;

2. To identify, using a participatory approach, the major issues of concern or constraints to, and activities that might promote, biodiversity conservation and sustainable development;

3. To collect relevant background information on the nature of the proposed pilot islands and communities, the biodiversity, and the nature of current development and political, community and developmental infrastructure in the HCA; and,

4. To consider, and discuss with local communities, community leaders and resident government authorities, potential strategies, activities and project management alternatives.

The information collected on the mission has subsequently been incorporated into the PPD and, thus, reflects to a great extent the views of the local residents and government officials. Persons who were consulted are listed in Appendix 1.

2 PROJECT BACKGROUND

This section provides background on the Kingdom of Tonga's initiative to designate the entire Ha'apai island group as a Conservation Area under the South Pacific Biodiversity Conservation Programme of the South Pacific Regional Environment Programme. It includes information on: 1) increasing international interest in biodiversity conservation and management; 2) SPBCP and Conservation Area Project development; 3) the rationale for the proposed Ha'apai Conservation Area Project under SPBCP; 4) selection criteria for priority islands and pilot communities within the HCA; and 5) definitions of the concepts of "biodiversity" and "biodiversity conservation" in the context of the HCAP.

2.1 Increasing International Interest in Biodiversity

The formalisation of the Convention on Biological Diversity (CBD) at the United Nations Conference on Environment and Development (UNCED), the "Earth Summit", held in Rio de Janeiro in June 1992, underlines the increasing realisation of the importance of biodiversity conservation as a basis for sustainable development at the international and national levels. The CBD, which provides a framework for the protection of both terrestrial and marine biodiversity, was signed by nine Pacific island countries. It is particularly important to areas of the Pacific Islands, such the Kingdom of Tonga, that have "globally significant areas of biological diversity" and whose people, culture and economies depend on the protection and sustainable use of their terrestrial and marine life. The importance of the protection of small island ecosystems is also mentioned in Agenda 21, the UNCED action plan for the next decade leading up to the 21st Century.

The implementation of the CBD in the Pacific Islands is being facilitated by the South Pacific Regional Environment (SPREP)-based $US10 million South Pacific Biodiversity Conservation Program (SPBCP), a five-year programme funded through the Global Environment Facility (GEF) and the Government of Australia. The GEF is a Programme to help developing countries deal with regional and global environmental issues and is administered by the World Bank, the United Nations Environment Programme (UNEP), and the United Nations Development Programme (UNDP).

2.2 Rationale for SPBCP and Conservation Area Project Development

The main aim of the South Pacific Biodiversity Conservation Programme is to develop strategies and to provide technical and financial assistance to eligible independent Pacific Forum countries for the conservation and sustainable use of biodiversity. These countries are the Cook

Islands, the Federated States of Micronesia, Fiji, Kiribati, the Marshall Islands, Nauru, Niue, Palau, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu and Western Samoa. Other member countries of SPREP (which has a wider membership than the Forum) may participate in SPBCP-supported activities although they are not eligible to receive support from the GEF.

The main emphasis of SPBCP is the establishment, in eligible countries, of a system of diverse Conservation Areas (CAs) in which human activities will be guided to protect important ecological features and to enable sustainable use of natural resources within the CA. Ancillary activities include the provision of information, species protection, regional policy and educational programmes.

The rationale for the establishment of a system of CAs is that in areas like Ha'apai, and elsewhere in the Pacific Islands, where people depend on their terrestrial and marine resources for almost all of their subsistence and cash production, there is a need to promote the conservation and sustainable utilisation of these resources. As mentioned above, under the SPBCP, CAs are not totally protected areas wherein development is prohibited. Rather, CAs are to be areas within which the sustainable utilisation of resources is promoted in an effort to conserve biodiversity (terrestrial and marine ecosystems and habitats and plant and animal species and varieties) for the benefit of future generations. This differs from models for national parks and conservation areas in industrialised countries in which people are not so dependent on their natural environment for their day-to-day survival, and where conservation efforts are focused mainly on protection and recreation, rather than on sustainable utilisation.

The more specific objectives of SPBCP, in terms of the establishment of CAs, are:

1. Identification of priority areas for the conservation of biological diversity which could become CAs;

2. Assisting in the creation of CAs that protect biodiversity and demonstrate ecologically sustainable development by the management of natural resources by local communities, NGOs and government agencies;

3. Protection of threatened or endangered terrestrial and marine species in the Pacific region;

4. Improvement of regional awareness of the importance and means of conserving biological diversity; and,

5. Improvement of capabilities and working relationships between different sectors and agencies contributing to the conservation of biological diversity.

Major emphasis is placed on the convictions that:

1. It is absolutely essential that local communities be an integral part of the project initiation process and that they agree to participate in the development and implementation; and

2. Conservation Areas Projects are intended to be community driven and owned and must reflect the wishes and desires of the local people, with local communities ultimately taking over the administration and management of the CA.

The SPBCP also recognises that:

1. There will probably be a lack of awareness and management skills amongst the local communities who have a direct interest (primary stakeholders) in conserving the environment;

2. There will be a need to provide and create tangible benefits, including financial returns, through sustainable development activities, to induce primary stakeholders to conserve the biodiversity of the areas selected for inclusion in the CAP; and,

3. Sustainable development will be an ongoing and lengthy process extending beyond the initial funding period of SPBCP. In the long term, stakeholders will have to become self-reliant and substantially dependent on their own community resources to carry out the conservation measures to ensure the protection and enhancement of the environment for future generations.

In terms of eligibility, Conservation Area Projects may be conceived and promoted for funding by a government, a non-government or a private sector institution. In all cases, they should have the formal endorsement of the government.

2.3 Rationale for the Proposed Ha'apai Conservation Area

The Ministry of Lands, Survey and Natural Resources (MLSNR), after taking into consideration the above criteria and considering the economic and environmental conditions prevailing in Tonga, proposed that the entire Ha'apai Group be designated as the Ha'apai conservation Area (HCA) under SPBCP and that funds be solicited to initiate a five-year Ha'apai Conservation Area Project (HCAP).

It was further suggested that the project be phased, with initial activities being concentrated in a limited number priority islands and pilot target communities in Ha'apai. The concept has been discussed with residents of most of the proposed pilot communities, government officials in Ha'apai, and relevant Government officials in Tongatapu. and the Ha'apai Development Committee (HDC). The support received from these discussions ultimately resulted in the proposed HCAP being formally endorsed by the Ha'apai Development Committee (HDC) and the Cabinet. Funding for the project has been approved under the SPBCP.

The Ha'apai Group was selected by Tonga as a priority CA for the following reasons:

1. Ha'apai has the largest area of coral reefs in the Kingdom and great marine biodiversity;

2. It has unique geological, marine, and terrestrial features of local and international interest;

3. Because of its beauty and its relatively undisturbed marine environment, the area is under consideration for designation as a World Heritage Site by UNESCO;

4. There a few development opportunities, with its resident communities depending on their marine and terrestrial biodiversity for almost all of their cash and non-cash needs; and,

5. Increasing involvement of Tonga in the world market (cash) economy is placing increasing pressure on the terrestrial and marine biodiversity of Ha'apai, which, if not controlled or modified along the lines suggested for CA projects, could have significant, perhaps irreversible, negative impacts on both the biodiversity and the quality of life in Ha'apai.

The designation of Ha'apai as a Conservation Area also seems to satisfy most of the stated "National development Objectives" of the Tonga Sixth Five Year Development Plan 1990-1995 (DP6). These objectives are:

1. Sustainable economic growth conducive to a higher per capita income;

2. More equitable distribution of incomes and more equitable access to goods and services between regional community groups and between income groups;

3. Generation of employment opportunities;

4. Restoration and control of external financial balances;

5. Enhancement of the quality of life by raising health standards, maintaining national security and continuing to promote the cultural heritage of the Kingdom;

6. Development of beneficial relations with other nations; and,

7. Continued protection and management of natural resources for sustainable growth.

In support of these objectives, the HCAP is designed to:

1. Promote the sustainable use and development of the natural resources (biodiversity) of the Ha'apai;

2. Provide increased employment, income and access to relevant consumer and capital goods for the communities of Ha'apai;

3. Promote more sustainable terrestrial and marine production systems which would increase Ha'apai's self-sufficiency and play a role in maintaining more favourable long-term external balance of trade nationally;

4. Improve environmental and nutritional health, increase food production and protect important resource-use traditions, all of which are central to the resiliency of Tongan culture, and all which would contribute to national and cultural security and the maintenance of the quality of life in Ha'apai;

5. Enhance the reputation of both Ha'apai and Tonga internationally through the promotion of the areas as a World Heritage Site and an area of excellence for ecotourism, skindiving, small-scale cultural tourism and other forms of environmentally conservative tourism; and,

6. Ensure the protection and management of natural resources for sustainable growth in Ha'apai.

Other issues addressed under individual sectoral plans in DP6 (and DP6 chapters), which could be advanced under the HCAP include:

1. The active promotion of cultural and sporting/recreational activities in rural areas, such as Ha'apai (Youth, Sport and Culture);

2. Addressing conflicts between traditional and modern values and the need to find satisfactory ways of helping youth address the challenges of modern society while preserving traditional values, one of which is the preservation of knowledge about and uses of natural resources (Youth, Sport and Culture);

3. Decentralisation of educational services and the proposed establishment of Ha'apai High School which will respond to the needs for secondary education consistent with those standards already met in Tongatapu (It is stressed in DP6 that Ha'apai has traditionally been the source region of specially able students)(Education);

4. The integration into the school curricula of subjects pertaining to population issues, natural resources and the environment and the expansion of post-secondary programmes in the areas of marine science and environmental awareness (Education);

5. Improvement of primary health care (PHC), including minimisation of health hazards associated with the use of toxic substances, unsafe work practices (e.g., use of pesticides, dynamite for fishing, unsafe boats, deep SCUBA diving, etc.), improved environmental health (including improved waste disposal, provision of safe water, pollution control, proper disposal of solid and liquid waste, better location of dumps, vector control, etc. (Health);

6. Promotion of better nutrition among all segments of the population to reduce the

incidence of nutrition-related diseases, encouragement of the consumption of local food, particularly protein food, fruits and vegetables, and the promotion of appropriate means of storage and processing of local fisheries products, root and tuber crops and fruits and vegetables (Food and Nutrition); and,

7. Minimisation of construction and other activities which disregard coastal dynamics and lead to increased vulnerability during storms, control of growth patterns leading to increased risks during times of natural disaster, and the development of a comprehensive national disaster plan (Construction, Housing and Disaster Preparedness).

These are only some of the issues addressed in DP6, which are integral to the promotion of sustainable development within the HCA, and which could be furthered by attempts, under the HCAP, to conserve and enhance biodiversity of both wild and domesticated plants and animals in Ha'apai.

3 SELECTION OF PRIORITY ISLANDS AND PILOT COMMUNITIES

SPBCP stipulates that two or three priority islands or pilot communities should be selected as the initial focus during Phase 1 of Conservation Areas Projects. Following the SPBCP User Guidelines, the criteria used for the selection of "priority islands" within Ha'apai are as follows:

1. The islands should have a wide range of terrestrial and marine ecosystems and biodiversity which are representative of the Ha'apai group as a whole;

2. The islands should have a wide range of current and potential commercial and subsistence economic alternatives/activities which are representative of the Ha'apai group;

3. The islands should have terrestrial and marine species or genotypes that are endangered within the Ha'apai group, or nationally, or which have particular cultural or economic value to the people of Ha'apai and Tonga;

4. The island ecosystems and biodiversity could be threatened by overexploitation, degradation or conversion to non-sustainable uses;

5. The island communities (resource users) and their representatives must give a clear commitment to participatory involvement in the planning, implementation, monitoring, modification and expansion of the project; and,

6. The location of the islands could optimise the possibility of the success of the implementation, monitoring and modification of Phase 1 of the project in terms of logistics, cost and time constraints and the desire for the spread of the benefits of the project to other areas of Ha'apai and Tonga.

It is stressed that, although there may be no single island or community that satisfies all

of these criteria, islands or groups of islands which best satisfy most of these criteria are those which offer the greatest potential for: 1) assessing the potential for the sustainable use and management of biodiversity in Ha'apai; 2) developing and evaluating strategies to address the major threats to biodiversity; and, 3) developing models or strategies that can be transferred to or modified for adoption by other island communities, both in Ha'apai and elsewhere in Tonga to protect important ecosystems and to enable sustainable use of the biodiversity and natural resources in these ecosystems.

Based on these criteria the islands that are suggested as the focus during Phase 1 (the first year) of the Project are:

1. The islands low-lying larger islands extending from Foa (and Nukunamo) in the north to 'Uiha in the south, and including the intermediate islands of Lifuka, Uoleva, Tatafa and the island of Lofanga about 15 km due west of Uoleva (see map); and,

2. The recent volcanic high islands of Tofua and Kao, in the far west of the group.

The reasons for the selection of these areas are discussed below.

3.1. Foa, Lifuka, Uoleva, 'Uiha, Tatafa and Lofanga

It is suggested that the area encompassing Foa (and the nearby island of Nukunamo), Lifuka, Uoleva, 'Uiha, Tatafa and Lofanga, and nearby reef areas, an area which includes eleven villages, be selected for the following reasons:

1. The area has the widest range of the terrestrial and marine ecosystems represented in Ha'apai.

2. The areas has one of the most important inshore fisheries in the Ha'apai group, has an extensive reef system with numerous offshore reefs and reef passes, has two of the four existing Ha'apai Fisheries Centres, and is the base of the Ministry of Fisheries in Ha'apai.

3. The area contains the 'Auhangamea Passage, between Uoleva and 'Uiha and Tatafa, which, because of its very strong tidal currents, offers great potential as a marine reserve area for the Ha'apai group. From this area free-floating juvenile or larval stages of finfish, shellfish and other important invertebrate species, such as octopus, sea urchins, lobster and beche-de-mer, with free-floating larval or juvenile stages could settle on most of the reefs within the CA.

4. Between the tip of Foa and Lofanga is an important turtle-nesting island, Luahoko.

5. It includes, Pangai (on Lifuka), the Government Centre and administrative, transportation, communication and education centre of the group. This provides great benefits in terms of the logistics, promotion, coordination, monitoring and dissemination

of the components of the Project.

6. It has significant potential for sustainable subsistence and limited commercial agricultural production and includes the two islands in the group (Lifuka and Foa) currently involved in the potentially environmentally destructive and unsustainable squash export industry. It also contains the base of the Ministry of Agriculture and Forestry in Ha'apai.

7. It is, and will probably continue to be, the centre of the small-scale tourism industry of Ha'apai, an industry which could be significantly expanded under the Tonga National Tourism Plan.

8. It has high population densities, has most of the development and cash employment opportunities in the group, and thus, is most threatened by overexploitation, degradation and pollution of its ecosystems and biodiversity.

9. It has, in the cases of Uoleva, Tatafa and Nukunamo, relatively large uninhabited resource islands (islands with no permanent Tongan villages) that currently serve as garden areas, grazing areas, firewood and terrestrial resource reserves, fishing camps, and, in the case of Uoleva, has a small adventure tourism development. In the case of Nukunamo, there is a significant amount of sandalwood, currently the focus of Chinese sandalwood traders.

10. In the case of Lofanga, has a community that is small, isolated, and predominantly subsistence in its orientation, which could be used as an example of a relatively traditional and sustainable development model that could be extrapolated to other small, isolated islands in the group. It has been stressed by authorities in Ha'apai that this single-village community has a very strong record in the implementation of community-based development projects.

3.2 Tofua and Kao

It is suggested that Tofua and Kao be selected for the following reasons:

1. They are classical recent andesitic volcanic islands of considerable international scientific and touristic importance.

2. They have a unique, and relatively undisturbed indigenous flora and fauna, and thus could constitute national and international natural heritage sites.

3. They constitute resource islands, the terrestrial and marine resources of which could be exploited on a sustainable basis if managed properly. This includes a turtle-nesting site on Tofua.

4. They are both the increasing focus of unplanned exploitation of their terrestrial and marine resources.

5. There are reports that the deep waters, relatively close to islands, have demonstrated high catch rates for tuna and other large pelagic fish species and offer substantial potential for fisheries development.

3.3 Pilot Communities

In terms of "pilot communities" on each of the "priority islands", the following communities were visited during the preparation of the PPD and will constitute the main focus of Phase 1 of the project. These include: Faleloa and Lotofoa on Foa, Pangai and Hihifo on Lifuka, 'Uiha Village on 'Uiha; and Lofanga Village on Lofanga. It was not possible to visit Tofua, but Manaka and/or Hokula Village on Tofua will be the pilot community there. These communities will be the focus of most of the suggested activities during the first year of the project (Phase 1).

3.4 Focus in Later Phases

It is stressed that, although these two groups of priority islands and the pilot communities will be the focus of activities under Phase 1 of the project, as the project progresses: 1) other islands will be periodically selected to become more directly involved in the Project; and, 2) during the initial phases of the Project, information on all activities, including relevant promotional and educational materials and meetings, will be made available to all communities in the Ha'apai group. Opportunities will also be provided for non-pilot communities to participate in workshops and other activities. This will be done to: 1) maximise the extension and educational aspects of the project, and 2), to allow those islands or communities not originally selected to adopt, on a more self-help basis, appropriate strategies for the sustainable utilisation of their biodiversity. By taking such an approach, it is believed that the ultimate aim of the HCAP, i.e., the promotion of the conservation and sustainable use of biodiversity within the Ha'apai Conservation Area (HCA), will have a greater chance for success.

4 BIODIVERSITY AND BIODIVERSITY CONSERVATION

4.1 Definition of Biodiversity

The way in which the concepts of biodiversity and biodiversity conservation are defined are central to the success of the HCAP. In the context of the proposed HCA the "biodiversity" of Ha'apai would include:

1. All terrestrial and marine ecosystems (e.g. forests, grasslands, agricultural areas, towns, reefs, lagoons, etc.)(See Appendix 2 for a more detailed account of the ecosystems in Ha'apai);

2. All plant and animal species and varieties found in these ecosystems (e.g., all species of trees, shrubs, vines, herbs, grasses, seaweeds, shellfish, finfish, beche-de-mer, crustaceans, etc. and all varieties of yams, sweet potatoes, mangoes, etc.); and

3. The knowledge, uses, beliefs and language that the people of Ha'apai have in relation to their biodiversity. This would include the time-tested "biodiversity-management systems" which have served as a basis for the relatively sustainable habitation of the islands for over three thousand years, beginning long before the expansion of the global market economy over the islands.

4.2 Biodiversity Conservation

In the context of the SPBCP, biodiversity conservation is seen as synonymous with sustainable use. It is argued, based on the experiences of other areas of the world, that if the biodiversity of Ha'apai is not conserved or used on a sustainable basis, and if traditional sustainable management traditions, and the knowledge and language (e.g., plant and animal names and language associated with farming and fishing techniques, seasons, tides, etc.) are not maintained or strengthened, that all other modern development (e.g., business, political, social, education, etc.) will fail in the long term. Moreover, as stressed in the SPBCP programme document, biodiversity conservation is best achieved if it is done by the resource owners and users at the community level.

4.3 Biodiversity in the Context of Ha'apai

When the people of Ha'apai are asked which aspects of their cultural heritage they value most, among the most commonly mentioned include myths, legends, songs, dances, traditional feasts, seafoods, leis and garlands, kava, fine mats, tapa cloth, their seafaring and fishing skills, and yam or taro gardens. The importance of unselfishly sharing these traditions with family and community is, of course, also widely stressed. Moreover, an analysis of the most common sources of foreign exchange and cash shows that, for most people, finfish, shellfish, copra, yams and other rootcrops, fine mats and livestock are most important. Most of these culturally and economically important items have one thing in common: they depend on, are derived from, or focus on (in the case of many myths, legends, songs and dances) the island environment and its plants and animals, increasingly referred to as "biodiversity", the conservation of which is the main focus of SPBCP.

It can also be argued that the biodiversity and the traditional biodiversity-use traditions of Ha'apai are one of the main reasons why Ha'apai offers great potential as a small-scale tourism destination and a model of the traditional Tongan way of life.

Traditionally, Tongans are not highly specialised and individualistic. They are extremely "biodiversified": economically, socially, ecologically and nutritionally. They share and manage their resources and their knowledge for the benefit of the community and future generations. They are traditionally a communal society dependent on the sustainable management and sharing of their biodiversity traditions. These traditions are their strength and insurance against unforseen natural and economic disasters and life crises.

For the people of Ha'apai, "biodiversity" is not just a matter of scientific, economic (in

monetary terms), recreational or ecological value. It is a capital inheritance, which has been passed on, relatively intact or in some cases enhanced, by past generations to current generations. Biodiversity is not income that should be spent or destroyed. It is the "capital" needed for development and maintenance of the local communities and upon which almost all "income" (both cash and non-cash) is derived.

The predominant focus for most rich-country motivated biodiversity conservation includes uniqueness or endemism, scientific importance, importance as potential gene pools for genetic engineering, biotechnology, plant breeding, medicinal discoveries or other technological breakthroughs for the benefit of humankind, export or touristic potential, or the ecological benefits of biodiversity and ecosystem preservation. For the people of Ha'apai, however, the focus of biodiversity conservation should be the CONSERVATION OF THEIR BIODIVERSITY as the basis for ecological, cultural and economic survival of local communities. Particular stress is placed on the fact that for the people of Ha'apai, an estimated 25 to 90% of the real income of Ha'apai's rural or outer island communities is in the form of non-cash income derived from local terrestrial and marine plant and animal resources. Moreover, this income is relatively unaffected by inflation and deterioration in terms of trade which have historically caused imported goods (e.g., petrol, outboard engines, flour, sugar, kerosine, clothing, fishing nets, etc.) increase in cost more rapidly than increases of wages in the cash economy or payments received in return for products exported overseas or sold locally (e.g., cash crops, fish, handicrafts, etc). The availability of such locally available products is also not effected by the unreliability, breakdown or non-existence of transportation networks.

Moreover, if cultural survival and sustainability are important objectives, the focus of biodiversity conservation programmes must include not only native and endemic terrestrial and marine species, or larger "charismatic megafauna", such as the whales, sea turtles, giant clams, rare birds, etc., but must also include a wide range of endangered or ecologically and culturally important ubiquitous indigenous and exotic (non-indigenous), and wild and domesticated, species or varieties. This is seen as particularly critical in the context of smaller islands, such as the islands of Ha'apai, which (with the exception of Kao, and possibly Tofua) have limited terrestrial ecosystem diversity and few if any endemic plants or animals of global scientific interest, but where the protection of often ubiquitous plants and animals, both indigenous and exotic, must be given at least equal priority as the protection of rare, highly endemic biota of larger islands, because it is their ONLY biota. For example, a large proportion of coastal and inland tree species of cultural and economic importance (e.g. **hea**, **heilala**, **koli**, **lekileki**, **pua Tonga**, **puataukanave**, **puopua**, **tamanu**, **toi** and **wi**, to mention only a few) are rare or endangered due to overexploitation, indiscriminate ploughing, destruction by cyclones or failure of the current generation to replant, and, as a result, are in need of protection or re-establishment. Because of situations like this, the biodiversity of these small islands is much more endangered and much more in need of management than that of the larger islands in the western Pacific, such as most of the larger islands of Papua New Guinea, Solomon Islands and Fiji.

4.4 Types of Biodiversity to Be Conserved

What types of biodiversity should be conserved within the HCA? As suggested above, biodiversity can be defined in terms of both the diversity of different types of ecosystems or in

terms of diversity of plants and animals (organisms or taxa) found in a given place.

In terms of ecosystem diversity, a SPREP-sponsored survey by Dahl (1980) of characteristic ecosystems, to determine their state of endangerment and to make proposals for their conservation, identified over 70 ecosystem or biome types found in the Pacific Islands. These included: 1) terrestrial or freshwater ecosystems such as tropical lowland and upland forests, swamp and riverine forests, mangrove and coastal beach forest, woodlands and savannas, meadows, scrublands, deserts, marshes, rivers, streams and lakes; 2) marine ecosystems such as algal and seagrass beds, beaches, a range of reef and lagoon types, estuaries, offshore slopes, terraces, shelfs, canyons, sea mounts and abyssal plains; plus, 3) what seem to be subsets of these, such as seabird rookeries, sea turtle nesting areas and upwelling systems in the ocean. These are further broken down into approximately 600 individual ecosystems based on different island types, substrates, slope exposures, climate, etc. A similar diversity of ecosystems, particularly marine ecosystems is found in Ha'apai. A simplified classification of ecosystems found in Ha'apai is presented in Appendix 2.

To truly appreciate what biodiversity really means to the people of Ha'apai, it is useful to take each different ecosystem in Ha'apai and identify the types or categories of non-vascular and vascular plants and invertebrate and vertebrate animals that are found in that ecosystem. An attempt to identify some of the types of organisms that might be found in a given ecosystem are shown in Appendix 3. There are undoubtedly other classes, sub-classes or types of biological resources, or more "scientific" ways of classifying them. The system presented, however, is a first attempt at providing a system that could be used at the community, school and policy-making levels to bring to people's attention the diverse biological resources found in their ecosystems, and its ecological, economic and cultural value as a basis for sustainable development at the household, community, national and regional levels.

It becomes clear that, if all species, subspecies, forms, varieties, cultivars, races, breeds, etc. of wild and domesticated plants and animals that are present in each class, subclass or type in each terrestrial and marine ecosystem are included, biodiversity will be seen to be great in almost any ecosystem. From such a perspective, the "biodiversity" of even the smallest inhabited Ha'apai island would be considerable, in some cases almost incomprehensible to urban-based economists or "pure scientists".

Finally, the importance of biodiversity as a basis for sustainable human development becomes even clearer when a cultural or "ethnobiological" dimension is added, and an attempt is made to catalogue the uses and the cultural importance (the "bio-utility") of all organisms to a given community. As the preliminary discussions with the pilot communities showed, the priorities for biodiversity conservation in Ha'apai are almost exclusively those species which have cultural and/or economic value.

For example, an attempt to understand the cultural importance of Pacific trees (Thaman and Clarke 1993), based partly on studies in Tonga, shows that trees serve at least twelve distinct ecological functions, have over 70 cultural uses (Table 3.1), and provide between 10 to as high as 75% of the real income and production of rural Pacific peoples. To replace these products with imported substitutes would either be impossible or too expensive. To eliminate these trees would, thus, constitute a major ecological, cultural and economic disaster which would seriously

undermine self-reliance and sustainability. Unfortunately, preliminary surveys of Pilot Communities, show that, in Ha'apai, many of the trees that provided these benefits are now rare or endangered and in need of replacement.

Table 4.1. Ecological and cultural functions and uses of trees in the Pacific islands.

ECOLOGICAL		
Shade	Soil Improvement	Animal/Plant Habitats
Erosion Control	Frost Protection	Flood/Runoff Control
Wind Protection	Wild Animal Food	Weed/Disease Control
CULTURAL/ECONOMIC		
Timber(commercial)	Broom	Prop or Nurse Plants
Timber(subsistence)	Parcelling/Wrapping	Staple foods
Fuelwood	Abrasive	Supplementary Foods
Boatbuilding(canoes)	Illumination/Torches	Wild/Snack/Emergency Foods
Sails	Insulation	
Tools	Decoration	Spices/Sauces
Weapons Hunting	Body Ornamentation	Teas/Coffee
Containers	Cordage/Lashing	Non-alcoholic Beverages
Woodcarving	Glues/Adhesives	Alcoholic Beverages
Handicrafts	Caulking	Stimulants
Fishing Equipment	Fibre/Fabric	Narcotics
Floats	Dyes	Chewing Gum/Masticants
Toys	Plaited Ware	Meat Tenderiser
Switch for Children/ Discipline	Hats	Preservatives
	Mats	Medicines
Brush/Paint Brush	Baskets	Aphrodisiacs
Musical Instruments	Commercial/Export Products	Fertility Control
Cages/Roosts		Abortifacients
Tannin	Ritual Exchange	Scents/Perfumes
Rubber	Poisons	Recreation
Oils	Insect Repellents	Magico-religious
Toothbrush	Deodorants	Totems
Toilet Paper	Embalming Corpses	Subjects of Mythology
Fire Making	Lovemaking Sites	Secret Meeting Sites

Source: Adapted from Thaman and Clarke, 1987.

Similarly, an analysis of the ecological and cultural importance of 140 ubiquitous or locally important Pacific Island coastal and mangrove species, most of which are found in

Ha'apai, showed these plants to be extremely useful wherever they are found (Thaman 1992).

In terms of the ecological utility of coastal plant resources, the most important functions include the provision of shade and animal and plant habitats, protection from wind, erosion, flood and saltwater incursion, land stabilisation, protection from the desiccating effects of salt spray, soil improvement and mulching, and as animal food or links in important terrestrial and marine food chains.

Of particular importance are mangrove ecosystems which contribute either directly or indirectly, through primary and secondary productivity, to the nutritional requirements of a high proportion of marine food species (Watling 1985). Research in Fiji has shown that over 60% of commercially important species live in mangroves or depend on mangrove food webs at some stage in their life cycle (Lal et al. 1983), whereas more rigorous research gives figures of 67% and 80% for eastern Australia and Florida (Watling 1985). Destruction and reclamation of mangroves have deleterious effects on fisheries yields, with studies in the Malacca Straits indicating that mangrove reclamation for industrial expansion led to a substantial drop in catches per effort (Khoo 1976). Although mangroves are only found on Nomuka and 'O'ua, they are an important resource that must be protected. Mangrove have been reportedly almost totally removed from areas where they once were on 'Uiha and Foa.

Similarly, Pisonia grandis is the most important seabird rookery species throughout the atoll Pacific. It is a species under which phosphate-rich, bird-guano derived soil and rock are found, and a very important pig feed and living pig pen in Tonga. Where Pisonia has been removed, seabird populations decline and the location of surface schools of tuna based on the presence of seabird flocks becomes more difficult for fishermen.

One of the most important ecological roles played by coastal plants is the protection of inland agricultural areas, non-coastal vegetation and fauna, settlements, and water supplies from saltwater spray and storm surge. Of particular value, are plants with particularly high tolerance to salt spray and saline soils. Farmers in Ha'apai purposely leave strand forest intact seaside of their gardens, as they know that to remove these trees would make farming problematic. This is particularly important given the potential problems related to global warming-induced sea-level rise. One of the main problems mentioned in the preliminary surveys of Pilot Communities was the impact of salt spray on inland agricultural areas where coastal vegetation had been removed on the windward side of Ha'apai's main islands.

In terms of cultural utility, the study by Thaman (1992) showed that there are some 75 different purpose/use categories for coastal plants, with the total frequency of usage for 140 plants being 1024, an average of 7.3 purpose/use categories per plant, ranging from no reported uses for only two species to as many as 125 for the coconut, if distinct uses within categories (e.g., tools with distinct functions, different types of fishing equipment) are counted. Another 17 species have 20 or more reported uses, and 29 species have at least 7 uses each. Moreover, these figures do not include the more strictly ecological functions of coastal plants mentioned above.

In terms of specific uses, the most widely reported uses are for medicine, general construction, body ornamentation, fuelwood, ceremony and ritual, cultivated or ornamental plants, toolmaking, food, boat or canoe making, dyes or pigments, magic and sorcery, fishing

equipment, cordage and fibre, games or toys, perfumes and scenting coconut oil, fertiliser and mulching, woodcarving, weapons or traps, food parcelisation or wrapping, subjects of legends, mythology, songs, riddles, and proverbs, domesticated and wild animal feed, handicrafts, cooking equipment, clothing, fish poisons, items for export of local sale, adhesives or caulking, and musical instruments, all of which were reported for at least eleven species.

In the case of Ha'apai, analysis of preliminary survey results indicate that are over 120 finfish species, over 40 shellfish and 20 crab species are eaten, many of which are also main sources of cash income to villages. The same surveys indicated that there are over 300 plants that have economic or cultural significance. For example, are at least 74 food plants, 66 plants used medicinally, 42 as fuelwood, 35 classified as sacred or fragrant **kakala** used for garlands and scenting coconut oil, 28 for timber, 27 for animal feed, 21 for woodcarving, 19 for living fencing and hedging and 15 each for weaving and plaited ware and as dyes.

These few examples from the analysis of the utility of biodiversity to the people of Pacific island coastal areas and of Ha'apai shows the cultural sophistication and storehouse of empirical knowledge possessed by Pacific island societies in relation to their biodiversity inheritances. However, the economic, cultural and ecological value of biodiversity is rarely specifically acknowledged in development plans, project documents, or aid proposals, despite the fact that the products and benefits provided by it (even in the case of coastal vegetation alone) would be extremely expensive or impossible to replace with imported substitutes.

5 THE HA'APAI ENVIRONMENT

5.1 Geography and Physical Environment

The Ha'apai Group lies in the centre of the Kingdom of Tonga between 19° 35' and 20° 30' s. latitude and 174° 15' and 175° 6' w. longitude. To the south is the main Tongatapu Group (which includes the island of 'Eua and other smaller islands) and to the north the Vava'u and Niua Groups (see maps). Ha'apai extends 150 kilometres from Hunga Tonga Island in the southwest to Ofolanga and Ha'ano Islands in the north and northeast, and covers an ocean area of approximately 10,000 square kilometres. It consists of 62 islands[1], plus numerous rocks, sandbars, and reefs. Summary information for each island in Ha'apai is provided in Appendix 4. For some purposes (e.g., the national census) the Ha'apai Group is divided into three subregions: Hahake in the northeast, Lulunga in the west, and Mu'omu'a in the south.

Some generalisations can be made about the Ha'apai Group. An extensive barrier reef borders the group area on the east. This reef is broken into four segments and is somewhat subsided (sunken) in the south and uplifted (raised) in the north where some of the largest Ha'apai islands of Ha'apai are located. These islands, Ha'ano, Foa, Lifuka, and 'Uiha, tend to be elevated on the exposed eastern side and on the west, low-lying with sandy beaches and extensive lagoon areas. The islands to the west of the barrier reef, such as Lofanga, tend to be smaller and flatter.

The chain of high islands in the west of Ha'apai have been formed by recent volcanic activity. These islands, like the barrier reef islands, are larger and higher in the north, with the 1046 m cone of Kao Island being the highest point in Tonga. (see map). Tofua, just to the southwest of Kao, has three young cones, one of which produced a violent eruption in 1958-59. Subsurface eruptions have taken place close to Hunga Ha'apai, and the island of Fonua Fo'ou (Falcon Is.) 27 km north of Hunga Ha'apai has erupted into a substantial landmass and subsided (been eroded) below the ocean surface on several occasions since 1865. The most recent activity of Fonua Fo'ou was in 1985 which produced large rafts of floating pumice which drifted thousands of kilometres.

The 62 islands of Ha'apai range in size from less than 1 ha to 46.6 km^2 in the case of Foa Island. From Table 5.1 it can be seen that most of the islands are quite small, with only four islands having areas over 10 km^2.

[1]. For the purposes of this report an "island" is defined as a piece of land which has substantial permanent terrestrial vegetation.

Table 5.1
The Size Frequency Distribution
of the Ha'apai Islands

Island Size Category (km^2)	Number of Islands
<0.1	25
0.1 to 1	25
1.1 to 10	8
10.1 to 20	3
> 20.1	1
Total	62

Of particular importance in terms of biodiversity conservation are the extensive reef systems of Ha'apai which include the entire spectrum of reef development. This includes a 130 km barrier reef along the eastern edge of the group complete with uplifted and submerged sections, as well as numerous fringing reefs, isolated patch reefs, newly established coral colonies on recently formed islands, and the absence of reefs on active volcanic structures, such as Fonua Fo'ou. The Ministry of Lands, Survey and Natural Resources (MLSNR) reports that 15% of the Ha'apai area is coral reef.

Despite the proliferation of reefs, good all-weather anchorages for vessels are not common in Ha'apai, the exceptions being Ha'afeva and Mango. The poor quality natural harbours of the area are mostly due to the absence of a protective reef (e.g. Tofua), having only a fringing reef (e.g., Lofanga), or having a well-developed barrier reef without a pass (Ofolanga).

The underwater topography of Ha'apai is oriented in north-south bands. The Tonga Trench, one of the deepest areas in the South Pacific, is located about 130 km to the east of the group. The eastern islands of Ha'apai are situated on the Tonga Ridge which is separated from the western volcanic islands by the Tofua Trough which is about 1800 m deep. To the west of the group lies the Lau Basin, an area of active seafloor spreading. About 10% of the estimated 100 seamounts found in Tonga's EEZ are found in the Ha'apai group. These are very important ecosystems for certain types of fishing (e.g., deepwater snapper).

The waters of the Tonga Ridge between the eastern Ha'apai islands are quite shallow, especially in the central and southern portions where much of the water is around 80 meters deep. This has important implications for marine life, most of which occur in areas accessible to SCUBA divers.

Surface currents in the area are complex. The normal wind-driven surface currents to the east are affected by eddies around the islands and reefs, by wind direction changes, and by tidal flow through passages in the barrier reef. These latter currents can reach 5 knots and produce very rough seas when their direction is contrary to that of the wind. The mean high-water interval in Ha'apai is 7 hours 16 minutes, with a spring tidal range of 1.3 m and a mean tidal range of 1.1 m.

5.2 Climate

The Kingdom of Tonga lies within the southeast trade wind zone of the South Pacific Ocean, where wind patterns show remarkable consistency. Meteorological data collected at Pangai, Ha'apai since 1947 indicate that 13% of the days are calm in Ha'apai compared to 3% for Tongatapu and 17% for Vava'u. In Ha'apai the wind blows 41% of the time from the southeast. Winds from the northwest, west, or southwest, which adversely affect many of the anchorages in Ha'apai, occur about 5% of the time. The mean monthly wind speeds for Ha'apai range between 8 and 9 knots (Thompson 1986).

Air temperatures remain high all year long with slightly higher temperatures during the warm, rainy season between November and April. The mean daily temperature ranges from 22.6°C in August to 26.9°C in February, the mean daily maximum temperature from 25.5°C in August to 29.8°C in February, and the mean daily minimum temperature from 19.7°C in August to 23.9°C in February.

Historical data show an average annual sea-surface temperature (sst) of 26.6° C for the Tonga area in general. At the latitude of Ha'apai there is considerable seasonality, with a usual annual sst range of 3.2° C.

Estimates of monthly sunshine, an important consideration for the use of solar energy, range from 160 hours in July to 197 in January, and average 2151 hours per year, approximately the same as Vava'u (2150 hours) and just over 1% greater than Tongatapu (2125 hours).

The mean annual rainfall for Ha'apai is 1805 mm, with 1214 mm (67%) occurring during the six-month cyclone season from November to April. With the exception of the high islands of Kao and Tofua, Ha'apai is drier than the rest of Tonga, with periodic dry periods. Very dry spells, defined as periods of 15 or more days with no rain, occur about 24 times per decade in Ha'apai. This is about 3 times more often than in Tongatapu or Vava'u.

Tropical cyclones are also a common occurrence. In the 46 year period from 1939 to 1985, Ha'apai has been affected by 38 tropical cyclones, the most notable being Tropical Cyclone Isaac (know locally as 'Aisake) in March 1982. It was reported that the wind and accompanying storm surge destroyed 90% of the buildings in Ha'apai. Other natural disasters suffered by Ha'apai include earthquakes (one 7.5 magnitude or greater every ten years) and tsunamis or seismic sea waves (8 since 1853).

5.3 The Marine Environment

5.3.1 Nature of Reefs and Physical Structure

As stressed above, one of the prominent features of the marine ecosystem in Ha'apai is its coral reef system. The complexity and variety of the coral structures in the area is rivalled by few

other areas in the Pacific islands. The absence of significant fresh water and siltation in Ha'apai together with extensive areas of shallow water may be factors contributing to the proliferation of coral reefs in the area.

Despite the importance of coral reefs in Ha'apai, few studies have been carried out on the subject. Bell (*et al.* 1994) states that no references could be found which list the coral species, their distribution and habitat in Tonga. Wells (1988) summarizes the general information on coral reefs in Tonga and makes some general comments on reefs on 54 Ha'apai islands. Woldering (1985) contains observations on some Ha'apai reefs.

Although coral reefs are well developed around most of Ha'apai's islands, the occurrence of coral on the volcanic islands in the west is quite different. Wells (1988) reports that only small amounts of coral are found in patches at Kao and Tofua has coral only in shallow water.

The extensive areas of shallow water in the Ha'apai region creates an especially productive marine environment. Preston and Lokani (1990) estimate that in the Hahake and Lulunga subregions of Ha'apai there are 263,043,000 m^2 of water 0 to 30 meters in depth. This relatively large area is conducive to substantial populations of benthic invertebrates and sea-grasses and creates especially favourable habitats for shallow-water finfish and turtles.

Of particular interest from an ecological perspective, in terms of biodiversity conservation, are the numerous passages in Ha'apai's eastern barrier reef, particularly 'Auhangamea Passage between Lifuka and 'Uiha. The swift tidal currents that move through these passages create a situation where the planktonic eggs or larvae emanating from spawning in the passages could settle virtually anywhere in the Ha'apai group. Many of reef organisms, including finfish, shellfish, beche-de-mer, crustaceans and octopus, produce planktonic eggs, larvae or juvenile stages (e.g. free-floating juvenile stages of finfish), often numbering in the millions, that drift in the current for days to months, which may settle as bottom dwelling juveniles or adults. If sections of such passages could become reserves, eggs, larvae and juvenile stages of a wide range of species could disperse to surrounding areas providing some degree of protection against stock collapse.

5.3.2 Nature of Marine Biodiversity

Despite this favourable environment, the diversity of inshore marine species in Ha'apai, as well as in the rest of Tonga, is significantly less than Fiji to the east. It is hypothesized that the geological history of the islands of Tonga is responsible for this phenomenon. Species such as the commercial trochus (*Trochus niloticus*), the blue anchovy (*Stolephorus heterolobus*), and the Spanish mackerel (*Scomberomorus comerson*) are examples of an invertebrate, an inshore fish, and a nearshore pelagic fish, respectively, which are common in the Lau Islands of Fiji but do not occur naturally in Ha'apai less than 400 km to the east.

Several species of marine organisms have been introduced into Ha'apai. In 1982 the seaweed *Eucheuma* was brought to Vava'u from Fiji and was later cultured on a trial basis in Ha'apai. Most recently, 587 commercial trochus shells (*Trochus niloticus*) were transplanted from Fiji to the 'Auhangamea Passage between Uoleva and 'Uiha in January 1995 as part of the

Ha'apai Fisheries Development Programme. Tilapia (*Oreochromis mossambica*)(known locally as **lapila**), a fresh- to brackish-water fish, was introduced into Tonga by the South Pacific Commission in the 1950s (Gillett 1989) and eventually released into the lake in Nomuka and wells on Ha'ano. Reports are that it now well-established and it is likely that tilapia is now also present in inshore areas around these islands. It is likely that other marine species have inadvertently been introduced, the fouling communities on the hulls of ship being a probable mechanism.

In the pelagic marine environment four species of tuna are found in large abundance: albacore, yellowfin, bigeye, and skipjack. High mobility, large biomass, and widespread spawning are general characteristics of the resource in the tropical Pacific. In addition, the tunas in Ha'apai exhibit a marked seasonality, with maximum abundance in the warmer months. In the late 1970s research done by South Pacific Commission showed that tuna tagged in the Tonga 200-mile zone and the area immediately around the zone move to Papua New Guinea, Tahiti, New Zealand and Micronesia.

Numerous species-focused fisheries surveys have been carried out in the Ha'apai area in the past 50 years. These include surveys of turtles (Vaea and Straatmans 1954; Mauck and Mauck 1972; Koloa 1972; Braley 1973; Anon 1993); bottomfish (Mead 1979, 1980, 1987; Thomas 1978); giant clams (McKoy 1980; Manu *et al*. 1989); beche-de-mer (Okamoto 1984; Preston 1990); whales (Dawbin 1953; Thomas 1978; Cawthorn and Manu 1980; Keller 1981); tuna (Thomas 1978; Gillett and Kearney 1978; Tuna Programme 1983); lobsters (Prescott 1990); baitfish (Alexander 1902; Vaea and Straatmans 1954, JICA 1973); flyingfish (SPC 1992); sharks (Koloa 1973); precious corals (Eade 1980); black coral (Chesher 1985); inshore fish (Smithsonian 1994, unpub.); and freshwater fish (Maciolek and Tamada 1981).

General marine environmental surveys which have focussed to some extent on Ha'apai include: Dawson (1971, includes Kao and Tofua); Dahl (1978); Fenn (1972); and Wolterding (1985). Information on the above are provided in the Bibliography and References section, in the *Tonga Fisheries Bibliography* (Gillett 1994), and in the *Kingdom of Tonga Marine Resource Profiles* (Bell *et al*. 1994).

These studies show that the marine biodiversity in Ha'apai is somewhat different than the situation on land (see below) in that there are no immediate local threats to entire ecosystems in the ocean. Several marine species in Ha'apai do, however, deserve special attention with respect to either biodiversity or sustainable development. As the Ha'apai Conservation Area develops, it is expected that local residents will identify species which they consider to be of special concern. An initial impression of these species (and the reason for the interest) are:

1. sea turtles because of recent decreases in nesting sites in Ha'apai;

2. giant clams, including *Tridacna tevoroa* which is endemic to central Tonga and southeastern Lau, *T.derasa* which has experienced recent population decreases, and *Hippopus hippopus* which has possibly become extinct in Tonga in recent times;

3. coconut crab (*Birgus latro*) which has been recently eliminated from most Ha'apai islands due to over-harvesting;

4. beche-de-mer, currently of great commercial importance but is being over-harvested;

5. lobsters which is of great commercial importance but is presently being over-harvested;

6. black-lip pearl oyster (*Pinctada margaritifera*) which has great commercial potential for aquaculture but is possibly rare in area;

7. humpback whale (*Megatera novaeangliae*) which is seasonally abundant in Ha'apai, is endangered and offer considerable potential as a tourist attraction for whale watching;

8. triton shell (*Charonia tritonis*) which is sold commercially on a small-scale, mainly to tourists, and which has an essential role in the control of the crown-of-thorns starfish (*Acanther planchii*); and,

9. stony (Scleractinian) corals which are an essential component of ecosystem and a target in Tonga for large-scale harvesting for export.

Several of the marine animal species present in Ha'apai are formally considered endangered by various organizations. Species in the area which are covered by the IUCN Red List of Threatened Animals, the U.S. Endangered Species Act, and the Convention on International Trade in Endangered Species (CITES) include: humpback whale (*Megaptera novaeangliae*), green turtle (*Chelonia mydas*), hawksbill turtle (*Eretmochelys imbricata*), all stony coral species (Order Scleratinia), southern giant clam (*Tridacna derasa*), elongate giant clam (*Tridacna maxima*) and the fluted giant clam (*Tridacna squamosa*).

On the topic of marine reserves, Bohnsack (1994) argues that tropical coral reef reserves, in addition to providing direct benefits to fisheries, can protect biodiversity and provide areas in natural balance, free from direct human disturbance. J. Munro (1995: pers.comm.) states that topographically complex areas which generate lots of gyres and eddies (circular or spiral currents) are probably more effective as reservoirs of broodstock than marine protected areas situated on small oceanic islands or narrow linear shelves. Following from this, the 'Auhangamea Passage, because of its complex and cyclical current patterns, appears to be a relatively favourable site for a marine reserve.

The establishment of marine reserves, as nursery areas for Ha'apai, has implications for many marine species of special biodiversity conservation concern in Ha'apai. For example important commercial species, which are very susceptible to stock collapses, such as giant clams (*Tridacna* spp.), beche-de-mer (Holothurians) and trochus, have larvae which remain in the plankton for about 21 days, 20 days and 3 or 4 days, respectively. The establishment of reserves could protect them and other important species from stock collapses.

5.4 The Land Environment

As stressed above, relative to ocean area, the land area of Ha'apai is extremely limited, with the 62 islands of Ha'apai ranging in size from less than 1 ha to 46.6 km^2. Only four islands have areas over 10 km^2. Nevertheless, it is estimated, based on preliminary surveys conducted as part of the PPD preparation, that most of the total income (cash + non-cash) of rural people in Ha'apai comes from the land in the form of staple and supplementary foods, firewood, construction materials, handicrafts, medicines, cosmetics and a wide range of other products of economic and cultural importance.

5.4.1 Hydrology and Water Resources

Scarcity of freshwater is an important constraint to sustainable development in the islands of Ha'apai. The main water resources are rainwater catchment systems and groundwater, with surface freshwater being found on only a few islands.

In terms of surface water resources, Tofua has the 8 km^2 freshwater Lake Lofia, the surface of which is 23 m above sea level, and a small freshwater lake of about 0.5 km^2 exists in the crater on Kao Island. Lake Ano'ava on Nomuka Island, a brackish lake with an area of 1.8 km^2, is 1.2 to 1.5 m deep and fringed with mangroves and salt marsh. There is also a large undrained depression occupied in part by a freshwater swamp on Foa, which probably represents a residual lagoon or deepwater feature of the ancient reef complex that was uplifted to form the island (Dickenson *et al*. 1994). The volcanic islands also have small groundwater aquifers.

On other limestone islands, there are no streams, lakes or other surface water resources, the main sources of water being groundwater and rainwater caught from rooftops and stored in cement, fibreglass and iron cisterns or tanks. The main groundwater source is a thin freshwater lens formed by rainwater which percolates down into porous limestone substrate, where is hydrostatically held within the permeable limestone layer floating on the heavier saltwater beneath the islands. The size and shape of the lens depends on the size, shape, elevation and geology (permeability) of the island, amount and distribution of rainfall, tidal effects and degree of saltwater incursion, seepage or lateral flow and the water extraction or use-rate.

There is little data on the exact configuration or size of the freshwater lenses in Ha'apai, although some evidence indicates that the freshwater lenses on Foa and Lifuka appear to be restricted by the presence of dense, plastic clay in the weathered ash at depths of a few metres and dense limestone layers, both of which reduce infiltration and recharge rates and separate the main aquifer in the centre of the islands from the shallow aquifers on the low-lying west sides of the islands. Although a well-defined freshwater lens exists on Lifuka north of existing wells, it is charged with organic gases. The lens on Foa is limited and not well-defined, and small coral islands less than 400 metres across usually have no fresh groundwater (IDEC 1990).

The Department of Health estimates that 85% of the Tongan population uses groundwater while the remaining 15% relies on rainwater catchments. There is a reticulated water system providing groundwater to the Pangai-Hihifo area of Lifuka and there are village wells in 7 Ha'apai villages. The remaining villages and household depend on individual household wells or on rainwater catchment systems. In most households brackish groundwater is used for washing, cleaning and flushing toilets, while rainwater is used for drinking. On some of the small outer islands, only rainwater is available, and during extended periods of drought, as occurred in 1987, coconuts provide the only readily available source of liquid refreshment. In Ha'apai investigations have located supplies of fresh water close to the main reticulated area in Pangai. Further studies will identify the potential number and location of wells which could replace the existing salty water supply. Such studies are being carried out on 'Uiha, Foa and Ha'ano. The results are being used in the Tonga Water Supply Master Plan Study to develop a model for village water supply (Thistlethwaite 1992).

Increasing local urbanisation in the Pangai-Hihifo area, the development of small-scale tourism and other proposed developments under the National Tourism Plan, the development of the new wharf, and the possible expansion of squash cultivated for export will place further demands on scarce groundwater resources and require improvements in rainwater catchment systems. The estimated daily consumption in rural areas where a reticulated water supply is available, such as in Pangai-Hihifo, is 30-50 litres per person. In Tongatapu, where the demand for water has risen because of higher standards of living, it is estimated that potable water consumption increased nearly tenfold over the 1970s and 1980s, with the average daily consumption in Nuku'alofa now about 80 litres per person (Thistlethwaite 1992).

In terms of water quality, Analyses of trace elements in Ha'apai indicate that the pH of all samples fell within the range of 7.0-7.5, chloride concentrations were below 200 mg/l, and total hardness was within the WHO standards of 100 (permissible) and 500 mg/l (excessive). Actual data for chlorides and hardness were not presented and total solids were not measured. Magnesium exceeded the "excessive" standards for Pangai. All trace metal (cadmium, chromium, arsenic, selenium, manganese, lead, copper, mercury and zinc) were within the permissible levels in wells tested at Pangai and Faleloa on Pangai and Foa, respectively (Fuavao 1987). Stoll (1987) found the groundwater from Foa and Lifuka unsatisfactory for drinking owing to unacceptably high salt content. Although Fuavao (1987) did not measure salinity, the sodium content at Faleloa was 371.3 mg/l, enough to impart a "decidedly salty taste to the water." During a pumping test at a Tonga Water Board well in Pangai, salinities were observed to increase from 7.0 parts per thousand (ppt) to 8.7 ppt after four hours pumping. The taste threshold for salinity is about 1.0 ppt (IDEC 1990).

In order to ensure the maintenance of water quality, bore holes or wells tapping the freshwater lens should be located in the thickest part of the lens and pumping should be closely monitored, continuously and at a rate which ensures that the thickness of the lens above sea level is not reduced to less than half the original thickness, because when the cone of pumping depression intersects sea level datum, sea water will upwell into the bore. Once contaminated with sea water, wells may take years before the delicate freshwater:saltwater balance is re-established (Dale and Waterhouse, 1985).

Because of the shallow, permeable nature of the soils and the proximity of the water table (top of the freshwater lens) to the surface, the freshwater lens is very vulnerable to surface pollutants such as human waste from pit and water-seal latrines and septic tanks, agricultural chemicals, such as nitrogenous fertilisers and pesticides, and oil. Increasing salinity due to overpumping, drought and saltwater incursion are also problems affecting freshwater supply. Other problems related to water quality include the contamination and non-maintenance of rainwater catchment and storage systems and the possibility of low-level contamination from lead, mercury, organotins and other harmful contaminants, such as paints used on materials in the roofing and storage tanks of the rainwater catchment systems. Although no studies have been conducted in Tonga, ingestion of particles of lead-based paints can yield intakes thousands of times greater than safe drinking water standards, and tests did show that the lead levels in dry paints in some areas of Tonga exceeded the safety standards in New Zealand (Chesher 1984).

5.4.2 Mineral Resources

Limestone and sand, used mainly for construction, constitute the only minerals of commercial value at present. There are no known commercial deposits of fossil fuels, gold, copper or other valuable minerals in Tonga. Although oil exploration commenced in Tongatapu in the late 1960s, and extensive seismic surveys were conducted during the DP5 period in the Lau Basin of Fiji, which is considered by geologists as a promising area, no oil was found. However, based on a recent major review of the oil potential, new oil exploration activity is likely (Thistlethwaite *et al*. 1993).

There are number of limestone quarries in Ha'apai, from which limestone rock and aggregate has been mined for used in general construction and for the completion of the airstrip on Lifuka. Major quarries include the quarry at Nu'anga which was the major source of material for the airstrip, a new quarry near the ocean coast (**liku**) opposite Pangai on Lifuka, and a major quarry on Foa which is being mined to provide large amounts of limestone for the new harbour and wharf facility at Pangai.

Quarrying is carried out by digging, blasting and ripping the foraminiferous limestone and fossil coral. Quarrying near the ocean coast, often penetrating to the beach areas on the coastal terrace, is major environmental concern and a caused of increased vulnerability to tropical cyclone and salt spray damage to inland agricultural areas. Quarrying at Nu'anga, which led to the removal of the coastal littoral forest, is believed to have been a least partly responsible for heavily damage of inland areas during Tropical Cyclone Isaac in 1982. Current quarrying on Foa and Lifuka for the new harbour construction is a major source of concern in Ha'apai, and is being closely monitored by both AUSaid and LEPU.

Sand is used to make aggregate for cement and, with increasing modern construction activity, is in rapidly increasing demand. Large quantities of sand are also used traditionally for covering graves in Tongan cemeteries. Sand is surface mined from beaches by heavy equipment, with a number of beaches, in Tongatapu, having been stripped to the limestone rock substrate. Although MLSNR is responsible for issuing permits for sand mining, sand is still taken by individuals despite a law forbidding unapproved removals.

Sand surveys have been conducted for the past decade to locate marine or terrestrial beds of sand for construction purposes. Many deposits have been considered but the sand either proves too silty or too fragile for construction purposes. A suitable aggregate for cement may be obtained by crushing limestone, but this practice has not yet been introduced to Tonga (Thistlethwaite *et al*. 1993).

5.4.3 Soils

In general, most of Ha'apai's soils are friable, well-structured, well drained and, with adequate fertilizer and reasonable management, are capable of sustaining production of a wide range of tree and ground crops. The soils range from recent volcanic soils on Tofua and Kao and on the nearby island of Fotuha'a to sandy, well-drained soils of low fertility on Uoleva, some of the smaller inhabited and uninhabited islands and in coastal areas.

The now-weathered volcanic ash found on most of the larger low-lying islands was deposited during two distinct volcanic epochs from eruptions of the nearby volcanoes of Tofua and Kao in the west of the Ha'apai group and Late and Fonualei to the west of the Vava'u group. These volcanic epochs occurred about 5,000 to 10,000 years ago and about 20,000 years ago, respectively (Orbell 1983).

The main agricultural soils of the raised limestone islands are brown clay soils derived from volcanic ash. The soils on the western sides of the islands (closer to the volcanic activity) have larger particle sizes while soils on the eastern sides tend to be composed of finer volcanic ash. These soils are deep, friable, well-structured and have high water holding capacities and good aeration. They have marked deficiencies in nitrogen, phosphorous, sulphur and potassium (Beecroft 1976; IDEC 1990).

Tropical yellow-brown coral sandy soils are found in coastal areas of the raised limestone islands and in the interiors of the smaller sand keys and reef islets. These have serious chemical and physical limitations for agriculture, are excessively well-drained, have low nutrient content, low water holding capacity and a very loose structure. High pH limits the uptake of trace elements such as iron, magnesium, copper and zinc. The soils of the large, low-lying sandy island of Uoleva, southeast of Lifuka, for example, are generally only suitable for the production of coconuts and a narrow range of, mainly subsistence crops, such as cassava, sweet potato and melons, which do well on sandy soils.

There are some poorly drained or hydromorphic (waterlogged) soils in some areas. These include the central area of Uoleva where the soil surface is close to the water table and which is often waterlogged during spring tides, and the large undrained central depression on Foa which is occupied, in part, by a freshwater swamp (Dickenson *et al*. 1994).

The windward sides of many islands have shallow dark-brown calcareous sandy-loam soils which overlay near-surface coral-limestone. These soils have severe limitations imposed by shallow rooting depth, low water holding capacity and salt-spray damage. Such areas are generally kept under coastal littoral forest as a protection zone for inland garden areas from

saltspray and wind damage (IDEC 1990).

The steep volcanic islands of Tofua and Kao are covered with partially weathered lava. There is a thin layer of coarse ash is found on flat surfaces and in cracks and depressions in the lava. There is little topsoil (Orbell 1983).

5.4.4 Flora and Vegetation

The native flora and vegetation on most of Ha'apai's islands, except on the upper slopes of Tofua and Kao and on some of the uninhabited smaller islands, has been highly disturbed by over three thousand years of human habitation. Despite the high degree of disturbance and the small size of the islands, the indigenous and exotic flora supply most of the basic needs and a high proportion of the commercial income of the people of Ha'apai.

The only islands in the Ha'apai group for which detailed published data on the flora exist are Pangai, Nomuka and Kao. References to these are found in Yuncker's *Plants of Tonga* (1957). Whistler's "Vegetation of Samoa and Tonga" (1992a) is the best source on the vegetation of Tonga, but includes only limited reference to Ha'apai. Whistler's *The ethnobotany of Tonga: The plants, their names, and their uses* (1991) provides valuable information about the plants of Tonga and their names, habitats, uses and Tongan names, and cites the presence of some species in Ha'apai, based on collections by Buelow in the 1970s and Whistler himself in the 1980s. Also useful in terms of providing habitat information, current scientific and Tongan names, uses, plant descriptions and photographs are Whistler's *Coastal flowers of the tropical Pacific* (1980), *Flowers of the Pacific Island seashore: A guide to the littoral plants of Hawai'i, Tahiti, Samoa, Tonga, Cook Islands, Fiji and Micronesia* (1992b), and his *Herbal medicine in the Kingdom of Tonga* (Whistler 1991). Sykes' *The vegetation of Late, Tonga* (1989), a recent volcanic island similar in many ways to Tofua and Kao, provides valuable information which could serve as a check list for botanical surveys of Tofua and Kao. Preliminary surveys of the plants, their uses, names and endangerment status during the preparation of this PPD and visits to Foa, Lifuka and Mo'unga'one by R. Thaman in 1981 also provided additional information on the flora and vegetation. The following account is based on these data.

In terms of the overall flora of Ha'apai, preliminary analyses of available sources indicate that the terrestrial vascular flora of Ha'apai is composed of somewhere around 500 species (Table 5.2). Very little is known about the non-vascular flora (e.g., fungi, lichens, mosses, etc.). Of these 500 species, at least 12% are only found in Ha'apai on the high volcanic islands of Tofua and Kao, with at least two species being endemic species found nowhere else in the world. For all of Ha'apai, indigenous plants represent about 40% of the flora with the balance being made up by exotic introductions, which include some aboriginal introductions by the early Tongan inhabitants (e.g., taro, yam, breadfruit, kava, plantains, fruit trees, medicinal plants, other useful plants and some weeds), with the bulk of the exotics representing recent post-European-contact introductions (e.g., new food crops, timber trees, weeds, ornamentals, etc.). Indigenous species would undoubtedly represent a larger proportion of the flora on Tofua and Kao and on some of the smaller uninhabited islands. These numbers, possibly including the numbers of endemics, would increase appreciably as

further botanical studies are carried out. There have been few if any published studies on the marine flora of Ha'apai.

Table 5.2. Plants reported present in Ha'apai by Yuncker (1957) or Whistler (1991) or recorded during a rapid rural appraisal of Foa, Lifuka, Uoleva, 'Uiha and Lofanga in 1995 (Notes: I = indigenous species, E = exotic species that have been introduced by humans; * the totals for Tofua and Kao are not the total flora for these islands, but only those species found there, but not reported from other islands in Ha'apai. The Ha'apai total does, however, include species from Tofua and Kao).

Class	Tofua/Kao		Total Ha'apai		Total Species
	I	E	I	E	
Fungi	-	-	2	-	2
Lichens	1	-	1	-	1
Mosses	4	-	4	-	4
Ferns/Allies	17	-	20	1	21
Gymnosperms	-	-	-	5	5
Monocotyledons	11	1	27	68	95
Dicotyledons	27	1	143	212	355
TOTAL	60	2	192	286	478

In terms of vegetation, the main indigenous vegetation types found in Ha'apai include: 1) marine-aquatic vegetation, 2) coastal littoral vegetation, 3) mangrove, 4) wetland vegetation, 5) lowland rainforest, and 6) montane scrub. Disturbed or cultural vegetation types include: 1) secondary forest, 2) secondary scrub, 3) plantation and garden areas, 5) ruderal vegetation, and 6) houseyard and village gardens.

Marine-Aquatic Vegetation: Ha'apai's marine-aquatic vegetation includes a wide range of marine algae and a number of sea grasses, all of which are of considerable ecological importance. No detailed information could be found on either the marine algae, a number of which are eaten, or on sea grasses of Ha'apai. A review of existing literature by Bell *et al.* (1994) and tentative identifications during the 1995 visit to Ha'apai, indicate that the main edible seaweeds are *Caulerpa racemosa* (**limu fuofua**), *C. serratula* (**limu kaka**?), *Caulerpa sertularoides* (**limu loniu**), *Hypnea nidifica* (**limu tanga'u**) and *Codium gepii* (**limu te'emoa**). Two unidentified species could possibly be *Graciliaria verrucosa* or

Solieria sp. which are eaten in Fiji, and which might also be referred to as **limu kaka**. Other local names recorded during the RRA include **limu tu'u, limu tiemaka**, **limu po'oi** and **limu kula**.

The most abundant marine vascular plants are the sea grasses (**limulimu**?), *Syringonium isoetifolium* and *Halodule uninervis*, both which look superficially like grass, and *Halophila ovalis*. The principal and largest seagrass in Tonga is *Syringonium isoetifolium*, which is abundant sub-tidally. It is erect, reaches 30 cm or more in height, is round (terete) in cross-section and has two or three leaves at each node. Its rhizomes consolidate loose and friable sand. Also very common intertidally on reef flats, is *Halodule uninervis*, which reaches 8 cm or longer, and has two to three very slender stems and flat, very thin leaves arising at each node. *Halophila ovalis*, the most un-grasslike, is a slender, shallow-rooted plant with paired oval leaves with cross veins which arise from each node. It creeps over the surface and is often exposed at low tide. *Ruppia maritima* is also probably present (Yuncker 1957).

Sea grass beds are important food resources for turtles, some important shellfish, such as *Lambis lambis* (**anga anga**), a range of finfish, the cake urchin, *Tripneustes gratilla* (**tukumisi**) and serve as an spawning ground for a number of important finfish species.

Coastal Littoral Vegetation: The coastal littoral vegetation is composed almost entirely of salt-tolerant ocean-dispersed plants. The outer ("outpost") zone is comprised of mainly herbaceous species, the most common being vines such as *Ipomoea pes-caprae* (**fue tahi**), *Vigna marina* (**lau tolu**) and *Canavalia sericea* (**fue tahi veveli**). Common grass species include *Thuarea involuta* (**kefukefu**) and *Lepturus repens*. A locally common sedge (grasslike plants which, unlike grasses, have stems which are triangular rather than round in cross section) in beach sand is the culturally useful *Cyperus stoloniferus* (**pako** or **pakopako**), the juice of the nut-like root tuber of which is used to scent coconut oil. Small shrublike plants include *Triumfetta procumbens* (**mo'osipo**, **mo'osipo Tonga**?) and *Chamaesyce chamissonis (atoto)* (**kavahuhu tahi, kihikihi tahi?**). In disturbed areas close to habitation the exotic common beach burr, *Cenchrus echinatus* (**hefa**) is common. It is considered a noxious weed and has possibly replaced the indigenous *Cenchrus calyculatus*. In rocky areas or outcrops of coastal limestone the sedge *Fimbristylis cymosa* is found along with *Lepturus repens*. The parasitic *Cassytha filiformis* (**fatai**) is also common in the outpost zone as well as in inland thickets.

Inland from the herbaceous communities is the littoral shrubland community which is dominated by *Scaevola taccada* (**ngahu**) and *Wollastonia biflora* (**ate**). Other species occasionally found in this zone which lies coastward of, or intergrading into the coastal littoral forest or *Pandanus* scrub, include the shrubby species *Ficus scabra* (**masi ata**), *Premna serratifolia* (**volovalo**) and *Colubrina asiatica* (**fiho'a**). Uncommon are *Dendrolobium (Desmodium) umbellatum* (**lala 'tua**), *Sophora tomentosa* (**lata**), *Tephrosia purpurea* (**kavahuhu**); and the vines or clambering shrubs *Abrus precatorius* (**matamoho**, **moho**), *Caesalpinia major* (**talatala'amoa**), *Clerodendrum inerme* (**tutuhina**) and *Mucuna gigantea* (**valai**, **pa'anga 'ae kuma**). Common on jagged coastal limestone terraces and outcrops and seaside cliffs is *Pemphis acidula* (**ngingie**), while *Sesuvium portulacastrum* (**kihikihimaka**) is occasional on coastal limestone and lava rocks. Also locally common on

the windward coastal beaches is *Suriana maritima* (also called **ngahu**).

Common salt-tolerant tree species found in coastal littoral forest include *Barringtonia asiatica* (**futu**), *Calophyllum inophyllum* (**feta'u**), *Hernandia nymphaeifolia* (*fotulona*), *Terminalia catappa* (**telie**), *Tournefortia argentea* (**touhuni**), *Pandanus tectorius* (**fa**), *Pisonia grandis* and the ubiquitous coconut palm, *Cocos nucifera* (**niu**). Other less common, often endangered, species include *Acacia simplex* (**tatangia**), *Cerbera odollam* (**toto**), *Cordia subcordata* (**puataukanave**), *Ficus scabra* (*masi'ata*), *Guettarda speciosa* (**puopua**), *Neisosperma oppositifolium* (syn. *Ochrosia oppositifolia*) (**fao**), *Schleinitzia (Leucaena) insularum* (feifai), *Syzygium richii* (**lepa, heavula**), *Terminalia litoralis* (**telie'amanu**), *Thespesia populnea* (**milo**) and *Vitex trifolia* (**lala tahi**). Also a common component of the littoral forest, although possibly an aboriginal introduction, is *Hibiscus tiliaceus* (**fau**). *Casuarina eqisetifolia* (**toa**), also possibly an early Polynesian introduction, is occasionally found in the littoral zone. Locally common in limestone areas are the tree, *Excoecaria agallocha* (**feta'anu**) and the small shrub *Bikkia tetrandra* (**sialetafa**). Other shrubby species found occasionally in the littoral forest or thickets include *Dalbergia candenatensis* (**moho**), *Canthium barbatum* (**olamaka**), *Psydrax odorata* (*Canthium odoratum*)(**olamaka**), *Eugenia reinwardtiana (rariflora*) (**unuoi**), *Ipomoea macrantha* (**fue hina**), *Phalaria disperma* (**huni**) and *Ximenia americana* (**vi tahi**). Occasional understorey species include *Achyranthes aspera* (**tamatama**), *Derris trifoliata* (**kavahaha**),**and** *Tacca leontopetaloidies* (**mahoa'a**, **mahoa'a Tonga**). Coastal species also reported from Ha'apai in 1953 include *Gymnosporia vitiensis* which is well adapted to limestone areas and reported from Nomuka, and *Corchorus torresianus*, which was reported present on the north end of Lifuka just above the high-tide limit (Yuncker 1957). The more important coastal littoral species are listed in Appendix 5).

Directly inland from, and often intergrading into the coastal littoral forest (but not found directly on the seashore) is an intermediate coastal forest which includes *Diospyros elliptica (ferrea*) (**kanume**), *Geniostoma rupestre* and *Geniostoma vitiense* (both **te'epilo'a Maui**), *Glochidion ramiflorum* and *Glochidion concolor* (**masikoka**, **malolo**), *Grewia crenata* (**fo'ui**), *Myristica hypargyraea* (**kotone**), *Planchonella grayana (costata*)(**kalaka**), *Santalum yasi* (**ahi**), *Syzygium clusiifolium* (**fekika vao**). Now rare in such forests is the small indigenous tree *Cordia aspera* (**tou**). A common shrub found in this zone on Uoleva, but also reported present on Nomuka, Lifuka and Kao, is *Wikstroemia rotundifolia* (**lala vao**), which is considered by Yuncker (1957) to be endemic to Tonga.

Mangrove: Mangroves are now probably limited to Nomuka and 'O'ua, although there were reportedly small localised concentrations of mangroves on Foa, Lifuka and 'Uiha, which have since been cleared. Species present in the mangroves on Nomuka, which are found bordering the central Lake Ano'ava include *Bruguiera gymnorrhiza* (**tongo ta'ane**), *Rhizophora mangle* (**tongolei**) and *Excoecaria agallocha* (**feta'anu**). A small population of a red-flowered (calyxed) variety of *Bruguiera gymnorrhiza* (**fa'onelua**) which bordered the harbour at 'Uiha was cleared when the new jetty was constructed, with a single tree remaining (probably deliberately planted) in 'Uiha Village about 300 m south of the jetty and 200 m inland from the coast. The culturally important mangrove species *Xylocarpus granatum* (**lekileki**), although not reported present in Ha'apai by either Yuncker or Whistler, was reported in the RRA to be present on Foa, Pangai and 'Uiha, although now extremely scarce or extinct. Also probably present mangrove areas is the grass *Paspalum vaginatum*

(distichum) (**mohuku ano)**, which is common bordering mangroves throughout the Pacific. Possibly absent from Ha'apai is the common mangrove-associated fern, *Acrosticum aureum* (**hakato**), which is common in mangrove areas elsewhere in Tonga.

Wetland Vegetation: In terms of wetland or marsh vegetation, species which have been reported from the freshwater swamp area on Foa or bordering brackish Lake Ano'ava on Nomuka include *Coix lachryma-jobi* (**hana**), *Elaeocharis dulcis* (**kutu** or **kuta**), *Mariscus (Cyperus) javanicus* (**mahelehele**) and *Scleria lithosperma* (**mahelehele**). *Elaeocharis geniculata* has been reported from the margins of a small alpine lake near the summit of Kao at about 950 m, which could be considered to be a montane marsh community, the flora of which should be explored in more detail. *Ludwigia octovalvis* (syn. *Jussiaea erecta*)(**loa ano**) is also found in some poorly drained areas. Trees which are common to occasional in swampy areas include *Inocarpus fagifer* (**ifi**), *Erythrina fusca* (**ngatae fusca**), *Excoecaria agallocha* (**feta'anu**), *Citrus grandis* (**moli Tonga**) and *Psidium guajava* (**kuava**). It would also be expected that the common marsh grass, *Paspalum vaginatum*, would also be present in swampy areas in Ha'apai. *Miscanthus floridulus*, a useful bamboo-like grass is also occasionally found is moist sites, and *Leucas flaccida* is also reported from crevices and pockets of soil in rocks just offshore in the central lake in Nomuka (Yuncker 1957).

Lowland Rainforest: With the exception of an estimated 324 ha of forest on Tofua outside the crater which could be exploited and the forest which extends to about 500 m elevation on Kao, the lowland forest of Ha'apai has been almost totally removed during agricultural clearance, to obtain construction materials and firewood and, during the banana boom of the late 1960s and early 1970s, to obtain timber to make boxes for shipping bananas. Although the forest on Kao could be considered a lower montane forest, it is included in lowland rainforest in accordance with Whistler's (1992) categorisation of montane forest as forest occurring above 550 m.

From available data, trees species found in the forests of Tofua and Kao (mainly based on studies on Kao) include *Alphitonia zizyphoides* (**toi**), *Calophyllum neo-ebudicum* (**tamanu**), *Canarium samoense* (**makai**), *Canthium barbatum*?? (**olamaka**), *Diospyros samoensis* (**tutuna**), *Elattostachys falcata* (**ngatata**), *Garcinia myrtifolia* (**feto'omaka**), *Geniostoma fleischmannii*?, *Heritiera littoralis* (**ifi 'ae kuma, mamea**?), *Melicope seemannii* (**uhi vai**), *Mussaenda raiateensis* (**monomono hina, monomono'ahina**), *Myristica hypargyraea* (**kotone**), *Neisosperma oppositifolium* (**fao**), *Neonauclea forsteri* (**afa**), *Psychotria insularum*, *Rhus taitensis* (**tavahi**), *Syzygium clusiifolium* (**fekika vao**), *Tarenna sambucina* (**manonu**) and *Vavaea amicorum* (**ahivao**). Of particular interest is an endemic tree, *Psychotria kaoensis*, about 4.5 m tall, reported from open forest on a rocky slope at about 180 m elevation. Also reported from Kao at about 30 m elevation in 1953 (Yuncker 1957) was *Intsia bijuga* (**fehi**), the only reported occurrence of this very important carving wood which is common in Fiji and somewhat less common in Samoa, but which has very important cultural significance in Tonga. Although Whistler believes that this tree was introduced from Fiji, the Kao record could be natural as it is found in similar volcanic habitats on the recent volcanic island of Savai'i in Western Samoa.

Vines or lianas reported from forested areas on Kao and Tofua include *Alyxia stellata* (**maile**), *Faradaya amicorum* (**mamange, fufula**?), *Hoya australis* (**lau matolu**), *Ipomoea*

littoralis (**fue 'ae puaka**), *Melothria grayana*, *Morinda umbellata*, *Rouria minor* (**va'a'uli)** and *Santaloides samoense* (**tuamea**), with *Passiflora samoensis* covering weeds and shrubs on the lower slopes. The shrub *Dodonaea viscosa* was also reported on the edge of the forest on a steep rocky slope (Yuncker 1957).

Other species, most of which are found in Ha'apai only on Kao or Tofua, that are reported from steep forested areas, open forested areas or on the edge of forest on Kao, and in some cases also on Tofua, include the tree fern *Cyathea lunulata* (**ponga**); other terrestrial and epiphytic ferns including *Asplenium gibbersoum*, *Asplenium nidus* (**pununga**?) *Davallia solida* (**kulutuma**, **kulutumu**?), *Dryopteris unita*, *Hymenolepis mucronata*, *Nephrolepis* cf. *hirsutula*, *Phymatosorus scolopendria* (**laufale**), *Schizaea dichotoma* (**masalu**, **masalu ngaue**); the sedge, *Scleria polycarpa* (**mahelehele**); and the orchids, *Appendicula reflexa*, *Bulbophyllum rostriceps*, *Dendrobium platygastrium*, *Malaxis latisegmenta*, *Phreatia graffei*; *Macropiper puberulum* var. *puberulum*. Another species reported from Kao from a range of habitats is *Desmodium heterocarpum* (**ngingie'uta**?).

In terms of the relict stands of lowland rainforest which still exist, or which did exist on the larger low-lying islands in Ha'apai, common species include *Alphitonia zizyphoides* (**toi**), *Bischofia javanica* (**koka**), *Dysoxylum forsteri* (**mo'ota**), *Elattostachys falcata* (**ngatata**), *Ervatamia obtusiuscula (orientalis)* (**te'ete'emanu**), *Ficus obliqua* (*'ovava*, **'ovava Tonga**), *Ficus scabra* (*masi'ata*), *Geniostoma rupestre* (**te'epilo'a Maui**), *Glochidion ramiflorum* and *Glochidion concolor* (**masikoka**, **malolo**), *Grewia crenata* (**fo'ui**), *Morinda citrifolia* (**nonu**), *Neisosperma oppositifolium* (**fao**), *Pittosporum arborescens* (**masi kona**, **masi'aukava**), *Rhus taitensis* (**tavahi**), *Syzygium clusiifolium* (**fekika vao**) and *Vavaea amicorum* (**ahivao**). Other forest or tree grove species, some of which were probably aboriginal introductions, and most of which are endangered or extinct, include *Atuna racemosa* (syn. *Parinari glaberrima*)(**pipi**, **pipi failolo**), *Burkella richii* (**kau**), *Calophyllum neo-ebudicum* (**tamanu**), *Canarium harveyi* (**'ai**), *Citrus macroptera* (**moli uku**), *Diospyros major (laterifolia*)(**mapa**), *Dysoxylum forsteri* (**mo'ota**), *Fagraea berteroana (berteriana)*, *Manilkara dissecta* (**ngeesi**), *Maniltoa grandiflora* (**pekepeka**, **tautau'amanu**), *Meryta macrophylla* (**kulukulu**), *Myristica hypargyraea* (**kotone**), *Parinari insularum* (**hea**), *Pisonia grandis* (**puko**), *Pleiogynium timoriense* (**tangato**) and *Tarenna sambucina* (**manonu**). Also reported from Nomuka is *Celtis* cf. *harperii* sp.

Vines or lianas, some of which are rare, found in the remaining forest of the low-lying islands, include *Canavalia rosea* (**fue uta**), *Entada phasioloides* (**valai**, **sipi**), *Epipremnum pinnatum* (**alu**) and *Mucuna gigantea* (**valai, pa'anga 'ae kuma**). Understorey species in remnant inland forest include *Alyxia stellata* (**maile**), *Jasminum simplicifolium* (**tut'uli**), *Macropiper puberulum* var. *glabrum* (**kavakava'ulie**) and *Micromelum minutum* (**takafalu**). Orchids reported from shady thickets on the low-lying islands of Ha'apai include *Spiranthes sinensis* (Lifuka) and *Geodorum pictum* (Nomuka).

Montane Scrub: The upland scrub or "alpine" community on the open upper slopes of Kao, above the forest zone, at about 550 m and above, includes a wide range of non-vascular and vascular plants, many of which are found in Tonga only on Kao. Non-vascular plants, some of which were found near a small alpine lake, include the lichen *Cladonia pityrea*, and the mosses *Aerobyopsis vitiana*, *Campylopus umbellatus*, *Ectropothecium molle*

and *Macromitrium incurvifloium*. Fern and fern allies include the bracken ferns, *Dicranopteris linearis* and *Pteridium esculentum* (both probably **kahiva'e**), *Blechnum* sp., *Diplazium petersenii*, *Histiopteris incisa*, *Schizoloma ensifolium*, *Spenomeris chinensis*; the club mosses, *Lycopodium cernuum* and *L. squarrosum* (**hiku'ikuli**); and psilotum, *Psilotum nudum* (**limu fonua**). Of particular interest is the endemic small club moss, *Selaginella yunckerii*, which is found on moist open rocky slopes between 650 to 900 m. Grasses reported from open alpine areas include *Imperata cylindrica* and *Paspalum cartilagineum*. Other herbaceous species include the sedge *Fimbristylis annua*, the native lily, *Dianella ensifolia* (**akahele**?); the orchids *Malaxis* sp. and *Spathoglottis plicata*; and, *Centella asiatica* (**tono**), *Lindernia crustacea* and *Nasturtium sarmentosum*. Woody species include *Cyrtandra listeri*, *Ficus scabra* (*masi'ata*), *Melastoma malabathricum (denticulatum*)(**pesikuku**?), *Pipturus argenteus* (**olonga**) and the endemic species, *Scaevola porrecta* (**ngahu 'uta**).

Secondary Forest: Most of the remaining inland forest on the low-lying islands of Ha'apai is secondary forest which is a mixture of species found in the original native lowland rainforest (listed above) and aboriginal and recent introductions that have become naturalised in Ha'apai.

Exotic species, not mentioned in the section on lowland rainforest, also common in secondary forests and relict tree groves and as individual trees in bush garden areas include the fruit trees, papaya or pawpaw, *Carica papaya* (**lesi**), lime, *Citrus aurantifolia* (**laimi**, **moli laimi**), sour or Seville orange, *Citrus aurantium* (**kola**), the pommelo, *Citrus grandis* (**moli Tonga**), rough lemon or Mauritius papeda, *Citrus hystrix* or *C. limon* (**lemani**, **moli lemani**), mandarin orange or tangerine *Citrus reticulata* (**moli peli**) and the sweet orange, *Citrus sinensis* (**moli inu**, **moli kai**), *Adenanthera pavonina* (**lopa**), Tahitian chestnut, *Inocarpus fagifer* (**ifi**), *Mangifera indica* (**mango**), oceanic lychee, *Pometia pinnata* (**tava**) and *Syzygium malaccense* (**fekika**, **fekika kai**), *Terminalia catappa* (**telie**). An occasional climber, which is rare today, is air yam, *Dioscorea bulbifera* (**hoi**). Also common in, or bordering secondary forest, are the ferns *Dryopteris invisa* and *Nephrolepis hirsutula* (both **hulufe**) and the epiphytic *Phymatosorus scolopendria* (**laufale**).

Secondary Scrub: Secondary scrub includes scrubby vegetation that occurs or recently abandoned land or on seriously degraded land which is under a state of continual disturbance. Most secondary scrub plants are sun-loving, easily dispersed and disappear and are replaced by secondary forest given the removal or disturbance (Whistler 1992).

Pioneer tree species common in this category, commonly found in thickets or on the margins of secondary and inland forest include *Trema cannabina (orientalis*)(**mangele**), *Macaranga harveyana* (**loupata**, **lepo**), *Hibiscus tiliaceus* (**fau**), *Kleinhovia hospita* (**fukofuka**) and possibly *Pipturus argenteus* (**olonga**). Also common are *Leucaena leucocephala* (**sialemohemohe**), which forms particularly dense stands on Foa, and *Psidium guajava* (**kuava**).

An example of secondary scrub is found on the highly disturbed inland vegetation of the low-lying, sandy interior of Uoleva. The island, which serves as a coconut plantation and grazing area for cattle, horses and goats for the people of southern Lifuka. The main species found in this secondary scrub association are *Psidium guajava* (**kuava**), *Lantana camara*

(**talatala**), *Glochidion ramiflorum* (**masikoka**), *Wikstroemia rotundifolia* (**lala vao**), *Asclepias currasivica* (**tu'ulapepe**) and *Catharanthus rosea* (**siale vao**). Of particular interest is the endemic *Wikstroemia rotundifolia*, which although reported from Kao, Lifuka and Nomuka, is extremely common and locally dominant in well-drained open, sandy areas on Uoleva inland from Toa beach.

Plantation and Garden Areas: Plantation and garden areas, on the Tongan bush allotments (**'api 'uta** or **'api tukuhau**), are a mosaic of active shifting agricultural plots and various stages of fallow vegetation, within a matrix of coconut palms and scattered useful trees.

Major staple crops include greater yam, *Dioscorea alata* (**'ufi**), cassava or manioc, *Manihot esculenta* (**manioke**) and tannia or tropical American taro, *Xanthosoma sagittifolium* (**talo Futuna, talo tea**, **talo fa'a'uli**), and sweet potato, *Ipomoea batatas* (**kumala**). Less important staples include true taro, *Colcasia esculenta* (**talo Tonga**), giant taro, *Alocasia macrorrhiza*) (**kape**), sweet or lesser yam, *Dioscorea esculenta* (**'ufilei**). Important supplementary crops include hibiscus spinach, *Abelmoschus (Hibiscus) manihot* (**pele**), sugarcane, *Saccharum officinarum* (**to**), corn or maize, *Zea mays* (**koane**). Other food crops of lesser importance include pumpkin, *Cucurbita pepo* (**hina**), perennial chilli peppers, *Capsicum frutescens* (**polo fifisi**), Chinese cabbage, *Brassica chinensis* (**kapisi Siaina**), mustard cabbage, *Brassica juncea* (**pauteni**), English cabbage, *Brassica oleracea* vars. *capitata* and *bullata* (**kapisi olo**, **kapisi Palangi**), collard greens, *Brassica oleracea* var.? (**kapisi Tonga, kapisi pele**), cucumber, *Cucumis sativus* (**kiukamipa**), tomato, *Lycopersicon esculentum* (**temata**), green or spring onions, *Allium fistulosum* and *A. ascalonicum* (**onioni Tonga**), passionfruit, *Passiflora edulis* (**vaine**), lemon grass, *Cymbopogon citratus* (**moengalo**).

Edible weeds that are often protected when weeding and are occasionally eaten or constitute famine foods include black nightshade, *Solanum americanum (nigrum*) (**polo kai**), sow thistle, *Sonchus oleraceus* (**longolongo'uha**), *Physalis angulata* (**polo pa**), and the amaranths, *Amaranthus gracilis* and *Amaranthus viridus* (both **tupu'a**).

Commercial crops include watermelon, *Citrullus lanatus* (**meleni**), peanuts, *Arachis hypogaea* (**pinati**), vanilla, *Vanilla planifolia* (**vanila**), although root crops, especially yams and cassava, are exported to Tongatapu and overseas, and surplus production from most other ground and tree crops is also often sold periodically.

Major non-food crops include paper mulberry, *Broussonetia papyrifera* (**hiapo, tutu**), *Piper methysticum* (**kava**) and a wide range of pandanus cultivars including *Pandanus tectorius* vars. (**kie**, **tapahina**, **tofua**, **tofua Lotuma**, **totolo**), *Pandanus spurius* (**tutu'ila**) and *P. whitmeeanus* (**paongo**). Other cultivated varieties of pandanus used for making garlands include **falahola** (possibly *Pandanus turritus*, a species endemic to the mountains of Samoa), **fa kula** and **kukuvalu**. Other non-food crops, some of which are found as escapes, and many of which are locally endangered, include *Alpinia zerumbet* (**kavapui**), *Amomum cevuga* (**tevunga**), *Coleus amboinicus* (**kaloni**), the cycad, *Cycas rumphii* (**longolongo**), tumeric, *Curcuma domestica* (**ango**, **ango kula**), *Derris malaccensis* (**kava Fisi**), *Euodia hortensis* (**uhi**), *Heliconia lathispatha* (**loufao**, **loufusi faikakai**), tobacco, *Nicotiana tabacum* (**tapaka**), *Pogostemon cablin* (**pasiole**), *Solanum viride* (**polo Tonga**) and *Zingiber*

zerumbet (**angoango**).

The coconut palm, *Cocos nucifera* (**niu**) is the most common tree and remains the main crop on most allotments, although copra production for export has ceased on most islands in Ha'apai. Other important food trees that are protected when clearing land for new gardens or which are planted or protected in tree groves on bush allotments include *breadfruit, Artocarpus altilis* (**mei**), of which there are many named varieties (e.g., **aveloloa, avenonou, kea, loutoko, ma'ofala, maopo, puou**); papaya or pawpaw, *Carica papaya* (**lesi**); lime, *Citrus aurantifolia* (**laimi**, **moli laimi**); sour or Seville orange, *Citrus aurantium* (**kola**); pommelo, *Citrus grandis* (**moli Tonga**), rough lemon or Mauritius papeda, *Citrus hystrix* or *C. limon* (**lemani**, **moli lemani**); mandarin orange or tangerine *Citrus reticulata* (**moli peli**); sweet orange, *Citrus sinensis* (**moli inu**, **moli kai**); red bead tree, *Adenanthera pavonina* (**lopa**); Tahitian chestnut, *Inocarpus fagifer* (**ifi**); *Mangifera indica* (**mango**); avocado, *Persea americana* (**'avoka**); oceanic lychee, *Pometia pinnata* (**tava**); Polynesian plum or vi-apple, *Spondias dulcis* (**vi**); Malay apple, *Syzygium malaccense* (**fekika**, **fekika kai**); and tropical almond, *Terminalia catappa* (**telie**).

Culturally important non-fruit trees occasionally found as individuals planted or protected trees in active garden areas include *Aglaia saltatorum* (**langakali**), *Aleurites moluccana* (**tuitui**), *Bischofia javanica* (**koka**), *Cananga odorata* (**mohokoi**), *Garcinia sessilis* (**heilala**), *Garuga floribunda* (**mana'ui**), *Glochidion ramiflorum* and *Glochidion concolor* (**masikoka**, **malolo**), *Macaranga harveyana* (**loupata, lepo**) and *Rhus taitensis* (**tavahi**). Also found in small stands or clumps in and around active cropping areas, although much more uncommon than in the past, are bamboos or bamboo-like grasses used for construction, fencing and other purposes. These include *Bambusa vulgaris* (**pitu**), *Schizostachyum glaucifolium* (**kofe**), *Miscanthus floridulus* (**kaho**, **kaho Tonga**) and *Arundo donax* (**kaho folalahi**, **kaho Papalangi**). The most of the important trees of agricultural areas in Ha'apai are listed in Appendix 6).

Trees now considered to be endangered or extinct include *Pritchardia pacifica* (**piu, niu piu**), *Spondias dulcis* (**vi**), *Syzygium neurocalyx* (**koli**, **koli toto**), *Veitchia joannis* (**niu kula**)

Trees most commonly used as living fencing and living pig pens include *Aleurites moluccana* (**tuitui**) *Bauhinia monandra* (**fehi**), *Ceiba pentandra* (**vavae Palangi**), *Erythrina variegata* var. *orientalis* (**ngatae**), *Garuga floribunda* (**mana'ui**), *Gyrocarpus americanus* (**pukovili**), *Hibiscus tiliaceus* (**fau**), *Jatropha curcas* (**fiki**), *Pisonia grandis* (**puko**) and *Spathodea campanulata* (**tiulipe**), although the use of **puko**, the leaves of which are edible, is far less common than in the past.

Timber species, sparingly introduced for planting on bush allotments in Ha'apai, include *Pinus caribaea* (**paini**), *Gevillea robusta* (**oke**), West Indian cedar, *Cedrela odorata* (**sita hina**), Australian red cedar, *Toona ciliata* var. *australis* (**sita kula**) and a number of eucalyptus, *Eucalyptus* spp. (**pulukamu**).

Houseyard and Village Gardens: Within the context of the Tongan land tenure system

which provides for town allotments (**'api kolo**) within village town reserves throughout Tonga, houseyard and village garden vegetation is very distinct and a source of considerable biodiversity. Common plants in houseyard gardens and along village roads include fruit trees, a wide range of ornamental plants, hedge plants and individual specimens of some of the same culturally useful plants found on bush allotments (see Appendix 7 for a listing of some of the most important plants of houseyard and village gardens).

Fruit trees found in houseyard gardens, villages, in garden areas and occasionally in tree groves or as escapes include coconut palms, *Cocos nucifera*, soursop, *Annona muricata* (**'apele 'Initia**), and sweetsop or sugar apple, *Annona squamosa* (**'apele Tonga**), breadfruit, *Artocarpus altilis* (**mei**), avocado, *Persea americana* (**'avoka**), guava, *Psidium guajava* (**kuava**), Malay apple, *Syzygium malaccense* (**fekika**, **fekika kai**) and tamarind, *Tamarindus indica* (**tamaline**). Fruit trees formerly found in houseyard gardens which are rare or extinct now include the common fig, *Ficus carica* (**fiki**) and white mulberry, *Morus alba* (**fuamelie**).

Other species commonly planted in houseyard gardens, along roads, around cemeteries and small trees groves and occasionally found as escapes include a wide range of trees, shrubs and herbaceous species. Trees include *Aglaia saltatorum* (**langakali**), candlenut, *Aleurites moluccana* (**tuitui**), Norfolk Island and hoop pines, *Araucaria cunninghamii* and *Araucaria heterophylla (excelsa*)(both **paini**), orchid tree, *Bauhinia monandra* (**fehi**), giant milkweed, *Calotropis gigantea* (**puanani**), perfume tree or ylangylang, *Cananga odorata* (**mohokoi**), flame tree or poincianna, yellow shower tree, *Cassia fistula* (**kasia**), stinking cassia, *Cassia grandis* (**kasia**), Mexican cypress, *Cupressus lusitanica* (**paine fai lolo**, **saipalesi**), *Delonix regia* (**'ohai**), *Fagraea berteroana* (**pua Tonga**), weeping fig, *Ficus benjamina* (**'ovava Fisi**), *Garcinia sessilis* (**heilala**), *Gyrocarpus americanus* (**pukovili**), *Hernandia moerenhoutiana* (**pipi kakala**, **pipitui**) allspice, *Pimenta officinalis* (**sipaisi**), bay rum, *Pimenta racemosa (doica*) (**sinamoni**), plumeria or frangipani, *Plumeria obtusa* and *P. rubra (acuminata* or *acutifolia*)(**kalosipani**), pomegranate, *Punica granatum* (**pomakanite, lemuna**), rain tree or monkeypod, *Samanea saman* (**kasia**), tropical almond, *Terminalia catappa* (**telie**), African tulip tree, *Spathodea campanulata* (**tiulipe**), *Syzygium corynocarpum* (**hehea**). Shrubby species include *Acalypha hamiltoniana* (**kalakala'pusi**?), *Acalypha hispida* (**iku'ipusi**), *Acalypha wilkesiana* (**kalakala'apusi**), *Allamanda cathartica* (**pua**), *Bougainvillea spectabilis* (**felila**), *Caesalpinia pulcherrima* (**'ohai**?), *Cestrum diurnum* (**vaitohi**), *Cestrum nocturnum* (**laukau po'uli**), *Cordyline fruticosa (terminalis)* (**si**), *Datura candida*, *Duranta repens* (**mavaetangi**), *Euphorbia pulcherrima* (**fe'ofa'aki**), *Euphorbia tirucalli* (**feo)**, *Gardenia augusta (jasminoides)* (**siale matalateau**), *Gardenia taitensis* (**siale Tonga**), *Hibiscus rosa-sinensis* (**kaute**), *Hibiscus schizopetalus* (**kaute**), *Ixora finlaysoniana* (**huni 'Initia**), *Ixora chinensis* (**huni 'Initia**), *Ixora coccinea* (**huni 'Initia, huni Samoa**), *Lagerstroemia indica* (**kilisimasi**), *Nerium oleander* (lolie), *Opuntia* sp. (**kakatisi**), *Pedilanthes tithymaloides* (**feo**?), *Pseuderanthemum bicolor*, *Quisqualis indica* (**kaloni kakala**), *Rosa* spp. (**lose**), *Senna (Cassia) alata* (**te'elango**), *Tecoma stans* (**piti**), *Thevetia peruviana* (**lolie**) and *Yucca brevifolia* (**laione**).

Shrubby species planted primarily for hedgerows in villages include *Acalypha wilkesiana* (**kalakala'apusi**), *Breynia disticha (nivosa)* (**pepe**), *Codiaeum variegatum* (**aveave**, **lave'imoa**, **uhi Palangi**), *Graptophyllum pictum*, *Hibiscus rosa-sinensis* (**kaute**), *Murraya paniculata* (**'olive**), *Pseuderanthemum carruthersii*, *Pseuderanthemum reticulatum*,

and the hedge panax species, *Polyscias guilfoylei*, *P. filicifolia*, *P. fruticosa*, *P. scuttelaria* and *P. tricochleata* (all known as **tanetane**).

Herbaceous perennial species include *Alpinia purpurata* (**tevunga**, **tevunga kula**), *Alternanthera tenella* (**loseli**), *Amaryllis belladonna* (**lile**), *Angelonia salicariaefolia* (**mangike**), *Catharanthus roseus* (**siale vao**), *Crinum asiaticum* (**samoa**), *Dahlia pinnata* (**talia**), *Dieffenbachia seguine* and *Dieffenbachia picta* (**talo**?), *Gerbera jamisonii* (**fetu'u**), *Hedychium coronarium* (**teuila**), *Hemigraphis alternatus*, *Hippaestrum* spp. (**lile**), *Hymenocallis littoralis* (**lile**), *Impatiens balsamina* and *Impatiens wallerana* (both **polosomo**), *Mirabilis jalapa* (**matala po'uli**), *Plectranthus scutellariodes* (syn. *Coleus blumei*)(**oloveti**), *Portulaca grandiflora* (**matala hoata**, **lose malei**), *Rhoeo spathacea (discolor*) (**faina kula**, **fain teuteu**), *Sanseviera trifasciata* (**'elelo**), *Wedelia trilobata*, and *Russelia equisetiformis*.

The most common short-term annuals include globe amaranth, *Gomphrena globosa* (**malila**), cockscomb, *Celosia argentea* (**lisi**), sunflower, *Helianthus agrophyllus* (**siola'a**), petunia, *Petunia* x *hybrida* (**petunia, pula**?), phlox, *Phlox drummondii* (**foloke**), marigold, *Tagetes erecta* (**melekoula**) and zinnia, *Zinnia elegans* (**potolaka, sinia**).

Planted ornamentals or culturally useful plants which are considered to be endangered include *Artabotrys uncinatus* (**mohokoi Honolulu**), *Bixa orellana* (**loa**), *Euphorbia fidgiana* (**toto Fisi, toto kula**), *Gossypium barbadense* (**vavae Tonga**), granadilla, *Passiflora quadrangularis* (**pasione**), and *Vetiveria zizanioides* (**ahi Siaina**).

Ruderal Vegetation: Ruderal vegetation is defined as vegetation found in continually disturbed areas, such as garden areas, roadsides, open lots, etc. Pioneer species commonly found as weeds in garden areas and in the early fallow stages of abandoned gardens include *Amarantus viridis* (**tupu'a**), *Canna indica* (**misimisi**), *Cassia occidentalis* (**piini**), *Cassia toro, Chamaesyce (Euphorbia) hirta* (**sakisi**), *Commelina diffusa* and *Commelina benghalensis* (**kanini**, **kaningi** or **mohuku vai**) *Lepidium virginicum*, *Mimosa pudica* (**mateloi**), *Phaseolus lathyroides (semierectus*) (**piini kulokula**) and *Portulaca oleracea* (**tamole**). Later, more long-lasting pioneer species in the succession, include the grasses *Panicum maximum* (**saafa**) and *Sorghum halepense* (**kola**), which often form extensive "fallow savanna grasslands" within a matrix of scattered coconut palms and other useful trees; *Canavalia rosea* (**heketa**, **lautolu 'uta**), *Passiflora laurifolia* (**vaine Palangi**, **vaine tinetine**) *Passiflora maliformis* (**vaine Tonga**, **vaine kilifefeka**) *Pueraria lobata* (**aka**), *Stictocardia tiliaefolia* (**fue**, **pula**?). Pioneer shrub or small tree species include *Indigofera suffruticosa* (**'akauveli**), *Lantana camara* var. *aculeata* (**talatala**), *Leucaena leucocephala* (**sialemohemohe**), *Psidium guajava* (**kuava**) and *Solanum verbascifolium* (**pula**). Of particular interest are the introduced lima bean, *Phaseolus lunulatus* (**piini Tonga**) and lablab bean, *Lablab purpureus (niger*)(**piini fakalelei 'ae kelekele**, **piini Tonga**?) which have long been planted or naturalised in Ha'apai as an improved fallow and a source of emergency food.

Common weeds or adventives found along roadside, trailsides, waste places and other ruderal sites, as well as in recent fallows, include the grasses, *Brachiaria subquadriparia*, *Cynodon dactylon*, *Dactyloctenium aegyptium*, *Digitaria setigera (pruriens)*

(**mohukuapopoa**), *Eleusine indica* (**takatak'a leala**), *Eragrostis amabilis*, *Paspalum conjugatum* (**vailima**), *Panicum ambiguum*, *Oplismenus compositus* and *Oplismenus imbecilllus* (both **mohuku'apopoa**), *Rhynchelytrum repens* (**salapona**), *Setaria pallidifusca*, and the sedges *Cyperus compressus*, *Cyperus rotundus* (**pakopako**), *Kyllingia brevifolia* (syn. *Cyperus brevifolius*)(**pakopako**) and *Kyllingia nemoralis* (syns. *Kyllingia monocephala*, *Cyperus kyllingia*)(**pakopako**). Other herbaceous species include *Ageratum conyzoides* (**te'ekosi**?), *Amaranthus viridus* (**tupu'a**), *Alysicarpus vaginalis* (**akataha hina**?), *Asclepias curassavica* (**tu'ulapepe**), *Asystasia gangetica*, *Bidens pilosa* (**fisi'uli**), *Centella asiatica* (**tono**), *Chamaesyce prostrata*, *Crassocephalum crepidioides* (**fisipuna**), *Elephantopus mollis* (**lauveveli**?), *Emilia sonchifolia*, *Erigeron sumatrensis* (**fisipuna**), *Euphorbia cyathophora* (**fe'ofa'aki**?), *Laportea interrupta* (**hongohongo**), *Leonurus sibericus*, *Malvastrum coromandelianum* (**te'ehoosi**), *Momordica charantia* (**meleni 'ae kuma, lole 'ai kuma**), *Oxalis corniculata* (**kihikihi**), *Passiflora foetida* (**vaine 'ae kuma**), *Pilea microphylla* (**limu**?), *Plantago lanceolata* (**filo**), *Phyllanthus amarus (niruri*), *Physalis angulata* (**polo pa**), *Salvia occidentalis* (**te'epulu**), *Spermacoce assurgens* (syn. *Borreria laevis*), *Stachytarpheta urticaefolia* (**iku'ikuma**), *Uraria lagopodioides* (**iku'ipusi**?), *Vernonia cinerea* (**fisipuna**). Shrubby species include *Clerodendrum buchanani* (**'amo'ula**), *Crotalaria pallida* and *Crotalaria retusa* (both **piini**), *Ricinus communis* (**lepo**), *Sida acuta*, *Sida cordifolia* and *Sida rhombifolia* (both **te'ehoosi**), *Synedrella nodiflora* (**pakaka**), *Tephrosia purpurea* (**kavahuhu**), *Trumfetta rhomboidea (bartramia)* (**mo'osipo**), *Urena lobata* (**mo'osipo kula**), and the naturalised exotics *Aspargus setaceus (plumosus)* (**taupo'ou**). As with other vegetation types, many of these plants have taken on cultural value, many of them being used medicinally.

Weedy species reported to be rare or locally extinct include *Achyranthes aspera* (**tamatama**), *Siegesbeckia orientalis* (**kakamika**) and *Amorphophallus paeoniifolius (campanulatus)* (**teve**). Other species, which are rare and reported to occur in ruderal sites and occasionally in coastal habitats, include *Boerhavia diffusa* (**akataha kula**)(Lifuka), *Rivina humilis* (**polo**?)(Nomuka) and *Stephania forsteri* (Nomuka).

5.4.5 Fauna

The main indigenous land animals of Ha'apai are birds, reptiles, insects and some land crabs. Some of these constitute resources of considerable importance to sustainable development in terms of their ecological and cultural utility, and their possible commercial importance to the development of national reserves and a limited tourist industry. Domestic animals are also constitute a very important resource. The much richer marine fauna is discussed in the section on marine resources.

With the exception of birds and reptiles, few studies have been conducted of the terrestrial fauna of Tonga. Carlson carried out an unpublished study of "The Avifauna of Tonga" (1974) and Watling's *Birds of Fiji, Tonga and Samoa* (1982) is an excellent source of information. The Brehm Foundation, which runs the Tonga Wildlife Centre on Tongatapu,

has also conducted extensive studies of Tonga's bird life and has gathered some information on Tongan reptiles.

The only indigenous land mammals in Ha'apai are the flying fox, **peka** (*Pteropus tonganus*), with the Polynesian rat, **kuma** (*Rattus exulans*) being probably an aboriginal introduction. Non-indigenous wild mammals include the roof rat (*Rattus rattus*) and the ship or Norwegian rat (*Rattus norvegicus*), both post-European-contact introductions. Domestic mammals include the pig and the dog, both early Polynesian introductions, and cattle, horses, goats and cats which were all post-contact introductions. Domesticated birds include the jungle fowl or chicken, which was a Polynesian introduction, and the duck which was an early post-European-contact introduction.

Pigs and chickens are important ceremonial exchange items and sources of protein, whereas local beef and horsemeat is consumed occasionally. Dog meat and feral cat meat, although eaten in the past, is now consumed infrequently. On most islands, rats constitute a serious pest to crops and humans and a threat to wildlife, particularly to indigenous land birds. On some islands, such as Uoleva, feral cats have eliminated most of the ground-nesting birds.

Excluding sea birds and migratory species, 26 bird species have been reported to be resident in Tonga. Of these, about 20 are probably still present in Ha'apai (These are listed in Appendix 8). There are also about 23 sea or migratory birds. Of these 11 are probably resident, 4 are migratory species that are found during part of the year in Ha'apai, 7 are vagrants that are seen only occasionally, and one is a migratory breeder. The sea birds nest primarily on uninhabited islets. Some species are threatened due to over-exploitation of both the adult birds and their eggs, which are both eaten.

Birds present only on Tofua or Kao include the Fiji shrikebill, *Clytorhynchus vitiensis* (**fuiva**) and the swamp harrier, *Circus approximus* (**taiseni**). The spotless crake, *Porzuna tabuensis* (**moho**) is only found on the Hungas in Ha'apai and in Niuafo'ou, Fonualei and Late. Absent from Ha'apai and Tonga are the common and jungle mynahs, which are believed by some people to have driven native birds into the bush in Fiji, although it may be that mynahs are just better adapted to human habitats due to their aggressive behavior (Watling 1982). The exotic red-vented bulbul (*Pycnonotus cafer*) is also absent from Ha'apai and is only found on Tongatapu, 'Eua and Niuafo'ou.

Based on information from the Brehm Fund's Tonga Wildlife Centre on Tongatapu, there are about 16 terrestrial reptiles reported present in Tonga (Appendix 9). These include the banded iguana, **fokai** (*Brachylophus fasciatus*), the distribution of which is restricted to Tonga and Fiji, 7 geckos (**moko**) and 8 skinks (**pili**). Of the geckos and skinks, at least four are not found in Ha'apai. These include the 'Eua gecko (*Lepidodactylus euaensis*) and the Pacific black skink (*Emoia nigra*), harlequin skink (*Emoia trossula*) and Polynesian ground skink (*Emoia adespera*), all of which have been reported only from the Niuas or Vava'u.

6 POPULATION DISTRIBUTION AND GROWTH

One of the main reasons Ha'apai was selected as a conservation area (CA) under SPBCP is because of the high population pressure on land and marine resources and ruesultant high emigration, due largely to the limited opportunity for generating cash incomes in the group.

The distribution of population in the Kingdom is very uneven. Assuming that the overall growth rate was constant over the decade 1976-1986 between the two censuses, the average annual growth for the entire Kingdom is estimated at 0.5%. Tongatapu was the fastest growing at an average annual rate of 1.1.%. The population of Niuas and Vava'u also grew during the intercensal period, although much more slowly than Tongatapu, and the population fell slightly in 'Eua. There was, however, a much steeper decline for Ha'apai (Table 6.1). A number of the important factors which influence this relatively low rate of growth, including migration, are discussed below.

Table 6.1 Population by division and growth rates for the 1976 and 1986 censuses.

Census Division	Population 1976		Annual rate 1986	of growth (%)
Tongatapu	57411	63794	1.1	
Vava'u 15068	15175	0.1		
Ha'apai 10792	8919	-1.9		
'Eua	4486	4393	-0.2	
Niuas 2328	2368	0.2		
TOTAL	**90085**	**94649**	**0.5**	

The Divisional breakdown into districts in 1986 is given in Table 6.2.

Table 6.2. Population by Divisions and Districts for the 1986 Census

Division/District	Number	Division/District	Number
Tongatapu Division	**63,794**	**Vava'u Division**	**15175**
Kolofo'ou	15,903	Neiafu	5268
Kolomotu'a	13115	Pangaimotu	1247
Vaini 11104		Hahake	2299
Tatakamotonga	6773	Leimatu'a	2884
Lapaha	7005	Hihifo	2093
Nukunuku	5863	Motu	1384
Kolovai	4031		
		Ha'apai Division	**8919**
'Eua Division	**4393**	Pangai	2850
'Eua Proper	2400	Foa	1410
'Eua Fo'ou	1993	Lulunga	1584
		Mu'omu'a	885
Niuas Division	**2368**	Ha'ano	891
Niuatoputapu	1605	'Uiha	1299
Niuafo'ou	763		

6.1 Migration

The average intercensal annual growth rate of 0.5% reflects the high level of overseas migration. While a detailed demographic analysis of the 1986 census is not yet available, the data indicate the birth rate was about 30 live births for every thousand people (i.e., 3% per annum). The current death rate can be assumed to be about 6-7 deaths per thousand population. Thus the natural increase is about 23.5 per thousand (or 2.35%). The net overseas migration rate (rate of natural increase - intercensal growth rate) is then about 1.85%.

If this overseas migration rate is applied to the census population, a net outflow of about 17,500 people occurs each year. Recent studies of passenger manifests for arrivals and departures suggest that current emigration rates are even higher (Thisthletwaite 1993). Because the census figures are averaged over a ten year period, this suggests also that emigration may be higher now than it was 10 years ago.

In terms of internal migration and its impact on Ha'apai, while census data can provide only limited information about the nature of overseas migration, it does provide more precise information about movement within the Kingdom. Net annual migration rates are given in Table 6.3

Table 6.3. Net migration rates between divisions of the Kingdom of Tonga (* the exposed population is the sum of the non-movers and out-migrants at the 1986 census).

Division	Non-Movers	Migrants	Exposed Pop.	Net Rate %
Tongatapu	36622	+1332	39150	+3.4
Vava'u 9961	-207	11564	-1.8	
Ha'apai	6005	-953	7921	-12.0
'Eua	984	-353	1184	-29.8
Niuas	1470	+181	1831	+9.9

Of the population of 94,649 accounted for in the 1986 census, the case histories of 61,650 persons were analyzed to determine the pattern of internal migration over the 10 year censal period. Categories of persons excluded from the analysis included non-Tongans, children born since the 1976 census, persons now resident but overseas in 1976, and Tongan visitors in 1986 who were residents in 1976. The 61,650 persons comprised 30,425 males and 31,225 females.

Table 6.3 summarizes the effects of movement between census divisions. Tongatapu gained with net in-migration of 1332 persons; Niuas also gained 181 persons. Although 'Eua and Vava'u both lost people during the 10 year period, the greatest losses were from Ha'apai, although the emigration rate was highest for the smaller population of 'Eua.

6.2 The Ha'apai Population Situation

The most recent population data for Ha'apai from the 1986 census show a total population of 8919 in 1,616 households. Table 6.2 (above) gives the distribution of residents by subregion. Presently there are 30 villages on 17 inhabited islands. Only the islands of Lifuka (5 villages), Foa (5 villages), Ha'ano (4 villages), 'Uiha (2 villages), and Tofua (2 villages) have more than one village.

General features of the population in Ha'apai are: 1) a concentration in Lifuka and the nearby islands of Ha'ano, Foa and 'Uiha, and, 2) a general population decline throughout the group, with the Ha'apai population representing a declining portion of the national total. It was predicted in 1988 that by 1996 the population will further decline to between 7,466 and 8,797 residents.

Table 6.4. Ha'apai population density and % change (1956-1986).

Island	**Density in 1986**	**% Change in Population**

	(people per km^2)	1976 - 1986
Lifuka	249	-3.3
'Uiha	170	-17.9
Lofanga	242	-17.9
Ha'ano	111	-38
Foa	105	-17.2
Mo'unga'one	140	-48.9
Ha'afeva	248	-18.1
Tungua	199	-30.5
Fotuha'a	168	-5.4
'O'ua	272	+3.9
Matuku	430	+.1
Kotu	706	+29.4
Nomuka (plus Nomuka Iki)	129	-28.4
Mango	143	-19.8
Fonoifua	287	-29.1

*Data for Kao and Tofua not available.

The reduction in number of residents is especially pronounced in the Lulunga and Mu'omu'a subregions which experienced a negative growth rate of 4.1% (Table 6.4), with some islands, such as Nomuka, Fonoifua, Kotu, Tungua, Ha'ano and Mo'unga'one having lost from a third to almost half of their population over the ten-year censal period. The major losses were from school-aged groups. According to CPD (1988) the following, often interrelated factors are responsible for out-migration from Ha'apai: land shortage, frequent natural disasters, limited sources of cash income, lack of markets, lack of employment opportunities, poor educational facilities, communication problems, existence of greater opportunities on Tongatapu, concentration of development on Tongatapu, and the fact that many of Ha'apai's leaders have left Ha'apai.

From a resource-use perspective, an examination of the data in Table 6.4 suggests that, for subsistence activities, there is declining pressure on land and sea resources on most islands. Commercial activities or destructive practices could, however, as they seem to have done in the past few years, result in increased impact, particularly on high value species such as giant clams, beche-de-mer, sea turtles, lobsters and certain high-value finfish.

7 INFRASTRUCTURE

The level of infrastructural development within the Ha'apai varies considerably. The 10 villages located on Lifuka and Foa (which are connected by causeway) have easy access to the facilities at the government administrative centre of Pangai and adjacent area. These

include: two wharves, the only airstrip in the group, bulk fuel storage, a 1.92 megawatt generator, reticulated electrical and water supplies, slipway, hospital, hotel, guesthouses, retail stores, banking facilities, primary schools, four secondary schools, paved road, ice plant, refrigeration facilities, communications earth station, and the offices of most government ministries.

Other inhabited islands generally have a primary school, church, radio-telephone, and a cement water tanks for each household. The subregional centres additionally have a secondary school, health centre, fisheries refrigeration facilities, retail stores, and some unpaved roads.

The transportation infrastructure in Ha'apai consists of wharves at Lifuka (2), Foa, and 'Uiha. Small passages have been blasted at several of the inhabited islands. 1993 nautical charts show that there are 13 lighthouses or lighted beacons in Ha'apai: 8 in Hahake (including 5 around Pangai), 4 in Lulunga, and 1 in Mu'omu'a. Channel markers with reflectors and solar lighting have been recently installed at many islands. Lifuka has an airstrip (1145 x 30 m) and shares with the neighboring island of Foa a causeway and a road of 17.6 km. Construction is soon to begin on a protected harbour for Lifuka and wharves for 'Uiha, Ha'ano, Mango, Nomuka, and Ha'afeva. The Environmental Management Plan for the Kingdom Tonga (ESCAP 1990) cites four other proposed causeway projects, all of which are for the major islands of the Hahake subregion. There are no plans to build additional airstrips in the near future.

In general, the physical infrastructure of Ha'apai is not well developed. In comparison with Tongatapu and Vava'u, there are far fewer transportation, communication, health, educational, and other facilities.

8 LAND AND MARINE TENURE

Land and marine tenure are important factors affecting the promotion of the conservation and sustainable use of biodiversity. In different ways Tonga's land and marine tenure systems are unique in the Pacific Islands. Whereas the land tenure system provides considerable opportunity for the management of biodiversity, the current marine tenure system constitutes one of the major obstacles to sustainable use of marine resources. Both systems are discussed below.

8.1 Land Tenure

All land in the Kingdom is Crown Land (technically owned by the King). This is comprised of the hereditary estate of the King, the estates of the rest of the Royal Family and the landed nobility (**hou`eiki and ha'a matapule**), and Government Land.

Under the 1875 Constitution, each Tongan male over 16 years of age is entitled to register both a town allotment (**`api kolo**), not exceeding 0.2 ha or two-fifths of an acre, and a bush allotment (**'api tukuhau** or **'api 'uta**), not exceeding 3.34 ha. (8.25 acres). These

allotments are granted from both hereditary and government estates depending on where a person resides. Title to allotments is individualised and becomes hereditary, passing to the oldest legal male heir according to the rules of primogeniture. A person can legally have only one hereditary town and one hereditary bush allotment. Land may not be sold, but it can be leased. Recent laws have made provisions to use land as security for loans. Thus, although there is no "freehold" (fee simple) land in Tonga, land has been "individualised" with the landholders themselves having clear responsibility for decisions relating to land use and biodiversity management. Although there are regulations encouraging planting of coconuts, trees, etc, and prohibiting certain negative resource use practices, these are rarely enforced. As a result, individual landowners and estate holders, as members of local communities, must be seen as the most important focus for initiatives to manage terrestrial biodiversity within the HCA.

Due to population densities of close to 140 persons per km^2, nationally, there are insufficient allotments to cater for the increasing number of males over 16 years of age (Bakker 1991), with only 6.9 per cent of all estates of the nobles remaining undistributed. Of this, more than 790 ha on the `Eua plateau are unsuitable for agriculture, but may be suitable for forestry. Most of the un-allocated government land consists of lakes, marshland or mangrove swamps, cliffs, small islands with little or no water, and volcanic islands with little access and poor agricultural potential (Thistlethwaite and Votaw 1992).

In Ha'apai, where islands are generally small and population densities high, the average bush allotment is only about 4.5 to 4.8 acres (under the legal maximum of 8.25 acres), with the total number of bush allotments in Ha'apai being 3188 for a population of about 9000 (MAF 1994).

Because of increasing land shortage, there is widespread sharing of allotments, on a usufruct ("use of the fruit") basis with family members or others who have no rights to land. There is also an increasing number of families with no access to land, particularly on the main island of Tongatapu, where immigrants from outer islands, often from Ha'apai, have no access to either bush or town allotments. In some areas, such as Ha'apai and Vava'u, where there has been significant out-migration, there are registered, but unutilised allotments. There is also an increasing trend for landholders to lease their land illegally, on a short-term basis, to persons wishing to grow short-term cash crops such as root crops and squash for export. This practice has reportedly led to increasing agrodeforestation (loss of trees from agricultural areas) and soil deterioration in Ha'apai and elsewhere in the Kingdom.

8.2 Marine Tenure

The degree of local village management of marine resources in Ha'apai prior to the current century is uncertain. Some works (e.g. the Environmental Management Plan for the Kingdom of Tonga) state that Tonga may never have had reef tenure systems. Gifford (1929), however, indicates that in traditional Tongan society the fishing rights for an area belonged to those that lived in the adjacent area. The Land Act of 1927 legally conferred on the Crown all land and sea areas within Tongan territorial limits. On the positive side, with a few exceptions, all Tongans are allowed fishing access to all Tongan waters.

On the negative side, problems have arisen with increasing commercialization, improved fishing technology (especially the use of scuba and hookah gear), and increased access to local and overseas markets. Quite simply, many inshore resources cannot withstand this increasing and indiscriminate commercial fishing pressure. Some form of management to reduce fishing pressure is therefore needed. One frequent comment from villagers in Ha'apai is that, even if a community conserves and manages its adjacent marine resources, as has been the case traditionally, it may be a useless exercise as outsiders can, and have, moved in to over-harvest resources.

Experience from many South Pacific countries indicates that fisheries based on inshore resources require management to maximize benefits. The need is even greater when these resources are subject to commercial fishing pressure. In most areas in the Pacific Islands, coastal communities have traditional ownership rights over nearby inshore resources and are able to exclude or limit fishing by other groups in the area adjacent to their communities. Because of this arrangement, the groups holding the fishing rights have a strong interest in managing the resources for the long-term future.

Although the management of inshore fishery resources could be carried out by central government authority, experience has shown that the chances of success are not great. Limited government funds and personnel, geographically dispersed fishing areas, low emphasis placed on enforcement, and reluctance or inability to apply punitive measures are factors which contribute to the failure of centrally-administered fisheries management in the Pacific Islands. In many cases the net result of well-intentioned management of fisheries by government fisheries officials is the absence of management.

If inshore fisheries resources are to be sustainably utilized in Ha'apai, some form of community-based fisheries management is urgently required. In the Ha'apai context, even if an island community promotes the sustainable use of the marine resources through their management efforts, their is no mechanism to prevent outsiders who may be interested in maximizing short-term benefits by over-exploiting the resources. Unless provisions are made for increased local control of the management of inshore fisheries resources, the situation will continue to be an example of the "Tragedy of the Commons" where resources with no private or local ownership are subject to indiscriminate overexploitation and degradation of the resource.

Despite the lack of community ownership of adjacent marine resources, there are a number of possibilities consistent with existing legislation for increasing local control and thereby fostering a long-term relationship with the resource. Using the Fisheries Act 1989 as the legal basis, these options include selective vessel licensing, selective exclusion of commercial fishing, aquaculture leasing, limited entry, and selective exclusion of fishing around FADs. These are discussed in greater detail below.

9 HA'APAI AND THE NATIONAL ECONOMY

9.1 The Economy in General

Although agriculture, fishing and tourism are the main source of export income at the national level, the Tongan economy, as a whole, is also highly dependent on development aid and remittances from Tongans working abroad. Aid contributes about 27 per cent of gross national product (GNP). Economic growth declined during the last three Development Plan (DP) periods (1975-1990), due largely to the stagnation of agriculture, which, in the past, made the dominant contribution to gross domestic product (GDP). This situation has changed over the past four years with the dramatic increase in the export of high-value squash (butter pumpkins) to Japan.

The importance of aid is critical to most development programmes in Tonga. The main sources of bilateral assistance are Australia, New Zealand, Japan and the European Union (EU).

Australian assistance has concentrated in recent years on the infrastructure sector (such as ports, airport, telecommunications), to social services (water supply, sanitation and education) and to the productive sectors of agriculture and fisheries.

New Zealand's program has focussed on the agriculture and forestry sectors, including reforestation on 'Eua, on public utilities and on education. Japan has concentrated on infrastructure (seawall, cultural centre, refrigerator facilities, airport terminal), on the fisheries sector, and on health and education sectors. The EU has assisted with regional planning (Vava'u Group) and a wide range of technical assistance. Germany and France, in particular, and also United Kingdom, Canada, USA and Norway all provide assistance, mostly through technical advice (Thistlethwaite 1992).

Many multilateral organizations, particularly within the UN framework, provide technical advisors and other assistance, and agencies such as the Asian Development Bank, the World Bank, the European Investment Bank and the International Fund for Agriculture Development provide support in the form of concessional loans, or by direct technical assistance (Thistlethwaite 1992). In the case of developments in environmental management, most of these have been funded either by SPREP or by the Asian Development Bank. These are discussed in more detail below.

The manufacturing sector became one of the strongest growth areas in the economy during DP V, largely due to government encouragement of private enterprise with the establishment of a Small Industries Centre on the periphery of Nuku'alofa. This sector has, however, stagnated, with many of the small industries that were established in the 1980s having now closed, leaving only a handful of industries still operating in the Small Industries Centre. Apart from local handcraft production there is no manufacturing in Ha'apai.

In 1989, the value of tourism rose to T$11.5 million (US$9 million), making it a major sector of the economy. There are indications that tourism income will continue to grow. Most of this is focused on Tongatapu, with an increasing share going to Vava'u, much of which is associated with the development of the area as a yachting centre. Tourism is poorly developed in Ha'apai. Current accommodation consists of 4 small guesthouses and one economy motel on Lifuka. There are no hotels, although an exclusive small resort is under

construction on the north end of Foa.

There is a substantial and growing deficit in the balance of trade. Past attempts to broaden the productive base of the economy and lessen the dependence on aid and remittances have, with the exception of tourism and the recent squash export boom, been unsuccessful. In the late 1960s, export receipts covered two-thirds of import expenses; in 1989-1990 imports were T$72.7 million (US$56.6 million) and exports about T$8.5 million (US$6.6 million), or only 12 per cent of imports (Thistlethwaite and Votaw 1992). The situation in Ha'apai, where people are relatively self-sufficient is not so bad, with less, but increasing dependence on imported goods.

In general, available data reveals that the per capita GDP for the Ha'apai area is lower than most other island groups in Tonga. Other features of the economy include a low level of commercial production and a high degree of reliance on subsistence production, significant transportation and marketing constraints, and a low level of infrastructural development. A small percentage of the resident population have wage employment, mostly with government agencies. There is also some income in the form of remittances from Ha'apai residents who reside permanently or temporarily overseas or in Tongatapu.

In short, the Ha'apai economy can be characterised as a semi-subsistence economy which depends, for its cash income on a limited range of agricultural exports and marine products and handicrafts, most of which are sold to, or through, markets in Tongatapu. All of these, including limited tourism returns, depend on the sustainable management of the terrestrial and marine ecosystems and biodiversity of Ha'apai.

9.2 Agriculture and Forestry

Despite the limited land area in Ha'apai, agriculture has always been the principal sector of the overall cash and subsistence economy and the primary livelihood for most of the people of Ha'apai. Nationally, agriculture accounted for about 35% of the GDP, 40% of the total export earnings, and at least 40% of total formal sector employment in the late 1980s. These figures do not reflect the true importance of agriculture because they do not include the considerable production from the mixed rural subsistence sector. Part of the agricultural output is also processed (e.g., made into tapa cloth, mats, etc.), thus contributing significantly to value added as part of manufacturing.

At the national level, the Ministry of Agriculture and Forestry (MAF) has the main responsibility for the promotion of agriculture and forestry development activities. The Agricultural Division of the Ministry is responsible for agricultural research and extension, the Forestry Division, for forestry development; and the Coconut Replanting Scheme, which has been inactively in recent years, has been responsible for coconut rehabilitation and replanting.

Farming on rural bush allotments (**'api 'uta**) in Ha'apai is essentially a multistorey agroforestry system with planted or protected coconut palms, fruit trees and a wide range of other useful trees creating an open overstorey for the shifting agricultural production a wide

range of root crops, supplementary food crops and fallow vegetation in various stages of regeneration. Surveys in 1992 and 1993 indicated that about 30% and 41% of the total areas of bush allotments under crops rose from about 30% to 41%, an increase which indicates a considerable increase in crop production. Of the 1784 acres surveyed in 1993, 1694 were under coconut palms, 30 without coconut palms and 60 acres had been ploughed, probably in preparation for planting yams (MAF 1994). A limited range of food crops and a wide range of other useful trees and plants are also cultivated on town allotments and constitute an integral part of the agroforestry strategy (Thaman 1976).

Nationally, the main export crops over the years have been coconut (copra, desiccated coconut and coconut oil), vanilla, banana, watermelon, pineapple, some temperate vegetables, kava (*Piper methysticum*) and root crops. In the past five years, however, the export of squash (butter pumpkin)(*Cucurbita maxima*?) to Japan has become the single largest export in the Kingdom. By mid-1994 there were an estimated 1300 growers and over 3000 acres under squash on Tongatapu, and an additional 300 growers in Vava'u, 100 in 'Eua and 60 new growers in Ha'apai on the islands of Lifuka and Foa. The estimated incomes from squash exports in 1992 and 1993 were US$9.4 and US$6.3 million respectively, with the fall in returns in 1993 resulting from the imposition of export quotas (IMF 1994). However, as stressed below, the rapid increase in export squash production has led to what constitutes and environmental crisis which threatens the entire traditional agroforestry system.

The main exports from Ha'apai during 1993 to Tongatapu and overseas are shown in Table 9.1. These include a range of fine and rough pandanus mats, processed paper mulberry bast fibre (**feta'aki**) shipped in rolls for sale to tapa cloth makers on Tongatapu, watermelons, live pigs, peanuts, yams, plantains and vanilla. These figures show that few people are involved in the formal export of agricultural produce, and do not include a range of produce shipped informally to relatives and other people in both Tongatapu and overseas.

Based on 1993 surveys, the most important root crops in Ha'apai, in terms of area, are cassava (**manioke**)(*Manihot esculenta*), giant taro (**kape**)(*Alocasia macrorrhiza*), yams (**'ufi**)(*Dioscorea alata*), tannia or American taro (**talo Futuna** or **talo tea**)(*Xanthosoma* spp.), sweet potato (**kumala**)(*Ipomoea batatas*), potatoes (**pateta**)(*Solanum tubersoum*), sweet yam (**'ufilei**)(*Dioscorea esculenta*), and true taro (**talo Tonga**)(*Colocasia esculenta*)(Table 9.2). Other important staples include plantain and banana (**hopa** and **siaine**)(*Musa*) cultivars (Table 9.2) and breadfruit (**mei**)(*Artocarpus altilis*) and coconut (**niu**)(*Cocos nucifera*, both important tree staples in the Tongan diet). Supplementary food crops include peanuts (**pinati**)(*Arachis hypogaea*), pineapple (**faina** (*Ananas comosus*), corn (**koane**)(*Zea mays*), short-term vegetables (e.g., cabbages, tomatoes, beans, lettuce, etc.), hibiscus spinach (**pele**)(*Hibiscus manihot*) and sugarcane (**to**)(*Saccharum officinarum*)(the latter two not included in the MAF 1993 survey)(Table 9.2).

Table 9.1. Major exports from Ha'apai to Tongatapu, Pago Pago, American Samoa, Hawaii, New Zealand and Australia in 1993 (Source: MAF 1994).

Product	Producers	Amount	Revenue

pandanus mats	73	427 items	$139,800
paper mulberry	14	250 rolls	$42,930
watermelon	7	4957 melons	$17,041
pigs/piglets	5	135 pigs	$6,750
peanuts	5	76 bags	$7,600
yams	2	78 baskets	$5,800
plantains	3	91 bunches	$1,570
vanilla	3	30 kg	$1,660
Total			**$223,151**

Table 9.2. Areas of specified crops based on 1993 surveys of 973 bush allotments with a total area of 1723.3 acres (697.7 hectares)(Source: MAF 1994).

Crop (**Tongan name**)	Total Area in Acres (hectares)
cassava (**manioke**)	518.3 (209.8)
giant taro (**kape**)	228.0 (92.3)
plantain (**hopa**)	227.9 (92.3)
yams (**'ufi**)	209.5 (84.8)
tannia/American taro (**talo Futuna/tea**)	179.4 (72.6)
sweet potato (**kumala**)	148.6 (60.2)
paper mulberry (**hiapo**)	41.7 (16.9)
potato (**pateta**)	40.3 (16.3)
bananas (**siaine**)	33.1 (13.4)
peanuts (**pinati**)	25.6 (10.4)
pineapple (**faina**)	19.3 (7.8)
vanilla (**vanila**)	14.3 (5.8)
watermelon (**meleni**)	11.3 (4.6)
sweet yam (**'ufilei**)	8.8 (3.6)
vegetables (**vesitapolo**)	6.0 (2.4)
corn (**koane**)	5.8 (2.3)
coffee (**kofi**)	4.4 (1.8)
true taro (**talo Tonga**)	0.9 (0.4)
kava (**kava**)	0.1 (<0.1)

Major trends in Ha'apai agriculture over the 1992-93 period include: 1) an increase in the area planted in root crops of 22.3% due to good weather; 2) the distribution of 2,019 coffee seedlings to 24 farmers on Lifuka and Foa, a yield of 100 kg from coffee planted at the MAF farm at Vaipoa, Foa, and the decision to designate coffee as a major cash crop and to construct a coffee processor in Ha'apai; 3 an increase in vegetable, peanut and watermelon production; 4) the continued production of kava as the major cash crop on Tofua; 5) limited response of growers to continued attempts by Government to encourage the production of

vanilla; and, 6) a drastic fall in copra production from 664,047 kg in 1992 to only 24,948 kg in 1993. This decrease in copra production of almost 96%, a trend which continued in 1994, severely limits the agricultural incomes of outer island communities, thus putting greater pressure on these communities to produce less environmentally sustainable cash crops, and to place greater emphasis on the commercial exploitation of marine resources. A further development in 1994 on Lifuka and Foa was the planting of squash (butter pumpkin) for export to Japan. This is discussed below.

Livestock are also a very important component of the agricultural economy. Surveys of livestock in 1993 indicate that there were approximately 36,478 pigs, 32,658 chickens, 24,260 horses, 7,530 dogs, 4,100 goats, 772 cattle, and 144 ducks in Ha'apai. Pigs and chickens, in particular constitute very important food sources, and in the case of pigs are one of the most important items of ceremonial exchange, and an item required at all important feasts and as tribute to the Royalty and estate holders in the Tongan land tenure system. Goat and beef is also occasionally eaten, and horses, although kept mainly for transportation, are also eaten and considered a delicacy. Dogs were eaten in the past, and are still occasionally consumed in the bush.

The presence of free-ranging, unpenned and unfenced animals, particularly pigs, was widely reported by the Pilot Communities, to be one of the major environmental problems in Ha'apai. Uncontrolled pigs and other animals led to devegetation and dusty conditions in town and villages and to the destruction of crops and valuable tree and plant seedling in both town and bush areas.

Important fruit trees include a range of *Citrus* species (**moli**), mango (**mango**)(*Mangifera indica*), papaya (**lesi**)(*Carica papaya*), oceanic lychee (**tava**)(*Pometia pinnata*), Tahitian chestnut (**ifi**)(*Inocarpus fagifer*), Malay apple (**fekika**) (*Syzygium malaccense*), Polynesian vi-apple (**vi**)(*Spondias dulcis*), coastal almond (**telie**)(*Terminalia catappa*), avocado (**avoka**)(*Persea americana*), soursop (**apele 'Initia**)(*Annona muricata*) and sweet sop or custard apple (**apele Tonga**)(*A. squamosa*), guava (**kuava**) (*Psidium guajava*) and tamarind (**tamaline**)(*Tamarindus indica*).

Other multipurpose tree species found on rural agricultural areas include *Bischofia javanica* (**koka**), *Aleurites moluccana* (**tuitui**), *Hibiscus tiliaceus* (**fau**), *Morinda citrifolia* (**nonu**), *Macaranga harveyana* (**loupata**), *Rhus taitensis* (**tavahi**), *Grewia crenata* (**fo'ui**), *Erythrina variegata* (**ngatae**), *Pandanus* spp. (**fa** and **louakau**), *Glochidion ramiflorum* (**malolo, masikoka**), *Ceiba pentandra* (**vavae**), *Santalum yasi* (**ahi**), *Alphitonia zizyphoides* (**toi**), *Cananga odorata* (**mohokoi**), *Pittosporum arborescens* (**masi kona, masi aukava**), *Vavaea amicorum* (**ahi vao**), *Pisonia grandis* (**puko**), *Elattostachys falcata* (**ngatata**), *Meryta macrophylla* (**kulukulu**), *Adenanthera pavonina* (**lopa**), *Garcinia sessilis* (**heilala**), *Ficus* spp. (**'ovava**, **masi**), *Micromelum minutum* (**takafalu**), *Cerbera odollam* (**toto**), *Diospyros major* (**mapa**), *Atuna racemosa* (**pipi failolo**) and *Jatropha curcas* (**fiki)**.

Trees more commonly found on town allotments include *Plumeria* spp. (**kalosipani**), *Casuarina equisetifolia* (**toa**), *Pimenta officinalis* (**sipaisi**) and *Pimenta racemosa* (**sinamoni**), *Phaleria disperma* (**huni**), *Aglaia saltatorum* (**langakali**), *Syzygium corynocarpum* (**hehea**), *Alyxia stellata* (**maile**), *Fagraea berteroana* (**pua Tonga**),

Tournefortia argentea (**touhuni**), *Premna serratifolia* (**volovalo**), *Calophyllum inophyllum* (**feta'u**) and *Hernandia moerenhoutiana* (**pipi kakala, pipitui**)(Thaman 1976)(Appendix 7 for a more detailed discussion of these trees).

Unfortunately, these extremely useful trees are rapidly disappearing from the agricultural landscape and very little forest remains on bush allotments or in other accessible areas with arable soil. This was widely stated during discussions with Pilot Communities, as one of the most serious problems in terms of both loss of biodiversity and environmental degradation in Ha'apai. The main reasons given for the loss of trees included: 1) an increasing tendency towards export cropping and other intensive or short-term monocultural forms of agriculture that require the use of a plough, inorganic fertilisers, and pesticides, 2) recent and widespread devastating tropical cyclones which uprooted trees or killed them with salt spray or storm surge (particularly during Tropical Cyclone Isaac in 1982), and, 3) a failure to replant.

Particularly serious on Tongatapu and in Vava'u has been the almost suicidal expansion of squash cultivation, which has led to unprecedented agrodeforestation, indiscriminate use of fertilisers and pesticides and associated environmental breakdown. On Tongatapu alone, it is estimated that 150 tonnes of fertiliser and 25 tonnes of pesticide are put into the ground every squash growing season (Fonua 1994).

As a result, despite the use of increasing amounts of fertilisers and a wide range of environmentally hazardous pesticides, yields are beginning to drop and the environmental breakdown of the squash cultivation system itself is increasingly widespread. As stressed by 'Ofa Fakalata, Head of the Research Division of the Ministry of Agriculture, Tonga's squash industry has reached the "crisis and disaster phases of its development" with an increasing number of growers already finding that no matter how much fertiliser or pesticide they apply to their crops, yields are actually dropping. He refers to these areas as "hot spots" and stresses that:

> Hot spots are big areas of land that have been cleared, with hardly any trees left, and where the land has been farmed continuously for an number of years. . . . so that the structure of the soil in these areas has been destroyed and the soil no longer can absorb water to feed the plants . . ..

He believes that "if nothing is done now to deal with the problem these "hot pots" could spread and contaminate the whole country." He believes that even if something is done now "it will take 20 years for a hot spot area to restore the balance of its ecosystem." (Fonua 1994). In short, this unprecedented wave of squash-related agrodeforestation threatens the trees that have been the foundation of the Tongan agroforestry and food systems for generations.

Fortunately, although export squash cultivation has been introduced into Ha'apai, a concerted effort has been made on the part of the local Agricultural Officer and local farmers to minimise the use of agricultural chemicals and excessive ploughing.

In terms of forestry, although Tonga does not have a formal national forest policy, a review has been made of the Forest Act of 1965 which is currently under consideration. National forestry objectives are, however, set out in the Government's current Five Year Development Plan. Areas of activity of the Forestry Division include: 1) conservation and rehabilitation of indigenous forests; 2) forestry plantation development; 3) nursery establishment and seedling propagation; 4) promotion of multipurpose agroforestry and tree planting; 5) land reclamation and rehabilitation; and 6) coconut timber milling.

The main activities carried out in Ha'apai include the establishment of a coconut sawmill and a nursery at Vaipoa Station on Foa. In 1993, the first year in production, the nursery produced 37,647 seedling. The main species included mahogany (**mahokani**)(*Swietenia macrophylla*), Queensland kauri (**kauli**)(*Agathis robusta*), Caribbean pine (**paini**)(*Pinus caribaea*) and eucalyptus (**pulukamu**)(*Eucalyptus* spp.) and Australian red cedar (**sita kula**)(*Toona australis*). There is also a range of other trees and ornamental plants that are being produced for local sale or free distribution for outplanting.

Most recently, at the request of the Prime Minister, the Forestry Division has commenced a pilot coastal reforestation/revegetation project in cooperation with SPREP and the University of the South Pacific (USP). The project is an attempt to re-establish coastal forest on the sea side of agricultural holdings on the windward blowhole coast of Tongatapu near Houma. The area had been deforested to supply wood for banana boxes during the banana boom of the 1960s and early 1970s. Deforestation has been further intensified by indiscriminate burning which has favoured the establishment of Guinea grass (*Panicum maximum*) over coastal and inland tree species, including coconuts. As a result, it has been very difficult to grow ground crops and useful trees due to the effects of excessive salt spray and recurrent fires in the area. Problems created by coastal deforestation were also reported by Pilot communities to be a major concern in Ha'apai, thus the extension of the currents attempts at coastal reforestation, which include the collection and propagation of salt-tolerant coastal littoral species would seem to be a priority.

Among the main species being propagated and trialled for revegetation are the salt-tolerant coastal species *Casuarina equisetifolia, Hibiscus tiliaceus, Tournefortia argentea, Barringtonia asiatica, Pandanus tectorius, Neisosperma oppositifolium, Terminalia catappa, Morinda citrifolia, Hernandia nymphaeifolia, Cerbera odollam, Erythrina variegata* var. *orientalis, Scaevola taccada, Vitex trifolia, Calophyllum inophyllum, Syzygium richii, Planchonella grayana, Inocarpus fagifer* and coconut palms.

Other species that will also be trialled include *Acacia simplex Myristica hypargyraea, Macaranga harveyana, Phaleria disperma, Pisonia grandis, Premna serratifolia, Dendrolobium umbellatum, Ximenia americana, Terminalia litoralis, Diospyros elliptica, Geniostoma rupestre, Grewia crenata, Pittosporum arborescens, Polyscias multijuga, Glochidion ramiflorum* and the exotic *Gliricidia sepium.*

Species which will also be propagated, trialled and possibly used for forest enrichment include endangered or culturally important species such as *Cordia subcordata, Thespesia populnea, Intsia bijuga, Gardenia taitensis, Guettarda speciosa, Santalum yasi, Eugenia reinwardtiana, Gyrocarpus americana, Heritiera littoralis* and *Schleinitzia (Leucaena)*

insularum (for detailed list of these species, most of which could be planted in Ha'apai see Appendix 5).

9.3 Fisheries in Ha'apai

Some generalizations about fishing activity in Ha'apai can be made. Subsistence fisheries are of great importance, especially on the islands away from the subregional centres. Commercial fishing activity plays a very important role in the cash economy of Ha'apai, especially close to the subregional centres. Poor access to markets is often cited by fishermen as being their greatest constraint.

Precise data on fisheries production in Ha'apai is not available. The Ministry of Fisheries does not collect information on either subsistence or commercial production in Ha'apai. Thomas (1978), reporting on the results of an FAO project, estimated a total subsistence and commercial catch in Ha'apai of 189.3 tons in 1977. Some information from a fisheries survey done 15 years ago is given in Halapua (1981) where it is stated that 70% of Ha'apai's fish catch is from reef/lagoon resources consisting mainly of surgeonfish, parrotfish, squirrel or soldier fish, wrasses, groupers, goatfish, butterflyfishes, mackerels, and scads. Presently an unknown portion of the Ha'apai fisheries production is exported to Tongatapu and sold in the Tuimatamoana Fish Market at Queen Salote Wharf in Nuku'alofa. The manager of that market estimates that of the 41,612 kg of seafood sold at the market over the past year, approximately 65% (27,048 kg) was from Ha'apai and that the composition of this was 80% finfish, 15% lobster, and 5% miscellaneous (octopus, giant clam, turtle, *Anadara antiquata* and other shellfish). Much smaller amounts of Ha'apai seafood are sold at the roadside Vuna and Faua markets where the Ministry of Fisheries data indicates the sale 1856 kg of *Anadara* (**kaloa'a**) and 42 kg of giant clam, *Tridacna* spp. (**vasuva**) in 1994.

In the early 1980s it was estimated that the commercial lobster landings in Ha'apai were 20,000 kg annually (Zann 1984). Beche-de-mer fishing in Ha'apai probably results in substantial catches but even rough estimates of the Ha'apai production or the total for the country do not exist. Although the export of deepwater snappers and groupers is of major importance to Tongatapu and to a lesser extent Vava'u, only about 10% of those fish are caught in Ha'apai.

In Ha'apai subsistence fishing is of great importance. This is due to the proximity to the ocean, relatively abundant and diverse marine resources, cultural practices, limited land area, few food supply alternatives (especially in terms of animal protein) and limited opportunity for commercial enterprise. Ministry of Fisheries staff in Ha'apai indicate that, although the harvest of marine resources for subsistence purposes is substantial and its high nutritional value is acknowledged by residents, its importance in the diet has declined in recent years. A brief survey conducted during the present project indicated that many of the younger generation do not eat or have lost the taste for a wide range of minor shellfish, other invertebrate and seaweed species, some of which were formerly considered to be delicacies. Some nutrition studies have been carried out in Ha'apai (e.g. Adachi 1976 on 'Uiha). The results, however, are not readily available. Thomas (1978) on the basis of interviewing 75

Ha'apai families estimated the per capita seafood consumption to be 41.6 pounds (18.9 kg) per year. This figure has probably declined significantly with increasing commercialisation of high value-resources, increased cash incomes and declining consumption of minor species by the younger generation over the past 25 years.

There is some specialization in types of activities undertaken by the various islands. For example, Ha'ano fishermen tend to troll and those from 'Uiha are predominantly divers, some using underwater breathing equipment. Much of the recent commercial activity is based on diving for high value species for export to Nuku'alofa or overseas and is predicated on a narrow range of species (beche-de-mer, lobster, giant clam and large bottomfish) which have notoriously poor resistance to commercial fishing pressure. Fishing pressures increased dramatically in the early 1990s with the use of hookah, initially for beche-de-mer and subsequently for other species. Many recent marine resources surveys of Ha'apai have concluded that the use of underwater breathing equipment (SCUBA and hookah) for commercial harvesting should be banned (e.g., McKoy 1980 for clams; Preston and Lokani 1990 for beche-de-mer). As a result, the Fisheries Regulations of 1994 banned the use for fishing, without the written permission of the Ministry of Fisheries, of both SCUBA and hookah gear. Presently the Ministry has issued 8 permits for the use of hookah gear in Ha'apai, but has indicate that all such permits will be phased out during 1995.

In December 1993 Cabinet banned the commercial export from Tonga of giant clams, *Tridacna* spp. (**vasuva**) which, although curtailing some commercial potential, should eventually result in a greater abundance of clams for domestic consumption and local marketing. Snappers, groupers and other high value bottomfish are currently being exploited at an optimum level in Ha'apai (mostly by Tongatapu-based boats), meaning that a large sustainable increase in catch is not expected from areas accessible to Ha'apai-based boats.

Important changes have taken place recently in the fish marketing situation. There are more entrepreneurs involved in fish marketing in Ha'apai, with a somewhat higher percentage of these being foreigners, especially Asians in the beche-de-mer industry (beche-de-mer species of particular importance in Ha'apai are listed in Appendix 10). Although transporting fish to Tongatapu is somewhat easier than in the past, there is considerable potential for improvement. The export price of high quality bottomfish has risen creating an opportunity for Ha'apai suppliers who can overcome the problems in fish transport logistics. A Tongan businessman has recently established a fish collection system for several island communities in Ha'apai. Although the effort is commendable and should be encouraged, fish collection systems in the Pacific have rarely, if ever, been successful. The lack of a regular supply of consistent quantities of fish to collection schemes by largely subsistence fishermen has been the usual cause of failure.

With respect to recent changes in the fishing fleet, a greater percentage of Ha'apai fishing boats are now diesel-powered. Many of the fishing vessels constructed under the UNCDF scheme by the Ministry of Fisheries which were intended for Ha'apai operation are now based in Tongatapu where the logistics of vessel maintenance and operating an export-oriented fishing business are less complicated resulting in greater profits.

Certain changes can be expected in the future. It is likely that longlining for sashimi-

grade tuna for export will prove feasible in Tongatapu and possibly Vava'u. A Ha'apai-based tuna longliner would have no special advantage with respect to access to the resource but would suffer from lack of support infrastructure and greater fish transport problems. It would therefore be premature in the near future to predicate Ha'apai fisheries development on longlining for tuna and other by-catch.

The collection of aquarium fish for export, however, does present an opportunity. It is likely that in the near future Tongatapu will be subject to management of the aquarium-fish fishery and be closed to new operators, who may wish to establish a collection base in another area of Tonga. Because the resource is present in Ha'apai, the industry is labour intensive, and because it requires skills which exist in Ha'apai, the possibility of establishing an aquarium fish industry in Ha'apai deserves consideration.

In an effort to coordinate fisheries development in Ha'apai, the Ha'apai fisheries development programme was approved by the Ha'apai Development Committee in January 1994 and subsequently funded by Australia for a total of T$47,975. The programme has three components: 1) post harvest projects, 2) resource enhancement projects, and 3)) pelagic fisheries development projects. These components are discussed in detail in Appendix 11.

10 RELEVANT INSTITUTIONS

Institutions that could play a major role in the promotion of the conservation and sustainable use of the biodiversity within the proposed Ha'apai Conservation Area (HCA) include many government and non-government organisations at the community, regional (Ha'apai), national and international levels.

10.1 Community Institutions

At the community level, these is a wide range of non-government organisations that play central roles in community development and which will be involved in specific activities under the HCAP. These include church, women's and youth groups, farming committees and fishing groups, and communal work groups, such as **toungaue** (rotational work groups), **toutu'u** (cooperative garden establishment groups) and kava drinking groups (**kalapu kava Tonga**) which are excellent forums for development activities. Depending on the specific activity, the involvement of such groups could maximise the chances of success of the HCAP.

On 'Uiha and Lofanga, for example, the men's fishermen's organisations play a very important role in coordinating fishing activities and should be involved, from the start, in all activities to promote more sustainable use of marine resources. Also very influential are local women's development organisations (**Komiti Fakalakalaka a Fafine**) and church groups (mainly Methodist and Catholic) which are active in all villages, and which play central roles in many aspects of community life. In some communities the school committee or parents teachers organisation (PTA) also play very important roles, particularly in fostering the involvement of children and youth in relevant activities. The roles of some of these organisation will be discussed below under specific activities proposed under the project. Also very active in community development activities in Ha'apai are the Ha'apai Youth Council, which was a major force behind a workshop on "Farm Management and Sustainable Agriculture" held in Ha'apai in June 1994, and the **Kalapu Kava Tonga**, to which many village men belong and which is very active in village affairs.

One particular institution which, has for many years, played an important role in community development activities is the competition. Important competitions include:

1. the annual household inspection or **'a'ahi** conducted by women's committees each year to inspect homes, gardens and other aspects of community and family life, such as the sufficiency of domestic household supplies and items of traditional wealth, such as fine pandanus mats and tapa cloth, which are seen as central to quality of life in Tonga;

2. the annual Ha'apai Agricultural Show (**Faka'ali'ali Ngoue**), which is always attended by the King, and at which substantial prizes are awarded for the best crops, best pigs, the best managed agricultural holdings, the best fine mats, best fish catches, etc.;

3. the AIDAB-funded competition, in 1994, for the best maintained household water supply system; and,

4. competitions for the longest, largest and most beautiful yams held by cooperative

yam gardening groups (**toutu'u 'ufi**).

The use of competitions with prizes for the villages or individuals who most successfully implement activities under the HCAP, or the inclusion of appropriate aspects of biodiversity conservation in the criteria for existing competitions or inspections seemed to have widespread support among the pilot communities, and among some funding agencies, such as AIDAB. Such competitions, in addition to promoting a given activity, seem to be an excellent educational forum and one of the best ways of promoting public awareness of the rationale and issues associated with a given activity.

Of particular importance at the village level is the Town Officer (**'Ofisa Kolo**), the official elected government representative in each village or town (**kolo**). The **Ofisa Kolo** is responsible for calling periodic or special village meetings (**fono**) during which community initiatives, projects, problems are discussed. The use of the **fono** and involvement of the **'Ofisa Kolo** of the pilot communities and other communities in Ha'apai is essential for the success of the project. Discussions organised by the **'Ofisa Kolo** in six pilot communities indicate that both the leaders and the communities as a whole, are all very supportive and enthusiastic about being involved in the planning, implementation and evolution of the HCAP.

At the District Level, District Officers (**Pule Fakavahe**) are also very influential. They are elected by the local communities within their district and represent their districts at regional meetings. They play a very important role in decision making at the district, regional (Ha'apai) and community levels. The **Pule Fakavahe** have higher rank than the **'Ofisa Kolo** and have the role of authorising the **'Ofisa Kolo** to call **fono** to discuss important local and regional issues. The **Pule Fakavahe** of Hahake District was very supportive of the project and played a major role in the **fono** meetings with the pilot communities of Pangai and Hihifo on Lifuka.

10.2 Ha'apai Institutions

At the Ha'apai level, the main government institutions which have been involved from the start of the project include a range of relevant Ha'apai-based Government agencies. These are the Governor's Office, the Ministry of Fisheries, the Divisions of Agriculture and Forestry of the Ministry of Agriculture and Forestry, the Ministry of Education, Ministry of Works, Ministry of Health, Ministry of Labour and Commerce, Ministry of Works, the Central Planning Department and the Tonga Visitors Bureau.

10.3 National Institutions

At the national level, the ministry with primary responsibility for environmental management is the Ministry of Lands, Survey and Natural Resources (MLSNR) which has as its overall mandate the proper current and future development and utilisation of scarce land and natural and physical resources.

Among its main duties, MLSNR is responsible for the allocation, registration, appraisal

and survey of all lands in the Kingdom. It regulates and arranges through Cabinet, land leasing and rentals, and controls compensation for land, crops, trees and buildings. MLSNR also has some responsibility of determining the extent and nature of the exploitable natural and physical resources of the Kingdom, including hydrocarbons, minerals, sand, limestone rock and precious and non-precious corals, and for monitoring the capacity of the groundwater resources. In addition, MLSNR is also responsible for the development of comprehensive environmental and town planning legislation and the establishment of urban planning schemes and guidelines to address rapid urban growth.

The Secretary for Lands, Surveys and Natural Resources is the Government's official representative to SPREP. Within MLSNR the Land and Environmental Planning Unit (LEPU) has been established to carry out the ministry's environmental mandate. It has a Head, an Environmental Officer, a marine biologist and two other staff. To oversee the preparation of a national environmental management strategy (NEMS), an Interdepartmental Environment Committee (IDEC) was established.

11 ENVIRONMENTAL, CONSERVATION, AND LAND USE POLICIES AND PROGRAMMES

As stated in DP6, The Government of Tonga has, among its national objectives, the management of natural resources for sustainable development. In support of this objective it aims to implement policies to prevent depletion of the Kingdom's natural resources while, at the same time, achieving sustainable economic growth. Recognizing that this objective may conflict, on occasion, with the objective of the protection of natural resources, the aim of environmental management is to ensure that there is no irreversible damage which could limit the prospect of long-term economic sustainability.

Major reviews of the state of Tonga's environmental management situation have been conducted by: 1) IDEC (1990) with the support of funding for a consultant from ESCAP to produce a *Environmental management plan for the Kingdom of Tonga* ; and 2) a SPREP consultant work with Government to produce a *National Report of the Kingdom of Tonga to the United Nations Conference on Environment and Development (UNCED)*(Thistlethwaite 1991). The findings of these studies are summarised below.

As stated in the UNCED Report, the main environmental concerns of the Government were:

1. Overfishing in coastal areas and over exploitation of black coral upon which the jewelry trade is based;

2. Climate change and sea level rise, particularly with respect to potential impacts on low-lying areas of the main islands and smaller low-lying island, such as those of Ha'apai; and,

3. The maintenance of remaining biological diversity, particularly the protection of rare bird species.

11.1 National Environmental Management Plan

In 1987 Government received ESCAP assistance in the preparation of a national environmental management plan (NEMP). Central to the exercise was the establishment of an Interdepartmental Environment Committee (IDEC) to oversee the preparation of the preparation of the NEMP, and to coordinate the compilation and review process.

The IDEC was chaired by the MLSNR, as the lead environment agency, and included the Ministry of Health (MOH), Ministry of Foreign Affairs and Defence (MFAD), Ministry of Agriculture and Forestry (MAF), Ministry of Fisheries (MOF)(established as a ministry on its own, separate from MAF, in 1987), Ministry of Works (MWLCI), Labour, Commerce and Industries, Central Planning Department (CPD) and the Tonga Visitors Bureau (TVB). It was also recommended that the Ministry of Police (MOP)(which is charged with the responsibility of policing the environmental provisions of acts and regulations) and the Ministry of Education (MOE) should be represented in the IDEC.

The IDEC/ESCAP Symposium held over August 27-29, 1990, finalised the NEMP, which was published by ESCAP in 1990 (IDEC 1990). The completion of the NEMP is a valuable first step in the process the implementation of environment management strategies and programs. The Symposium recommended to Cabinet that IDEC be retained to supervise the implementation of the NEMP (at least pending consideration by Government of the formation of a separate Department, or Ministry, of the Environment). At present a Land and Environmental Planning Unit (LEPU), within the MLSNR is responsible for the implementation of the NEMP.

The *Environmental Management Plan for the Kingdom of Tonga* (NEMP)(IDEC 1990) is a comprehensive document which provides detailed information on: 1) the demographic and economic situation, 2) geomorphology, mineral resources and coastal processes, 3) fisheries, agricultural, forestry resources, energy and water resources, 4) environmental health and sanitation, 5) industrial pollution, 6) tourism resources, 7) institutional and legal frameworks, and 8) an environmental management plan and follow-up strategy. It provides a wealth of information on Tonga's resources and biodiversity, constraints and problems related to their sustainable utilisation, and priority management issues and strategies which could be implemented. The Government's proposal for the establishment of the HCA is considered to be consistent with the stated priorities of the NEMP.

11.2 Action Strategy for Managing the Environment

It was intending that the NEMP was to be reviewed and revised on a regular basis to assure relevance to current issues. Accordingly, at the end of 1992 a fresh look at strategies and programmes for protection of the Tongan environment was undertaken with SPREP assistance. The resultant Action Strategy, *The Kingdom of Tonga: Action strategy for managing the environment* (Thistlethwaite *et al*. 1993), outlines key environmental issues and identifies new strategies to address them. The strategy targets the areas of:

1. The improvement of environmental awareness and education.

2. Disposal of solid wastes and sewage.

3. Strengthening of national capability for environmental management.

4. Assessing the implication of climate change and sea level rise.

5. Countering the misuse of hazardous chemicals.

6. Fostering the use of renewable energy sources.

7. Improving basic data on natural resources.

8. Fostering the sustainable use of marine resources and the coastal zone.

9. Ensuring the sustainable use of land resources.

10. Improving the supply of drinking water.

11. Protection of the Kingdom's biological diversity.

The programmes proposed to protect Tonga's biological diversity are:

1. Strengthening wildlife management capability in the Kingdom.

2. Replanting traditional, medicinal and culturally important plants.

3. Management planning for 'Eua National Park.

4. Preservation of key natural and cultural sites in Vava'u.

5. Consideration of conversion of the Royal Tombs into a botanical garden.

6. Pilot programme on eradication of rats and feral cats in outer islands.

11.3 Environmental Impact Assessment

In line with Government's stated objective of ensuring that there is no irreversible damage to the country's resource base and biodiversity that would limit the prospect of long-term economic sustainability, the Government has had an Environmental Impact Assessment (EIA) policy since 1985. Under this policy the Central Planning Department (CPD) is to pass on all development proposals to the MLSNR which then conducts its assessment of whether a proposal should require EIA. Where the MLSNR's Environmental Planning Section has the capacity, or can call on expertise available locally, the EIA is conducted in-house. Otherwise, a request is made to SPREP for technical assistance with the performance of the EIA. SPREP then decides

whether to use its own technical staff or to engage external consultants. A draft EIA report would then be circulated to relevant government authorities for comment before a final impact statement is prepared for submission to Cabinet. There is no public participation in the process.

In practice, there has been little call for SPREP's assistance for EIA, except for an EIA of a proposed causeway development in Vava'u in 1992 and coral harvesting in 1994. A few in-house EIA have been carried out on development proposals. Although the policy states that all new major development projects should be subject to EIA, this has been very difficult to put into practice because the policy is not backed by legislation.

Legislation for a Land Use, Natural Resource and Environment Planning Act has been drafted which would include EIA procedures. Until such legislation in enacted, the Division of Land and Planning of MLSNR has recommended that an EIA policy be made legally enforceable.

11.4 Environmental Legislation

Although there is at present no specific "environmental law", and while the Land Use, Natural Resource and Environment Planning Act is being considered for adoption, there is a large body of existing legislation containing provisions of environmental importance, some going back more than 50 years. Legislation of significant environmental importance is summarised below. In short, although there exists a range of acts and regulations (laws) which could form a basis for many of the activities proposed under the HCAP, there is a need to make the public and policy makers aware of such legislation and ways that it could be used as a basis for promoting the conservation of biodiversity.

"Parks and Reserves Act" (1976): This Act provides for the establishment of a "parks and reserves authority" responsible for the establishment, preservation and administration of parks and reserves. Important points covered in the Act include the authority to:

1. declare or cancel any area of land or sea as a park or reserve,

2. to draw up regulations to protect, preserve and maintain the natural, historical, scientific or other valuable features or any park or reserve, and,

3. set fees for services, employ personnel, erect signs, fences and buildings and make other improvements, and administer and apply for funds as necessary for the success of parks and reserve establishment and operation.

The stated objectives of parks and reserves are to:

1. prevent depletion or extinction of valuable wildlife species and communities and to enrich and improve production of land and marine resources, and,

2. protect areas of items or importance for the Tongan cultural heritage and provide

the people of Tonga and visitors with places of recreational, educational and scientific importance.

The specific objective of marine reserves are to:

1. provide protected, closed areas where representative species of Tongan marine life can grow to full maturity and spawn, thus enriching adjacent reef areas and preserving genetic diversity,

2. provide picnic and recreation sites for visitors and local people alike, all with excellent snorkeling and a wide assortment of marine organisms, and,

3. protect representative natural Tongan marine wildlife areas for educational and scientific purposes (IDEC 1990).

The five marine reserves established to date were dedicated and gazetted in 1979. These are all located on or adjacent to Tongatapu and include: Ha'atafu Beach Reserve, Hakau Mama'o Reef Reserve, Malinoa Reef Reserve and Island Park, Monuafe Reef Reserve and Island Park and Pangaimotu Reef Reserve. Three marine parks have also been suggested for Vava'u, but none have been suggested for Ha'apai, an issue that must receive priority under the HCAP. Although not related to the Parks and Reserves Act, two community-level giant clam sanctuaries have been established, one at Mounu Reef north of Nuku'alofa and one at Falevai Vava'u (Chesher 1988).

In terms of land parks and reserves, the Ha'amonga Trilithon Historic Park and Fa'onelua Botanical Garden and the Vuna Road Reserve, both in Nuku'alofa, have been established on Tongatapu, and a 3,779 ha forest reserve has been established on 'Eua along the eastern ridge of the island. Subdivision of the area into tax allotments for agriculture and deforestation by private and government logging have, however, significantly reduced the size of indigenous forest in the reserve area. There are also proposals for the establishment of a Muihopohoponga Coastal Reserve in northeastern Tongatapu and an 'Eua National Forest Park (on 'Eua) and a Mount Talau National Park in Vava'u (IDEC 1990). It has also been suggested that the forests of the volcanic islands of Nuiafo'ou, Late and Tofua and Kao, in Ha'apai, be gazetted as "forest reserves".

"Forests Act" (1961): This Act provides for the establishment and management of forest reserves and for the control and regulation of such areas (the legal significance of a forest reserve is not clear in terms of trees taking first priority in the event of a conflict of interest). Under this Act the King in Council may declare any unallocated or leased land as a forest reserve or reserve area. Also, the Minister, with consent of Cabinet, may make regulations to:

1. protect, control or manage forest reserves, foster growth of forest produce,

2. prohibit or regulate cutting, felling, taking, working, burning and injury of forest produce,

3. prohibit or regulate grazing, camping, residing, cultivating, entering, killing or taking any animals, bird, insects, fish or eggs;

4. grant licences and permits and conditions for taking, selling, purchasing and export of forest produce,

5. establish nurseries,

6. provide for survey and demarcation of forest reserves, and,

7. hire and control forest guards.

Under the Act "forest produce" includes forest produce anywhere in the Kingdom. Part III of the Forest Act provides for town and village forest areas. Under this provision, the District Officer may, with approval of the Minister, demarcate any unalienated land, village forest areas which shall be registered at the Department of Agriculture. Such "Village Forests" shall be governed as prescribed by the Minister and forest officers or police officers may seize and detain any forest produce or property used in taking forest produce.

"Forest Produce Regulations" (1979): This regulation requires an export licence for all forest produce, except for wood carvings and handicrafts and other semi-processed or processed (value-added) forms of logs, stems or roots. Of the 29 species protected under this regulation, the following 21 (**pipi** has been double listed, as it did not specify which **pipi** the regulation protected) are, or were, reportedly found in Ha'apai: *Aleurites moluccana* (**tuitui**) *Alphitonia zizyphoides* (**toi**), *Atuna racemosa* (**pipi**, **pipi failolo**), *Burkella richii* (**kau**), *Canarium harveyi* (**'ai**), *Diospyros elliptica* (**kanume**), *Diospyros major* (**mapa**), *Dysoxylum forsteri* (**mo'ota**), *Elattostachys falcata* (**ngatata**), *Fagraea berteroana* (**pua, pua Tonga**), *Ficus obliqua* (*'ovava*, **'ovava Tonga**) *Ficus* sp.? (*masi*), *Glochidion ramiflorum* and *Glochidion concolor* (**masikoka**, malolo), *Guettarda speciosa* (**puopua**), *Heritiera littoralis* (**ifi 'ae kuma, mamea**), *Hernandia moerenhoutiana* (**pipi kakala**, **pipitui**) *Hibiscus tiliaceus* (**fau**), *Inocarpus fagifer* (**ifi**), *Mussaenda raiateensis* (**monomono hina, monomono'ahina**), *Myristica hypargyraea* (**kotone**), *Pleiogynium timoriense* (**tangato**) *Rhus taitensis* (**tavahi**) and *Santalum yasi* (**ahi**). There are many other rare species, some of which are excellent carving woods, such as *Cordia subcordata* (**puataukanave**), *Intsia bijuga* (**fehi, fehi Fisi**) and *Thespesia populnea* (**milo**), and very important cultural plants, such as *Parinari insularum* (**hea**), *Syzygium neurocalyx* (**koli**) and *Tarenna sambucina* (**manonu**), which are not, but should be placed on a list of protected species.

"Birds and Fish Preservation Act" (1934): This Act provides for the designation of protected areas and the declaration of complete protection or closed seasons for specified wild bird and fish species, including sea turtles. Some of the provisions under the Act, include:

1. the prohibition of the killing or molesting of a protected species or its eggs or its young or the disturbance of its nest or habitat, and,

2. the prohibition in designated protected areas (unless consent is given by the Minister), of the discharge, or cause to be discharged, of any effluent or noxious or toxic

liquid or substance, erection of temporary or permanent harbours, wharves, jetties or other building works, cutting, damaging, removal or destruction of any mangrove, erection of fish fences, fish traps, trawling for fish or fishing for commercial purposes, or carrying out boring, drilling or dredging in designated protected areas.

Birds reported present in Ha'apai that are protected under the Act include: **fuleheu**, wattled honeyeater (*Foulehaio carunculata*), **henga**, blue-crowned lorikeet (*Vini australis*), **kalevaleva**, long-tailed cuckoo (*Eudynamis taitensis*), **kulukulu**, purple-crowned fruit-dove (*Ptilinopus porphyraceus*), **lupe**, Pacific pigeon (*Ducula pacifica*), **misi**, Polynesian starling (*Aplonis tabuensis*), **moho**, spotless crake (*Porzuna tabuensis*), pekepeka, white-rumped swiftlet (*Collocalia spodiopygia*), and tu, friendly ground-dove (*Gallicomba stairii*). Species reported from Ha'apai, but not listed, some of which are endangered, include: **kalae**, purple swamphen (*Pophyrio porphyrio*), **lulu**, barn owl (*Tyto alba*), **manuma'a**, many-coloured fruit-dove (*Ptilinopus perousii*), **moakaivao**, jungle fowl (*Gallus gallus*), **motuku**, Pacific reef heron (*Egretta sacra*), **sikiviu**, Polynesian triller (*Lalage maculosa*), **sikota**, collared kingfisher (*Halcyon chloris*), **taiseni**, swamp harrier (*Circus approximus*), **toloa**, Pacific black duck (*Anas superciliosa*), and **veka**, banded rail (*Gallirallus philippensis*).

"Fisheries Act" (1989): This Act is designed to promote the sustainable development and management of the Kingdom's fishery resources, and is basically a corporate plan for the national fisheries. The main features of the Act are:

1. the Director of Fisheries must prepare fishery management plans,

2. all local fishing vessels must be registered and licensed,

3. permission must be obtained for all foreign involvement in fisheries,

4. all foreign fishing vessels must have a valid license for Tongan waters,

5. no explosives or poisons be used to take fish,

6. the Minister may declare any area a reserve for subsistence fishing,

7. a license is required to operate a fish processing facility,

8. the government may lease land for aquaculture,

9. permission is required for the import/export of live fish, and,

10. the Minister, with the consent of Cabinet, may make regulations covering any of 25 named issues.

"Fisheries Regulations" (1994): These are subsidiary regulations under the Fisheries Act of 1989. The main provisions of the regulations are:

1. the export of live fish requires a permit,

2. a ban on fishing for marine mammals unless exceptionally authorized by the Secretary for Fisheries for the purpose of international scientific research,

3. a ban on the use SCUBA or hookah gear for fishing without written permission,

4. minimum mesh sizes for dragnets, beach seines, and cast nets,

5. a ban on net fishing within 200 metres of a fish fence,

6. specified minimum sizes for lobsters (7.5 cm carapace length), for slipper lobsters (15 cm carapace length), for winged pearl oyster (20 cm for winged pearl), triton shell (20 cm long), and for various species (*Tridacna* spp.) of giant clams and beche-de-mer,

7. a ban on the taking of coral or aquarium fish without written permission,

8. a ban on taking or possessing turtle eggs, interfering with turtle nesting, use of a spear for taking turtles, taking turtles less than 15 cm (carapace length), taking turtles during certain specified closed seasons, and taking any leatherback turtles,

9. a ban on taking mullet during specified closed seasons,

10. a requirement for a fish fence license and specifications for maximum and minimum dimensions, and

11. requirements for fish aggregation devices.

"Whaling Industry Act" (1935): This Act prohibits the taking or killing of baleen whales by persons belonging to ships registered in Tonga.

"Land Act" (1927): This Act and the Constitution of 1852 established the right of every Tongan male over 16 years of age to a bush and town allotment and, including subsequent amendment has provided the basis for the distribution and use of all lands, including leasehold lands on the four main classes of land in the Kingdom: the King's hereditary estate, Royal Family hereditary estates, hereditary estates of nobles (**nopele**) and high chiefs (**matapule**) and Government Land. Under the Act, land in Tonga can not be bought or sold, with individual bush and town allotments and hereditary estates all passing, on the basis of primogeniture, to the eldest male heir upon the death of the holder. Under the Act tenure is reasonably secure, with provisions being made for the proper maintenance of allotments and leaseholding (see discussion of land tenure above.

Section 22 of Act regulates cutting and taking of trees, removal of sand and quarrying. The Land (Timber Cutting) Regulations (G33/43) states that where permission to cut

timber on Crown Land is given, no timber can be cut within 50 feet of the high water mark.

"Public Health Act": This Act and numerous amendments governs all matters related to public health and covers issues relating to water supply, tanks and wells, health dangers, infectious disease control, food inspections, sanitary facilities, pit latrine location and upkeep, building regulations, litter, inspections of public facilities. It also includes provision to prohibit the keeping of any animals that are seen to be a nuisance or dangerous to health, a problem of widespread concern in villages in Ha'apai.

"Town Regulations Act" (1903): This Act, and subsequent Sections, is designed to ensure high standard of environmental health in town reserves and on town allotments (**'api kolo**). Major provisions include:

1. bimonthly inspections to ensure that all "plants" are cut, cleaned and swept,

2. litter regulations which make it illegal to place any glass, bottles, cans, bits of metal or iron, paper or rubbish or litter, whether a source of danger or not onto any government road, public place, the beach or on another person's premises Littering is also prohibited under the Mosquito Control Regulations, the Garbage Act and the Public Health Act),

3. the prohibition of keeping pigs or goats within the boundaries of nuku'alofa, Neiafu and Pangai, except under licence, with the police having the authority to shoot unlicenced pigs or goats.

"Garbage Act" (1949): This Act includes the following provisions:

1. a legal framework for the collection of garbage, with appropriate rules for the types of containers, compulsory removal of garbage,

2. the establishment of garbage dumps and dumping regulations in all towns and villages, and,

3. the establishment of a programme under the Quarantine Act of 1927, to prevent, through inspection, the introduction into the country an to individual islands, pests and communicable and non-communicable diseases by inspections of person arriving on airplanes, ships and yachts entering from abroad (the Quarantine Service of MAF, under the "Plant Quarantine Act (1981) is responsible for inspection of incoming plants and animals to prevent the spread of exotic pests and diseases).

"Minerals Act" (1949): This Act sets conditions for permits for mineral exploration and mining and for protection and restoration of forest areas affected by mining.

"Pesticides Act" (1975/1981): This Act regulates the registration, manufacture, sale and use of pesticides. As at 1988, no pesticides had been registered. While labels on many pesticides are now printed in Tongan, the NEMP reports "There are no standards or regulations covering the kinds of pesticides which are allowed to be imported and used in Tonga

and private individuals and companies can and do import whatever they want. There are no restrictions on where pesticides of different toxicities may be used ..[and] ..no..regulation of disposal of empty containers...".

"Noxious Weeds Act" (1903): This Act provides for the eradication of plants harmful to agriculture. Restrictions on the importation and transport of noxious weeds are provided but few actual weed species are identified.

"Customs and Excise Act" (1983): prohibits the export of "raw coral (including unprocessed black coral) except with the permission of the Controller of Customs following approval by Cabinet".

11.5 Environmental Treaties and Conventions

There are a number of international and regional conventions of environmental importance in the Pacific Islands. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the South Pacific Nuclear Free Zone Treaty (Rarotonga Treaty), and the Law of the Sea Convention are widely regarded as three critical initiatives for the Pacific Islands. Tonga is not yet party to these conventions.

The two major regional environmental conventions are the Convention on the Conservation of Nature in the South Pacific (Apia Convention); and the Convention for the Protection of the Natural Resources and Environment of the South Pacific (SPREP Convention), which has two protocols. Both of these regional Conventions are now in force. The Apia Convention was first circulated in 1975 and required ratification by four countries. In 1976 it was signed by Australia, France, Papua New Guinea and Western Samoa. Although other countries have since signed or ratified the convention, Tonga has not yet done so.

The SPREP Convention required the accession/ratification of ten countries before it entered into force. The tenth country ratified in July 1990. The 10 signatories are Australia, Cook Islands, Federated States of Micronesia, Fiji, France, Marshall Islands, New Zealand, Papua New Guinea, Solomon Islands and Western Samoa.

Two conventions of major importance which were ratified at UNCED in 1992 are the Convention on Biodiversity (CBD) and the Convention on Climate Change. Although Tonga has not signed either of these conventions, it is eligible for participation in SPBCP, the major vehicle for the implementation of the CBD in the independent countries of the Pacific.

11.6 Training, Education and Public Awareness

Training, education and public awareness are seen as a fundamental platform for addressing Tonga's environmental problems. To foster environmental awareness LEPU has in place a number of environmental awareness and education programmes.

The major annual activity is National Environmental Awareness Week (**Uike 'Atakai**) which is held during the first week of June each year to coincide with World Environment Day on 5 June. The World Environment Day theme is adopted for local awareness activities throughout the week. In 1995 national celebrations will be held in Pangai, with a major focus being on the Ha'apai Conservation Area Project and its objectives of biodiversity conservation and sustainable use of natural resources.

Radio programs are conducted at two levels: a three times daily radio spot in Tongan and English on an environmental theme in community news; and twice monthly radio sessions, usually lasting for 15 minutes. The latter can be interviews, panel discussions, or talks, supported by environmental songs and news snippets (Thistlethwaite *et al*. 1993)

Tongan language environmental articles are prepared occasionally for the newspapers, although their frequency is constrained by the cost of paying for space in the paper. There are plans to introduce a weekly environmental column, in both Tongan and English in the national *Tonga Chronicle*.

School visits are made on the average of four times a month, on the request of teachers. These are quite popular and can cover a wide range of activities, with an emphasis on doing rather than talking. LEPU currently has a U.S. Peace Corps Volunteer serving as Environmental Education Officer and responsible for preparation of environmental education materials for schools and the media. LEPU also has a small environmental resource library which is open to students.

LEPU maintains constant involvement with NGOs and, in particular, with community groups. These include women's church groups, Young Men's/Young Women's Christian Association, the National Youth Group, Scouts and Girl Guides, Red Cross; while on the regional or international NGO front with FSPI, Earth Quiet, Earth Watch, SPACHEE, and Greenpeace. LEPU representatives also address service organisations, such as Rotary International.

Environmental Science is taught as a core subject in classes 1-6 in the Primary Schools. There is also environmental content in standard subjects of primary and high school curricula in Tongan Studies and General Science for Forms 1-5, with more comprehensive coverage of environmental issues in Geography, Biology and Chemistry for Forms 3-6 in the Secondary Schools. Environmental issues are also treated at the tertiary level within the locally-taught agricultural science and biology diploma programmes and the USP Foundation Year and Extension programmes.

Apart from the education system, most ministries and other government agencies have teaching or extension roles. Ministries such as MAF and MLSNR and the Tonga Visitors Bureau have major extension or promotional programmes, but more emphasis is required on the production of brochures, posters, pamphlets and other educational materials. There is also a need for a more interactive, participatory approach with farmers, fishermen, tourist operators, women's groups and other appropriate target audiences.

12 PROJECT OBJECTIVES, CONSTRAINTS, WORK PLAN AND ACTIVITIES

This section contains: 1) the objectives of the Ha'apai Conservation Area Project (HCAP); 2) constraints to conservation and sustainable use of biodiversity in Ha'apai; 3) the project design and descriptions of the main activities which will constitute the Work Plan during Phase I of the project; 4) lead agencies responsible for specific activities; 5) the timing or phasing of project activities; and, 6) the proposed budget.

12.1 Project Objectives

The overall objective of the HCAP and its Work Plan during Phase I (year 1) is to PROMOTE THE CONSERVATION AND SUSTAINABLE USE OF "BIODIVERSITY" WITHIN THE HA'APAI CONSERVATION AREA (HCA). In pursuing this objective emphasis will be placed on: 1) participatory planning and community-based resource-use strategies; and, 2) diversified multi-ecosystem, multi-species and multi-purpose use of the biodiversity within the HCA.

In the context of the HCAP "biodiversity", as defined in section 4.1 above, would include:

1. All terrestrial and marine ecosystems (e.g. forests, grasslands, agricultural areas, towns, reefs, lagoons, etc.)(See Appendix 2 for a more detailed account of the ecosystems in Ha'apai);

2. All plant and animal species and varieties found in these ecosystems (e.g., all species of trees, shrubs, vines, herbs, grasses, seaweeds, shellfish, finfish, beche-de-mer, crustaceans, etc. and all varieties of yams, sweet potatoes, mangoes, etc.); and

3. The knowledge, uses, beliefs and language that the people of Ha'apai have in relation to their biodiversity. This would include the time-tested "biodiversity-management systems" which have served as a basis for the relatively sustainable habitation of the islands for over three thousand years, beginning long before the expansion of the global market economy over the islands.

Because most resource-use decisions, in Tonga, are made and enforced at the community and individual landowner levels, particular emphasis is placed on increasing the capabilities and involvement of local communities in planning for the sustainable use of their biodiversity resources. This will involve awareness raising and the identification, through community-level participatory planning, of priority activities that can be initiated and carried out at the community or resource-user level. It is also stressed that awareness raising should also include the preservation, reinforcement and reteaching (in the case of the young) of traditional biodiversity knowledge and traditional sustainable resource-use strategies that have relevance for biodiversity conservation.

Because there seems to be no single sustainable economic development activity or single ecosystem or species that satisfies all of the economic and cultural needs of the people of Ha'apai, stress will be placed on multi-ecosystem, multi-species and multi-purpose use of the biodiversity within the HCA in order satisfy the short- and long-term needs for BOTH cash and subsistence.

In pursuing the overall objective of participatory, multi-ecosystems, multi-species, multi-purpose biodiversity use, other specific objectives of the HCAP identified at this point include:

1. The identification of endangered or culturally and economically important ecosystems and plant and animals species within the HCA and that could become the focus of community-level protection and sustainable management programmes;

3. The identification of constraints to, and practices which do not favor, sustainable use and management of biodiversity in Ha'apai;

4. The identification of a range of opportunities or programmes for sustainable use and management of biodiversity with the intention of increasing cash and non-cash incomes and the quality of life of the people of Ha'apai;

5. The active promotion of activities that foster the sustainable use, protection and enhancement of the biodiversity of Ha'apai;

6. The active discouragement of practices that contribute to the loss of biodiversity and which undermine sustainable development in Ha'apai.

12.2 Constraints to Conservation and Sustainable Use of Biodiversity in Ha'apai

To develop a programme of activities to promote biodiversity conservation depends to a great extent on the identification of constraints to and prospects for biodiversity conservation. After these have been identified appropriate activities can be planned to address these constraints.

Based on discussions with local communities and resource development agencies in Ha'apai, the most important constraints to biodiversity conservation and sustainable use of natural resources in Ha'apai are:

1. Inadequate resource management mechanisms (e.g., absence of local community control over inshore marine resources, and non-implementation or non-enforcement of existing environmental legislation).

2. Loss of ethnobiological and environmental knowledge (e.g., urban-biased education, failure of older generation to pass on traditional knowledge to the young, inadequate environmental education, and resultant environmental "blindness").

3. Coastal and soil erosion (related to global warming-induced sea-level rise, removal of coastal littoral vegetation, establishment of quarries and use of dynamite near the coast, etc.).

4. Deforestation, agrodeforestation and loss of culturally, economically and ecologically valuable trees, plants and associated wildlife (e.g., the replacement of remaining inland forests and trees by **saafa** (*Panicum maximum*) grasslands and scrublands due to agricultural clearance, excessive ploughing and burning, tropical cyclone damage, and failure of current generation to replant).

5. Environmental problems caused by free-ranging animals (e.g., devegetation and destruction of plants in and around villages and destruction of gardens due to free-ranging pigs, horses and goats, dust and erosion problems in devegetated areas, human health problems and water pollution related to free-ranging pigs in human settlements, etc.).

6. Overexploitation of inshore fisheries resources (e.g., overexploitation of turtles, giant clams, beche-de-mer, large demersal species and other commercially-important target species through the use of SCUBA and hookah gear, small-mesh gillnets, etc., often by non-resident populations).

7. Increasing use of agricultural chemicals and imported agricultural inputs (e.g., indiscriminate use of expensive and dangerous insecticides, herbicides, fungicides without required safety equipment, increasing use of inorganic fertilisers and declining planting of leguminous improved fallows, increasing ploughing/complete tillage and associated loss of trees and breakdown in soil structure, etc.)

8. Declining indigenous bird and terrestrial animal populations due to habitat destruction, overexploitation or predation (e.g., human overexploitation of sea birds and sea-bird eggs on uninhabited islets, elimination of ground-nesting birds by feral cat populations, and habitat destruction by burning, forest clearance, and rooting, foraging and browsing of pigs, goats, horses and cattle).

9. Absence of a system of marine and terrestrial reserves and sanctuaries (absence of any established or designated reserves in Ha'apai, although similar areas have been established on Tongatapu and 'Eua and in Vava'u).

10. Water shortage and water quality (e.g., absence of surface water resources, limited groundwater resources, increasing domestic and agricultural water demands, limited rainwater catchment capacity, poor maintenance and/or pollution of groundwater and rainwater catchment resources, absence of a water conservation strategy, etc.).

11. Inadequate tourism development (e.g., almost total absence of promotional materials on ecotourism in Ha'apai, limited ability of local small-scale tourist operators to promote and to highlight the biodiversity resources and to identify areas of particular ecological and cultural interest to tourists, lack of trained local tour guides, etc.).

12. Poor marketing structure for primary products (e.g., poor marketing networks, procedures and facilities for fresh fish, beche-de-mer, food crops, handicrafts and other terrestrial and marine products that can be produced sustainably by the people of Ha'apai).

These constraints, most of which have been discussed in greater detail in sections 5 to 11 above, are addressed by the activities in described in this section.

12.3 Project Management

The HCAP management consists of national and local Ha'apai-level components, with a Conservation Area Support Officer (CASO) who constitutes the main link between the two (A summary of the terms of reference for the CASO is provided in Appendix 12).

12.3.1 National Level

At the national level, the Ha'apai Development Committee (HDC) is responsible for coordinating and approving all development activities in Ha'apai. The HDC is a high-level government committee, based in Nuku'alofa, and chaired by the Honourable Minister of Police. The Central Planning Department (CPD) serves as its secretariat. The HDC has representatives from all relevant ministries, including MLSNR, which has just been included in the membership. The HDC endorsed the HCAP for Cabinet approval in late February 1995.

In terms of the HCAP, the "Lead Agency" at the national level is the Land and Environmental Planning Unit (LEPU) of the MLSNR. LEPU will be responsible for the overall management of the HCAP, with appropriate staff members of LEPU contributing to and/or coordinating relevant components of the HCAP. Activities which fall within particular sectors (e.g., agriculture, fisheries, forestry, education, labour and commerce or tourism, will be implemented in consultation and cooperation with the relevant agencies in Ha'apai and nationally. Efforts will be made not to duplicate ongoing efforts of government and non-government agencies, but rather to implement activities that complement such efforts in the context of the overall objective of promoting the sustainable use of biodiversity in the Ha'apai group.

As the Lead Agency, LEPU will be the main link with SPBCP and other agencies that may fund activities under the project. LEPU will be responsible for administering project funds and for the submission of quarterly reports and work plans to SPBCP. LEPU will report on all planned activities and the progress of the HCAP to the HDC.

12.3.1 Ha'apai Level (Conservation Area Level)

A Ha'apai-based Conservation Area Support Officer (CASO), funded under SPBCP, but working for LEPU, will be responsible for the day to day management of the HCAP, and will be the link between LEPU and the Ha'apai-level management of the HCAP. He will do this in consultation with a Conservation Area Coordinating Committee (CACC) and representatives of participating communities.

The composition of the CACC includes high-ranking Ha'apai-based representative of relevant Ha'apai-based government agencies and representatives from participating communities. The composition of the CACC is shown in Table 10.1.

Table 12.1. Composition of the proposed Ha'apai Conservation Area Coordinating Committee.

Patron:	Honourable Governor of Ha'apai
Chair:	Police Magistrate and Government Representative
Deputy Chair:	Personal Secretary (Governor's Office)
Membership:	Fisheries Officer (Ha'apai) (MOF)
Secretary:	Conservation Area Support Officer (LEPU)
	Agricultural Officer (Ha'apai), (MAF)
	Area Education Officer (Ha'apai) (MOE)
	Ministry of Health Representative
	Central Planning Department Representative
	Tonga Visitors Bureau Representative
	Ministry of Labour and Commerce Representative
	District Officers (**Pule Fakavahe**)
	Town Officers (**'Ofisa Kolo**)
	Women's Development Committee Representative
	Ha'apai Youth Council Representative
	Church Representatives

Provisions were made for the co-option of additional relevant members as the need arises.

An initial meeting was also held with the Governor of Ha'apai, the Honourable Fakafanua, who gave his full support to the project, and designated his Personal Secretary to be liaison and to coordinate the activities of the PPD team while in Ha'apai. This proved extremely useful and facilitated the team's work, particularly in terms of establishing links with District and Town Officers and with local communities.

12.4 Specific Activities

Given objectives 1 to 5 above, specific activities or projects, proposed for implementation during Phase I include:

1. Participatory planning meetings/workshops;
2. Biodiversity use and baseline studies;
3. Education and public awareness campaigns;
4. Compilation of existing legislation;
5. Village biodiversity enhancement;
6. Agroforestry and organic farming;
7. Marine ecosystem management enhancement;
8. Key ecosystem and species protection;
9. Small-scale tourism development; and
10. Handicraft marketing and training.

It is stressed that most of these activities have been identified by, or in consultation with, and will be implemented, monitored and modified by local communities of Ha'apai, under the direction of the CACC, relevant Ha'apai-based government agencies, and with the support of the CASO who will be responsible for the day-to-day administration and logistics of the HCAP. The activities are not listed in order of importance and more than one activity can be implemented concurrently.

As suggested in the introduction, a multi-sectoral, multi-resource, multi-ecosystem approach to the conservation and sustainable use of biodiversity will probably be the only means of achieving the dual objectives of biodiversity conservation and the enhancement of the cash incomes of the people of Ha'apai on an environmentally sustainable basis. To do so, a variety of activities will have to run simultaneously. Experience elsewhere shows that conservation efforts which focus on only one environmental issue or on only one environmentally-sound economic enterprise have met with only limited success.

For most of the activities, there will need to be some training or workshops to learn or share skills. Most of these workshops and attachments can be done locally in Ha'apai, using either local expertise, both within and between communities and within Ha'apai-based government and non-government institutions. In some cases, however, persons with specific skills could be brought to Ha'apai from Tongatapu or overseas to run community or Ha'apai-based workshops, depending on the focus of a given activity.

12.5 Budget

The proposed budget is divided into: 1) salaries and cost of the management and implementation of the project; 2) costs of the individual activities suggested for inclusion in Phase 1 of the project; and, 3) Tongan Government contribution. The costs of transport, fees, per diems, materials production, equipment and contingencies are included within each of the suggested individual activities (Table 12.1). The main costs in terms of salaries and project management include the salary and support for the CASO, and limited funds to allow representative from the Land and Environmental Planning Unit (LEPU) in Nuku'alofa to make field visits to Ha'apai to support the CASO and to visit participating local government agencies and communities. The total estimated cost of Phase 1 of the Ha'apai Conservation Area Project (HCAP) is $US 92,910.

The Tongan Government contribution would include:

1. A commitment of T$5,000 for the financial year 1995/96.

2. Government staff time and subsistence allowance.

3. Use, depending on availability, of Ha'apai-based government boats.

4. Office space in Ha'apai and Nuku'alofa.

5. Fax, Telephone and photocopy services in Nuku'alofa.

6. Housing for the CASO in Ha'apai.

As can be seen from the summary budget provided in Table 12.2, most of the funds go to activities to be conducted at the community or Ha'apai regional levels. It is envisioned that, given inflation, and the fact that preliminary surveys and major botanical surveys will not be required during the last four years of the project that the estimated costs per year for years 1-4 would also be around $US 80,000. This also takes into consideration the large area of the proposed Conservation Area and the increased proportion of the budget that will go to costly inter-island transportation as the project increases it focus away from the Pangai area onto some of the more remote islands and island communities.

Table 12.2 Proposed summary budget for Phase 1 of the Ha'apai Conservation Area Project.

1	CONSERVATION AREA SUPPORT OFFICER (CASO)	
	Salary (Including emoluments)	$10,000
	Internal Travel (Annually)	
	4 Trips Ha'apai-Tongatapu @ $US100 per trip	$400
	Internal Boat Travel in Ha'apai	$1,000
	Internal Land Transport	$500
	Travel Allowance @ $12 per day x 30 days	$360
	Computer Equipment (lap top, printer, etc.)	$3000
	Contingencies (office supplies, etc.)	$1000
	SUBTOTAL	**$16,260**
2	VISITS BY LEPU STAFF TO HA'APAI	
	5 Trips Ha'apai-Tongatapu @ $US100	$500
	Travel Allowance @ $20 per day x 25 days	$500
	SUBTOTAL	**$1,000**
3	PROJECT ACTIVITIES	
	Participatory Planning Meetings/Workshops	$10,000
	Biodiversity Use and Baseline Studies	$15,650
	Education and Public Awareness	$10,000
	Modification and Enforcement of Existing Legislation	$2,000
	Village Biodiversity Enhancement	$9,000
	Agroforestry Protection and Enhancement	$9,000
	Marine Ecosystem Management and Enhancement	$8,000
	Key Ecosystem and Species Protection	$2,000
	Small-Scale Tourism Development	$5,000
	Handicraft Marketing and Training	$5,000
	SUBTOTAL	**$75,650**

GRAND TOTAL FOR PHASE 1	**$US92,910**

12.6 Timing

After approval of the PPD by Tongan authorities, SPREP and the participating communities, priority should be given to those activities upon which other activities are based or activities which could enhance future activities. It is especially important that the participatory planning meetings are conducted as soon as possible. Other foundation activities are the preparation of the HCAP brochure, the public awareness campaign, the compilation of existing environment-related legislation, the rapid compilation of existing biodiversity information and protection strategies and the strengthening the MAF nursery at Vaipoa, Foa and the establishment of village nurseries in the pilot communities.

12.7 Work Plan

The suggested Work Plan for the implementation of the suggested activities is provided below. It includes a detailed outline of the nature of proposed activities, lead agencies, timing and estimated costs. Although the most of the proposed activities will be continued, with modification, over the entire five-year duration of the Project, emphasis is placed on the specifying of those activities (1 to 10 above) that will be carried out during the first year of the Project. It is envisioned that new activities will be added in later stages of the project in response to the changing needs of the communities of Ha'apai and after evaluation of activities carried out during Phase I.

It is also important to note most activities during Phase I focus on the "pilot communities" in order to evolve models for future use. Where appropriate, activities during Phase I, particularly workshops and educational activities, could include representatives of non-pilot communities within the HCA in order to enhance the spread effects of the project.

Because of limited funding, there will need to be a balance between those activities which can be: 1) supported with funding from the HCAP or other Government or external funding, and 2) those activities which communities must initiate carry out with their own resources. In the latter case, the identification and initiation of such activities and some technical advice could come from the project. To achieve economies of scale, to maximise local participation in planning, implementation, monitoring, and to maximise capacity building within the HCA, an effort has been made to maximise use of local expertise and to base activities in Ha'apai.

Activities 1 to 10 listed above are detailed below.

12.7.1 Participatory Planning Meetings/Workshops

Because the main emphasis of the SPBCP is the conservation and sustainable use of biodiversity by resident communities, the emphasis of the project during Phase I will be participatory rural assessment (PRA) and participatory planning activities.

Nature of Activity: The main objectives of these activities will include:

1. Discussions with local communities of the objectives of SPBCP and the HCAP and the need/rationale for the conservation of biodiversity as a basis for sustainable development. This would include in-depth discussions on the biological, economic and cultural rationale for environmental legislation, nature conservation, and the importance of marine and terrestrial parks and reserves.

2. Identification of endangered or culturally and economically important ecosystems and plant and animals species within the HCA and that could become the focus of community-level protection and sustainable management activities.

3. Identification of activities and resource-use strategies which constitute serious constraints to conservation and the sustainable use of biodiversity within the HCA.

4. Identification by local communities, both individually and collectively, of activities which offer the most promise for promoting the sustainable use of biodiversity to improve cash and non-cash incomes and the quality of life.

5. Identification and prioritisation of activities, at the community, regional and national levels, which could promote the sustainable use of biodiversity and eliminate or minimise unsustainable practices in the HCA.

The participatory planning component of the Project, already initiated during the Project Preparation Document phase, is seen as the most important component of the entire Project and a component which must be carried out throughout the entire five-year duration of the Project. Depending on the nature of a given activity, a range of different forums will be used. These include official village and district meetings (**fono**), workshops, meetings with women's, fishermen's and farmer' groups, kava parties (**kalapu kava Tonga**), church groups, youth organisations, parent-teacher associations, etc.

These workshops/meetings will be the mechanism for contact with the communities on Tofua and Kao, which was not possible during the PPD phase due to transportation difficulties.

Suggested models for the conduct of this component include:

1. Initial one-day meetings/workshops in each of the Pilot Communities to address items 1-5 above. These meeting would include the entire village and would be organised by the Town Officer of each village.

2. Specialised meetings/workshops for relevant target groups to discuss and plan the implementation of specific projects or activities which have been given priority by the communities (e.g., meetings with fishermen, women fishers, handicraft makers, youth groups, women's groups, farmers, etc. which have identified important issues or activities). In later stages, such meetings could focus on the evaluation, monitoring and modification of activities. Such activities are discussed in detail below under other project activities.

3. Combined meetings at the Ha'apai level which would involve representatives from each of the Pilot Communities (e.g.,the Town Officer and the leader of the local women's' committee or their representatives) with District Officer (**Pule Fakavahe)** and members of the CACC to discuss the implementation, status and success of the work plan as it evolves.

Lead Agencies: The meetings/participatory planning workshops (PPWs) will be planned, scheduled and coordinated by the CASO and the CACC. They will involve appropriate persons/bodies when need arises and when deemed necessary by the CACC, in consultation with the Project management.

Timing: These meetings/workshops should begin immediately after the PPD has been finalised, ideally no later no later than June 1995 (it is envisioned that the community-based workshop to finalise the PPD will take place over the week of April 9 to 14). The exact timing and number of the workshops will be determined by the CASO in consultation with the CACC.

Estimated Costs: The estimated cost of the workshops, given an estimated number of 40 meeting/workshop-days and an average of at least 15 participants per meeting/workshop, which would include preparation costs, transport and nominal local subsistence for participants is as follows:

1.	Preparation (@ $30/work-shop day x 40)	$1200
2.	Transport (boat and road)	$2000
3.	Subsistence/participants (@ $4 per x 600 days)	$2400
4.	Contingencies	$500
5.	Technical expertise	$3900
TOTAL		$US10,000

12.7.2 Biodiversity Use and Baseline Studies

Selected surveys of the living resources and traditional knowledge about and use of biodiversity will be required to assess the nature, endangerment status and cultural and economic importance of ecosystems and species of concern. The extent of such surveys will depend on the availability of funding, but will maximise the use of existing information and will attempt to minimise the expenditure of funds on expensive surveys by involving local people in the surveys.

Nature of Activity: The rationale for such surveys are: 1) the acquired information can be used to assess, from the resident community perspective, the major biodiversity issues as well as the true endangerment status and management/protection priority of a given ecosystem or species; 2) can provide valuable ethnobiological knowledge as well as recording traditional knowledge on the names and cultural importance of biodiversity which is in danger of being lost when the current generation of female and male resource managers dies; 3) the information will be of value to local communities, the CACC and Project management as a basis for planning and prioritising Project activities; and 4) the information can be used in public awareness campaigns and for the preparation of educational materials and materials to promote and improve ecotourism in the HCA.

It is stressed that in all cases where information is gathered an effort will be made to: 1) involve as many local people as is appropriate to enhance local capabilities and knowledge of their biodiversity; 2) provide appropriate remuneration to informants and field or technical assistants; and 3) provide copies of all acquired information to the communities involved so that they can use it for their own education and development.

Although the exact priority of such surveys will be decided by Project management, in consultation with the CACC, suggested Priorities include:

1. Rapid surveys, in each of the Pilot Communities, of the marine and terrestrial plants and animals that each community considers to be of particular cultural or economic importance, their endangerment and management status and management strategies associated with different ecosystems or species. This has been initiated on a very limited scale to get initial impressions of the biodiversity inheritance of some Pilot communities, as part of the Project Preparation Document Phase. It is envisioned that these surveys would be conducted, under the supervision of the CASO, by local students and teachers and the most knowledgeable male and female persons in the Pilot Communities. There may be a need for the collection of some voucher specimens to correlate Tongan names with scientific (Latin) names for some organisms.

2. Rapid compilation of existing information on the living resources of Ha'apai (e.g., existing lists or studies of marine vertebrates and invertebrates, flora, birdlife, etc.). This could best be done by enlisting a known authority for one to four days to compile and collate what information exits (e.g., the National Wildlife Centre to compile information on bird and vertebrate terrestrial fauna of Ha'apai). This compilation should include suggestions for protection strategies, especially those which could be implemented by the local communities.

3. In-depth surveys of ecosystems and species of particular ecological, economic or cultural importance. Areas and species which would seen to warrant priority for survey include the ecosystems and species listed in Table 12.3.

Table 12.3. Ecosystems and species tentatively identified by Pilot Communities and local officials in Ha'apai as meriting priority for survey as part of Phase I activities of the HCAP (Note: such information may already exist. If this is the case, then this would require only collation or updating of current information. * indicates those species for which Ha'apai surveys have already been completed).

ECOSYSTEMS

Tofua (forest and alpine scrublands)
Nukunamo Island (sandalwood reserve)
mangroves
'Auhangamea Passage
undisturbed inland and littoral forest stands
uninhabited islands (especially bird and turtle nesting sites)

SPECIES

Marine Animals

triton shell, kele'a (*Charonia tritonis*)
*giant clams vasua - kukukuku, matahele, tokanoa, nge'esi sioata (*Tridacna* spp. and *Hippopus hippopus*)
*sea turtles, *fonu koloa* (*Eretmochelys imbricata*), *tu'akula* (*Chelonia mydas*), tufonu (*Caretta caretta*) and tungongu (?)
*beche-de-mer (*Holothuroidea*)
arc shell, kaloa'a (*Anadara antiquata*)
sea birds
* whales

Terrestrial Animals

coconut crab 'u'u (*Birgus latro*)
purple swamphen (*Porphyrio porphyrio*)
banded iguana (*Brachylophus fasciatus*)

Plants

island mahogany, fehi (*Intsia bijuga*)(only reported from Kao)
sandalwood, ahi (*Santalum yasi*)
mangrove species - tongo ta'ane, fa'onelua (*Bruguiera gymnorrhiza*), tongolei (*Rhizophora* spp.), lekileki (*Xylocarpus granatum* and *X. moluccensis*)
koli (*Syzygium neurocalyx*)
ai (*Canarium harveyi*)

heilala (*Garcinia sessilis*)
Malay apple, vi (*Spondias dulcis*)
seaweeds, limu

A botanical survey of Tofua is seen as a priority because, apart from the reference to a few specimens collected by Buelow and Whistler (Whistler 1991a), there is no published data on the island's flora. The only islands in the Ha'apai group for which there are published floristic studies are Lifuka, Kao and Nomuka. Kao, has, after 'Eua (in the Tongatapu group in the south of Tonga), the richest fern and orchid floras. It also has species that are either found only on Kao or which are new species endemic to Kao or Tonga (e.g., *Psychotria kaoensis* A.C. Smith, *Scaevola porrecta* Yuncker) (see section 5.4.3 above). This being the case, it is reasonable to believe that Tofua would also have a unique flora, similar to Kao, and, thus, worthy of inventory, particularly since there is an increasing amount of fisheries, agricultural, forestry, and ecotourism activities.

Mangroves, which are critical ecosystems at the boundary between marine and terrestrial ecosystems are currently believed to found on only two islands in the Ha'apai group, 'O'ua and Nomuka, but were reportedly present on Foa, 'Uiha and possibly Lifuka, in the past. There seems to be an urgent need to inventory all mangrove sites to assess the feasibility and need for their protection or re-establishment, as preliminary surveys indicate that mangrove species, in addition to enhancing coastal protection, water purification and serving as important fisheries habitats, also have very important cultural and economic value.

There is also a need to conduct rapid inventories of the status and species composition of the remaining areas of relatively undisturbed inland and coastal littoral forest, as these may be the only remaining reserves of a wide range of tree and non-tree species, which were reported as being culturally important and/or in short supply or endangered during the preliminary PPD surveys, and from which planting material for use in reforestation and nursery establishment can be obtained. Of particular interest are the remaining areas of sandalwood, which are increasingly targeted and cut illegally by overseas Chinese traders.

Where possible, such surveys should involve personnel from appropriate Ha'apai-based agencies, so that these agencies are strengthened through interaction with both local Tongan experts (village people) and, when appropriate, visiting experts or scientists.
There is also a need to obtain existing books and other appropriate reference materials on Tongan and Pacific Island biodiversity for use in Ha'apai (e.g., existing survey reports, books on plants, birds, fish, shellfish or beche-de-mer, etc.). Such books are normally very expensive, although selected reference materials are seen as critical to the strengthening of the scientific capabilities of Ha'apai-based agencies. In many cases such materials, such as the "Tonga Marine Resource Profiles" (Bell *et al*. 1994) can be obtained in Tonga or photocopied.

Lead Agencies: The lead agencies coordinating these surveys would be the CACC, LEPU and the residents of the survey areas. The involvement of local Ha'apai agencies will depend on the nature of the surveys (e.g., forestry for forest surveys, fisheries for marine surveys, etc.).

The rapid surveys of the marine and terrestrial plants and animals that each community considers to be of particular cultural or economic importance, their endangerment and management status and management strategies associated with different ecosystems or species would be coordinated by the CASO and conducted by local students, teachers and members of the pilot communities.

In terms of the compilation of existing data on biodiversity, when this can be best done by a recognised expert, the selection of that person, on a short-term consultancy basis will be done by LEPU in consultation with the CACC. The same would hold true for the selection of specialists/consultants to conduct required in-the-field inventories (e.g. of the flora of Tofua). Such persons should also be responsible for identifying appropriate reference materials that can be lodged with the CASO and other appropriate agencies in Ha'apai.

It is recommended that, for botanical surveys of Tofua and Kao, if possible, Dr. W.A. Whistler, a botanist from the University of Hawaii, and the recognised expert on the Tongan flora and ethnobotany, be considered, as a member of the survey team. There is no other person that could bring such expertise to the project. Other inventories could be conducted by local Tongan experts, possibly with some assistance from USP, SPREP or other agencies, with an eye to strengthening Ha'apai capabilities.

Timing: In terms of timing, the rapid surveys in the Pilot Communities, which were commenced on a reconnaissance basis during the PPD visit to Ha'apai in January 1995, should be carried out as soon as possible as the results would have a bearing on future Project activities.

The compilation of existing data on specific resources and protection strategies should be determined by the CASO in consultation with the CACC and the LEPU. An attempt to do this for some resources has been done as a basis for preparation of, and are included in, this PPD.

The in-depth surveys of critical ecosystems could begin as early as mid-1995, but should be completed by mid 1996, depending on the availability of consultants. The first priority is the in-depth botanical survey of Tofua. The surveys of mangroves, uninhabited islands, sandalwood islands and coastal forests could be done, when time and expertise is available, possibly in conjunction with or as an add-on to the botanical survey of Tofua.

Estimated Costs: The estimated costs of the three survey components are as follows:

1. Rapid surveys of Pilot Communities (8 x 4 days per community, including analysis)

Nominal subsistence to teachers/students (32 x 4 @ $5)	$640
Transport (boat and road)	$500
Reference materials	$500
Materials/computer analysis	$260
Contingencies	$100
Subtotal	**$2000**

2.	Compilation of existing data on biodiversity	
	10 person-days @ $250 (consultancy fee)	$2500
	Materials, photocopying, etc.	$150
	Subtotal	**$2650**
3.	Botanical surveys of Tofua and other sites	
	20 person days @ $250	$5000
	20 days per diem @ $50	$1000
	Cost/subsistence for field assistants	$800
	Air-Fares Honolulu-Ha'apai Return	$1200
	Internal Transport	$1000
	Collection, preparation and shipping of herbarium specimens	$500
Camera, film, processing for project use		$1000
	Contingencies	$500
	Subtotal	**$11,000**
	TOTAL (1, 2 AND 3)	**$15,650**
		add $500

12.7.3 Education and Public Awareness

Experience has shown that unless the general public, resource users and owners, the business community and decision makers understand the rationale, objectives and nature of a development initiative, the chances of success of that initiative are small. A major area of emphasis of the HCAP is, thus, placed on education and public awareness.

Nature of Activity: Suggested subject/content areas of the education and awareness programmes include:

1. Ecological, economic and cultural importance of biodiversity and biodiversity conservation as a foundation for sustainable development.

2. Constraints to biodiversity conservation and activities that destroy or degrade biodiversity.

3. Ecological and biological rational for environmental legislation, biodiversity conservation, and the establishment of terrestrial and marine reserves.

4. Models for, or case studies of, activities which promote the sustainable use of biodiversity.

Specific objectives and target audiences of the education and public awareness programme during phase I include:

1. Sensitisation of key decision makers to the key issues related to legislation and regulation of sustainable use of biodiversity in the Kingdom. This would be coordinated and conducted by LEPU and would include meetings with appropriate department and agency heads, the Interdepartmental Environment Committee (IDEC), the Ha'apai Development Committee (HDC), and representatives of funding agencies and NGOs, who could play a role in the funding or successful implementation of components of the HCAP.

2. Increase public and HCA community awareness of the role of biodiversity conservation as a foundation for sustainable development. This would have two main components. The first would be a national public awareness campaign and the second a continuing effort at the community level in Ha'apai to strengthen the resource users' resolve to promote the sustainable use of their resources for their own long-term benefit. The national campaign would include the following components: 1) a newspaper column on biodiversity conservation and the HCAP; 2) articles in local news magazines; 3) a weekly radio programme on conservation of biodiversity and the HCAP.

3. Preparation of appropriate curriculum materials for use in the school curriculum, teacher training and for tourism promotion. This would include associated field workshops on the importance of biodiversity (cultural and economic) and biodiversity conservation, and the importance of, and methodologies for, fieldwork/fieldtrips as a basis for improved environmental education. Such workshops would involve biodiversity

authorities from local Ha'apai communities (i.e., knowledgeable local men and women) and teacher training and curriculum development personnel as resource persons, with the target audiences being school teachers and tourist guides.

Lead Agencies: The lead agency in coordinating education and public awareness activities will be LEPU in cooperation with the Curriculum Development Unit (CDU), the Teachers Training College of the Ministry of Education and the Tonga Visitors Bureau. LEPU will be responsible for identifying the appropriate parties/contractors to produce the required materials and conduct field workshops. At the Ha'apai-level the CASO in cooperation with the CACC, the Area Education Officer (Ha'apai) and the local TVB representative, will coordinate activities.

Timing: The preparation of a short brochure on the HCA, to be launched and distributed as part of the Tonga National Environment Week activities in 1995 will be completed for distribution by June 1995. As part of this effort, Pangai, Ha'apai will be designated as the national centre for the focus of 1995 Environment Awareness Week activities.

Preparation of information for radio, the print and video/television media will begin as soon as the PPD is accepted and will continue for the duration of the project.

Preparation of short curriculum units for use in biology, geography, social science, English and Tongan Studies will begin, in conjunction with the CDU, in late 1995.

Preparation, updating and circulation of lists (data bases) of plants and animals found in the HCA has already begun and will continue throughout the project.

Teacher and tourist operators/guides field workshops will begin in early 1996, preferably in early January before the 1996 school year commences, although short workshops or meetings (e.g., with tourist operators, host villages, tourist guides, etc.) could be conducted during the second half of 1995 to begin to enhance the benefits of the HCAP to tourism.

Estimated Costs: the estimated costs are as follows:

1.	HCCP Brochure for Environment Week	$1500
2.	Preparation of radio and print materials	$2000
3.	Preparation of local video	$3000
4.	Curriculum development	$1500
5.	Teachers/Tourist Guide Field Workshops	$2000
TOTAL		**$10000**

12.7.Compilation of Existing Legislation

Although the effective enforcement of all environmental legislation is a desirable long-term solution, a knowledge of existing legislation must be seen as a priority for the HCAP. Preliminary assessment of the availability of existing resource and environmental legislation indicates that there is considerable scope for such activities. In addition, the compilation should be considered as foundation for much future HCAP work.

Nature of Activity: Activities related to the compilation of legislation which could be carried out during Phase I, or in subsequent phases of the project include:

1. The obtaining of an official copy of each law with an environmental implication (these laws are summarized in section 11.3). Ten copies are to made of each law which are to be compiled into 10 complete sets and hard-bound. These sets are for distribution to LEPU, CASO, Ha'apai Police Magistrate, the Crown Law Office, MAF, MOF and other relevant authorities. This is to overcome the present difficulty of having many agencies with environment responsibilities without ready access to the actual laws. When appropriate copies of the recent review of environmental law (Pule'a 1991??) short also be circulated to relevant agencies.

2. A national and community-directed awareness campaign to make the public and resource-users aware of current environmental legislation and the biological, economic and cultural basis for its enforcement.

Lead Agencies: The lead agency will be LEPU in consultation with the Crown Law Office of the Ministry of Justice and other appropriate ministries (e.g. MAF, MOF, Lands and Surveys Section of MLSNR).

Timing: This activity should begin in 1995 with the possibilities of identifying Acts and Regulations which could be used to promote the conservation and sustainable use of biodiversity. By the beginning of 1996 the national and community public awareness campaigns of environmental legislation should begin. Preparations for such campaigns should begin soon and can be based on the review of the current environment-related legislation that has already been done as part of the PPD preparation and as part of the *Tonga Environmental Management Plan* (Pule'a ??).

Estimated Costs: The estimated cost of this activity are as follows:

1.	Environmental law purchase/copying	$300
2.	Binding 5 copies of environmental law	$200
3.	Legal Awareness Campaign	$1500
TOTAL		$US2,000

12.7.5 Village Biodiversity Enhancement

One of the main areas of concern in Pilot Communities was the loss of terrestrial biodiversity in and around villages (i.e. in and around township reserves and, in particular, on town allotments (**'api kolo**). The main problem areas were a loss of key tree and plant species, loss of grass (lawns) and intolerable dust during the dry season and mud during the wet season. One of the main causes of these problems is the uncontrolled foraging of pigs (and to a lesser extent other livestock) in and around villages. Moreover, the local Ministry of Health representatives consider free-ranging pigs within villages to be one of the most serious environmental health problems in terms of the potential for spread of disease and water contamination.

Nature of Activity: Priority activities to solve these problems and to enhance village biodiversity include:

1. Replanting and rehabilitation of culturally important tree species in towns.

2. Improvement or establishment of pig pens and pig fences using traditional living fencing.

3. Planting of living hedges/fencing around, or bordering roads on all town allotments.

4. Strengthening of the capacity of the MAF Vaipoa Nursery on Foa to provide target species and to promote village nursery and plant propagation efforts.

5. Establishment of village-based nurseries or strategies for the propagation and distribution of trees and other desired plants in all Pilot Communities. This could include appropriate incentive payments to persons/groups which propagate/collect seedlings of difficult to propagate/find target species.

6. Workshops, at both the Ha'apai and community levels, to develop strategies and identify the most appropriate strategies for the location, development and maintenance of a system of village-based nurseries to propagate, care for, and distribute the trees seedling and plants required for village and rural tree-planting and revegetation programmes. A major focus of this programme should also be post-transplanting care of plants which have been distributed or sold from the nurseries. It is recommended that community-level workshops be held first to identify possible nursery sites and/or village-based tree propagation strategies, with a subsequent workshop (or visits) being organised at the Vaipoa Agricultural Station, Foa to teach more sophisticated propagation and plant care techniques for species for which local expertise in propagation doesn't exist. The workshops will also focus on creating greater community awareness of the seriousness of environmental and human health problems related to devegetation, free-ranging pigs, water pollution and excessive dust in villages.

7. Award of yearly prizes at the annual Ha'apai Agricultural Show for the three best community-based nurseries and associated village revegetation.

8. Establishment of diverse mixed tree plots or groves at primary schools which have

sufficient available land. This would be done by the students with the assistance of the school Parents-Teachers Association and MAF. Yearly prizes would be awarded at the Ha'apai Agricultural Show for the best school tree plots.

These activities are seen as being interrelated and reinforcing each other. The replanting and rehabilitation of culturally important trees and plants, the planting of hedges and the improvement of pig pens using living fencing should promote the re-establishment of trees, grass and other plants and reduce the dust problem. The establishment of village nurseries in each village is seen as a cost-effective and capability-enhancing means of providing the planting material needed for these activities and for the planting of trees in rural garden areas (**'api 'uta**) and coastal areas (see activity 12.7.6 below). The award of yearly prizes for the best community-based nurseries and revegetation efforts and the best school tree plots, to be awarded during the annual Ha'apai Agricultural Show (**Faka'ali'ali Ngoue**), is seen as an excellent way of providing both an incentive for the activity and a forum for enhancing public awareness of the rationale for village biodiversity enhancement and the need for improved environmental health.

Lead Agencies: The Agricultural and Forestry Divisions have indicated a willingness to assist in the establishment of the village nurseries as an extension of its nursery activities at Vaipoa on Foa. The main assistance needed will be in site selection, potting or propagation techniques and the provision of some planting materials. It should be possible for most villages to gather their own planting material in the form of seeds, cuttings and self-sown seedlings for most species, with possibly some exchange among communities which have surplus planting materials of desirable species. Lists of trees which communities could select for nursery propagation and/or planting in and around villages are provided in Appendices 8 and 9. It is also suggested that local women's organisations be made responsible for the maintenance or management of the nurseries and general village revegetation efforts (e.g. re-establishment of important cultural plants and hedging) and the men be responsible for establishment and maintenance of improved pig pens and fencing in and around villages and towns. The Ministry of Health and the local Police will also be involved in aspects related to environmental health and prosecution/enforcement of laws relating to public health and free-ranging livestock.

Timing: The identification of sites and establishment of community-based nurseries and the collection and propagation of target species should begin in 1995 and will continue throughout the project. Assistance from MAF in site selection and establishment can also start immediately, with more specialised assistance with the propagation of species unfamiliar, or unavailable to local communities beginning in 1996.

Estimated Costs: The main costs of the biodiversity enhancement activity will be related to the establishment and maintenance of the nursery and the distribution of selected species from Vaipoa Station to communities. These costs are shown below:

1.	Village nursery establishment (materials, tools, incentive payments, etc.)	$5000
2.	Propagation and transport of selected species by MAF	$3000
3.	Prizes for best nurseries ($300, $200 and $100)	$600
4.	Contingencies	$400
TOTAL		$9000

12.7.6 Agroforestry and Organic Farming

One of the most commonly mentioned problems in the Pilot Communities was "agrodeforestation" - the loss of valuable trees from agricultural areas because of an over-emphasis on commercial monocropping, indiscriminate use of fire, increasing ploughing, deliberate tree removal, destruction by tropical cyclones and the failure of the current generation of farmers to replant trees and minor supplementary crops that used to be important in the mixed Tongan agroforestry system. The encouragement of the protection of existing trees and tree groves and the replanting of key trees in and around agricultural areas is, thus, seen as one of the most important and practicable activities that could be promoted during phase I of the Project. Agroforestry is currently a high priority of MAF, although the emphasis in the past has been mostly on timber and nitrogen-fixing species and commercial export crops. MAF has indicated strong support for the HCAP focus on the protection and planting of a wider range of trees, including traditionally important species and varieties (See Appendix 6).

Included as part of this activity is the promotion of mixed "organic" farming which does not depend on the use of costly and environmentally unsound fertilisers and pesticides. Such an activity could provide immeasurable long-term ecological, economic and cultural benefits to the people of Ha'apai, and is currently seen as a priority of MAF which held workshop on sustainable agriculture in Ha'apai in mid-1994 and a recent on-day workshop on organic farming in early April 1995. The problems related to indiscriminate use of pesticides are discussed above and numerous studies have shown the dangers of groundwater pollution resulting from the use of inorganic fertilisers on low-lying limestone islands.

Nature of Activity: The components of this activity would include:

1. The active discouragement of tree removal and the encouragement of protection of trees when clearing new garden areas and seedlings when weeding (i.e., selective weeding). This includes the protection and replanting of salt-tolerant coastal littoral species which are of critical importance for protecting inland garden lands and settlements for salt spray, storm surge and tropical cyclone damage (See Appendix 5).

2. The preparation, by the Pilot Communities, of lists of "endangered" or culturally important species that could constitute protected species and which could be made priority status for protection, propagation and replanting, both at the community and regional levels in the HCA (Lists of most of the important Tongan agroforestry species are shown in Appendix 7).

3. The replanting of tree groves, living fencing and individual trees in appropriate areas on bush allotments ('api 'uta).

4. The active planting of paper mulberry (**hiapo, tutu**) and pandanus (**lou'akau**) varieties and other handicraft plants for sale as raw or partially process materials or for the production of marketable handicrafts. Particular emphasis will be placed on the propagation and planting on endangered and particularly high-value pandanus cultivars, many of which Pilot Communities have indicated are rare or in short supply.

5. The establishment of village-level nurseries for the propagation of key species that can not be propagated easily by individual farmers. (This could be incorporated into a single village nursery or propagation strategy, mentioned above under activity 12.7.5, to cater for the needs of both town and bush allotment planting).

6. Promotion of the protection and planting of nitrogen-fixing plants in active agricultural areas, with particular emphasis placed on the intensified planted of traditional legumes, such as lima bean and hyacinth bean (**piini Tonga** and **piini fakalelei 'ae kelekele**), plants with which the people of Ha'apai are very familiar. This would also include the protection and planting of other species (e.g. **koka**) which are known to improve soil fertility and reduce pest infestations in gardens).

7. The designation of Ha'apai as an "Organic Farming Zone" where diversified mixed cropping is encouraged and where the use of agrochemcials is prohibited or minimised. This idea has been strongly supported by MAF and could include an awareness campaign to highlight the ecological and health problems created by pesticides.

8. Community- and Ha'apai-level workshops on agroforestry and organic farming and the dangers of chemical farming in low-lying islands (These have already been initiated by MAF).

8. Award of yearly prizes, during the annual Ha'apai Agricultural Show (Faka'ali'ali Ngoue), for the allotments with the best mixed organic agroforestry systems. The judging would be based on the diversity of trees planted or protected and the effort made to maintain diversified non-chemical production of a wide range of commercial and subsistence crops and useful plants (Although a similar competition category already exists, the criteria could be modified to reflect the emphasis on tree planting and protection and organic farming).

Lists of trees that should be considered for protection and planting in or around agricultural areas in Ha'apai are shown in Appendices 6 and 7).

Lead Agencies: The lead agency would again be MAF through its Ha'apai headquarters which would, through its research, nursery and extension activities, work with the CASO and pilot communities to carry out the designated activities. The lead agency in designating Ha'apai as an "Organic Farming Zone" would be MAF Headquarters in Nuku'alofa, which would be responsible for designating appropriate consultants and marketing experts. The judging of the competition for the best allotments would be conducted by the same panel that does the judging for the annual Agricultural Show, in consultation with the CACC.

Timing: The active discouragement of the removal of designated trees species during agricultural development would commence immediately. The encouragement of a return to diversified mixed cropping, the protection and planting of tree groves, living fencing and animal pens and dispersed trees on bush allotments would also be promoted immediately. It is also recommended that the use of inorganic fertilisers and pesticides be discontinued, and that discussions, with farmers, about the negative aspects of chemical farming be commenced. The re-establishment of tree groves can best be done beginning in December 1995 at the onset of the

wet season.

Workshops on organic farming should begin by June 1995, before this year's squash planting begins, in order to prepare farmers on Lifuka and Foa, who plan to plant squash for export, to identify the most appropriate methods for producing squash organically.

Estimated Costs: Below are the estimated costs of the suggested activities. The main cost would be the collection, propagation of scarce planting materials and costs associated with the establishment and promotion of the specific components of the programme. Nursery costs are shown above under "village biodiversity enhancement. Cost of consultants on organic farming will be paid from overseas aid sources which have already been identified by MAF.

1.	Endangered tree protection	$1000
2.	Replanting of tree groves	$1000
3.	Intensification of paper mulberry and pandanus planting	$1000
4.	Planting of nitrogen-fixing species	$1000
5.	Costs to MAF (nursery, transport, etc.)	$2000
5.	Workshops on organic farming	$2000
6.	Prizes for allotments ($300, $200 and $100)	$600
4.	Contingencies	$400
TOTAL		$9000

12.7.7 Community Management of Marine Resources

With respect to sustainable development, one of the most frequent comments from villagers in Ha'apai is that, even if a community attempts to conserve and manage adjacent marine resources, it may be a useless exercise as outsiders others can move in and over-harvest. The almost complete lack of any marine resource management, traditional or modern, is considered as one of the most critical issues in HCA. If inshore fisheries resources are to be sustainably utilized in Ha'apai, some form of community-based fisheries management is urgently required. This would require empowering local communities with some degree of management control over nearby resources.

Without the management participation of local communities, efforts to conserve turtles and seabirds, establish effective marine reserves, reduce fishing pressure on over-exploited species, apply measures to protect endangered species, and promote clam circles will probably not be effective. It is therefore thought that community-based fisheries management is a fundamental issue upon which the success of many other endeavors depends. The HCAP, due to its community orientation, could be an ideal mechanism to at least initiate the process of community based management, however outside technical expertise for such an activity would be required.

During the PPD phase of the HCAP discussions on this issue were held with senior Government officials in Tongatapu. Although they acknowledged that a change to having some degree of community marine resource management represents a major departure from the status quo, they felt efforts were justified. It appears as though the existing legislation (Fisheries Act 1989) offers several possibilities for increasing local control.

Nature of Activity: Activities which could increase local community management of marine resources include:

1. Ha'apai- and community-level workshops on the issue encompassing currents problems, special difficulties, benefits of fisheries management, opportunities for increasing local participation in management, and required future efforts.

2A media campaign (radio, news magazines) to sensitise key policy makers to the importance of community-based marine resource management.

3. Discussions with key senior policy makers in Tongatapu on the issue.

4. Liaison with the Ministry of Fisheries officials to encourage interest in the community approach to management, rather than the currently ineffective centrally administered management.

5Drafting of documentation for consideration by Cabinet.

Lead Agencies: The activity will represent a tri-partite effort comprising the Ha'apai-based Ministry of Fisheries staff, the CASO, and a technical consultant. Work would be carried out both in Ha'apai and Tongatapu.

Timing: The specialised meeting on marine resource management could occur soon after the final approval of the PPD. The subsequent Tongatapu based activities should occur after the results of the workshop have been thoroughly considered by HCAP management.

Estimated Costs: The magnitude of the problem created by the lack of marine resource management is such that major expenditure is justified.

1.	Ha'apai and community workshops on fisheries management	$2000
2.	Media campaigns on the importance of community-based marine resource management.	$1000
3.	Technical consultant on community based marine resource management (fee, per diem, travel)	$4000
4.	Travel by Ha'apai-based fisheries officer/local fishermen's representatives to Tongatapu (one week)	$500
5.	Contingencies	$500
TOTAL		$US8000

12.7.8 Key Ecosystem and Species Protection

There are unique, endangered or economically or culturally important ecosystems and species within the HCA which, based on preliminary surveys and discussions with Pilot communities, deserve protection. Some areas, such as the higher elevation forests and scrub communities of Tofua and Kao; important marine ecosystems, such as the 'Auhangamea Passage; remaining mangrove areas; areas with sandalwood (**ahi**); and some turtle and sea bird nesting sites could be designated parks or reserves, or areas of limited entry or restricted exploitation. There are also a range of endangered ecosystems such as inland forest stands, diverse littoral forests and limited areas of wetland or swampland which should be protected either nationally or locally depending on the size of the areas or the nature of the land tenure.

There are also marine and terrestrial plant and animal species (and varieties or cultivars in the case of cultivated food plants such as yams, sugarcane, breadfruit, bananas and plantains and oceanic lychee or tava), which could be declared endangered or deliberately protected and/or propagated at the community level (See Table 3.1 above).

Nature of Activity: The main activities in the area of ecosystem and species protection during Phase I would include the following:

1. The identification of endangered or economically and culturally important ecosystems and species.

2. Assessment of the feasibility, desirability and means of protecting key ecosystems and species.

3. Implementation or initiation of programmes or plans to protect key ecosystems and species. This could include the designation of given species or individual trees as protected species or "objects for cultural preservation" (national treasures or monuments). Related to this could be the development of be a list or register of special trees, or people or families which have particularly large or good examples of endangered or culturally important species on their land. Such lists could be used as a resource for the promotion of ecotourism and environmental education.

4. A one-day Ha'apai-level workshop to identify specific ecosystems and plants and animals that require protection or management because of their ecological, cultural and economic importance.

These activities will, of course, overlap with some of the village biodiversity, agroforestry and biodiversity and ethnobiological survey activities suggested above.

Areas or ecosystems which, as suggested above, have been identified for immediate protection include:

1. Coastal littoral and mangrove forests which protect inland garden areas and coastal settlements from cyclone damage, storm surge, saltwater/tidal incursion, coastal erosion and saltspray (See Appendix 5 for coastal species which could receive priority for

protection or propagation);

2. Sea turtle and sea bird nesting sites; and

3. Mid- to high-elevation forests and scrublands of the recent volcanic islands of Tofua and Kao, which contain the majority of the undisturbed vegetation and unique and endemic plants of the Ha'apai group.

Lead Agencies: The lead agency for investigating the possibility of protecting key ecosystems and species will be LEPU, in cooperation with appropriate divisions of MLSNR, the Crown Law Office and other appropriate government agencies, and in consultation with the CACC and pilot communities. The CASO in cooperation with the CACC and the local communities could begin a register of important endangered or cultural trees and plants.

Timing: Investigations of the feasibility of designating key ecosystems and species as reserves or protected species should begin immediately. This should include the search for outside funding for the establishment of such reserves, possibly through UNESCO, as part of the Government's ongoing consideration of establishing Ha'apai as a World Heritage Site. The Ha'apai workshop should be held in conjunction with the community-based workshops discussed in 12.7.1 above, and could be coordinated by CASO, with input from LEPU. It could use for discussion, lists developed during the rapid surveys conducted during the PPD preparation visit to Ha'apai. The CASO in cooperation with local communities could also begin to make a list or register of trees of particular importance.

Estimated Costs:

1. Investigations of potential and feasibility of establishing reserves and/or protected species	$2000
TOTAL	$2000

12.7.9 Small-scale Tourism Development

Small-scale tourism offers considerable potential as an environmentally sustainable means of increasing cash incomes in Ha'apai.

Nature of Activity: The main activities in this area would include:

1. Enhancement of the ability of local tourist operations to optimise the attractions provided by the terrestrial and marine environments and the resource-use traditions of Ha'apai;

2. Promotion of environmentally sustainable cultural tourism and ecotourism (e.g., snorkeling, SCUBA diving, sport fishing, whale watching, plane flights to Tofua, etc.). The identification of spectacular dive sites is especially important. Worth considering is the identification of good surfing locations such as that found on Kelefesia. Whale watching seasons/areas could be identified using existing information and could encourage the development of a tourist activity similar to that presently operating in Vava'u. The preparation of a short brochure listing and briefly describing key attractions is important. This will also require greater control over cruising yachts which exploit black coral and other marine resources without the permission of local communities.

3. Promotion of, and training for, short-term ecocultural (cultural and eco) tourism, based on short-term village visits to Pilot Communities, which could include snorkeling, tours of traditional garden areas, short hikes or walks through village gardens and cultural sites, handicraft displays and sales, with information provided about the materials used, their sources and manufacture of traditional handicraft items, and locally prepared feasts/meals and entertainment, in most cases stressing the cultural importance of the use of biodiversity as a basis for the ecological, cultural and economic survival of the Tongan people. Stress could also be placed on the fact that the traditional Tongan lifestyle and dependence on the environment still remain reasonably in tact in Ha'apai. Such trips could be organised to Pilot Communities by the Tonga Visitors Bureau or by existing resorts.

This activity would include appropriate training workshops and the preparation of appropriate handouts for tourists. A local " Ecocultural Tourism Workshop" could be held in Pangai to discuss constraints and opportunities for sustainable cultural and ecotourism tourism in Ha'apai.

4. Exploration of funding sources for the development or rehabilitation of existing archaeological sites as a means of increasing tourist interest and satisfaction. Appendix 13 contains a summary of these sites in Ha'apai.

5. A one or two-day workshop, held in Lifuka, and attended representatives of all existing tourist accommodation and interested members of Pilot Communities and other communities in Ha'apai, who wish to strengthen cultural or ecotourism in Ha'apai. The main issues covered would be the development of improved nature and culture-based tours, hikes, etc, and the development of materials/handouts that could enhance the capabilities of accommodation owners and guides to capitalise on these niches in the

tourism market.

The main emphasis, during Phase I should be on an assessment of the feasibility and desirability of promoting such activities. Emphasis should also be placed on the sensitisation of both the participating villages and tourists so that tourist-host community interaction promotes optimal benefits for both parties and serves to highlight and protect the environment and living resources within the HCA.

Lead Agencies: The lead agency would be the Tonga Tourist Bureau and the CACC would organise workshops, prepare materials and develop the local infrastructure needed to support biodiversity dependent tourism activities. The workshop could be run representatives of the Tonga Tourist Bureau in conjunction with the CASO. Local Police and district and community leadership should be responsible for greater control over activities of visiting yachts that are potentially damaging to the local environment.

Timing: This activity should begin soon, with a preliminary meeting of appropriate parties taking place by July 1995 to discuss trial excursions, locations and biodiversity and ethnobiological information that could enrich the tourism experience of visitors to Ha'apai. A local "Ecocultural Tourism Workshop" could be planned for November in order to maximise returns and experience that could be gained during the major southern hemisphere tourist season between December and February.

Estimated Costs:

1.	Meetings, workshops, investigation and planning	$2000
2.	Preparation of trial promotional materials	$2000
3.	Background research and contingencies	$1000
TOTAL		$5000

12.7.10 Handicraft Marketing and Training

One of the most widely stated development needs was improved marketing of Ha'apai handicrafts. Ha'apai handicrafts, in particular fine mats and plaited ware made from a wide range of pandanus (lou'akau) cultivars, constituted the main agricultural export from Ha'apai to Nuku'alofa in 1993, but could be increased considerably. There are also a number of other activities or handicraft items, the production and sale of which could be increased considerably, with little or no negative impact on the environment. All of these activities seem to be environmentally sustainable and serve to reinforce Tongan handicraft traditions, some of which are being lost by the younger generation.

Nature of Activity: The main activities that could be promoted during Phase I, some of which are already being promoted by the Agricultural Division and the Tonga Tourist Bureau include:

1. Improved local and export marketing of fine mats, baskets and other quality weaved products.

2. Increased planting of paper mulberry (hiapo) and processing of bast fibre (feta'aki) for sale to tapa cloth (ngatu) makers on Tongatapu.

3. Protection or promotion of the sustainable use of marine and terrestrial species needed for handicraft production.

4. Revival of the production, for local sale and export, of necklaces and other handicrafts made of locals sea shells and beads.

5. Preparation of a short brochure on the handicrafts of Ha'apai.

6. A review of handicraft potential and the development of a handicraft improvement and marketing plan for Ha'apai. Aid sources would be solicited for this activity, which would be planned along the same lines as the Tuvalu Women's Handicraft Project initiative which revolutionalised handicraft production and marketing in Tuvalu in the mid-1980s.

7. A one-week workshop on improved production and marketing of local handicrafts, for local sale and for export to Tongatapu and overseas. This could include focus on the production and marketing of high quality pandanus mats, baskets and other plaited wares, the production and processing of paper mulberry, and the production of necklaces, leis (kahoa and sisi), other handicrafts, flower an shell arrangements (for tourist accommodation), etc. from sea shells, local seeds, flowers, hibiscus tree (fau) bark, etc. The proper collection, care and marketing of specimen sea shells could also be a topic of such a workshop.

Lead Agencies: These activities could be best run by a combination of local Ha'apai crafts people, representatives from national women's organisations which currently promote the production and sale of handicrafts, such as the Langafonua and the Tu'u'akitau, handicraft exporters from Tongatapu and appropriate representatives from the Tonga Tourist Bureau and the Ministry of Labour and Commerce. The consultant to conduct the review of handicraft

development potential and the development of a handicraft improvement and marketing plan will probably have to be recruited from overseas.

Timing: These activities could be commenced, by local women's groups and tourism representatives in late 1995. The major review of handicraft potential and the development of a handicraft improvement and marketing plan should probably be initiated in early 1996. Funding should be solicited as soon as possible.

Estimated Costs:

Local workshops and planning	$2000
Preparation of brochure on handcrafts	$2000
Review of handicraft potential and marketing (outside funding)	($6000)
Contingencies	$1000
TOTAL	$US5000

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