



Report On The 2016 Funafuti Community-Based Ridge-To-Reef (R2R)

Rapid Biodiversity Assessment of the Conservation Status of Biodiversity and Ecosystem Services (BES) In Tuvalu

*Randy Thaman, Feagaiga Penivao, Faoliu Teakau,
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Ridge to Reef Project (R2R)

Department of Environment

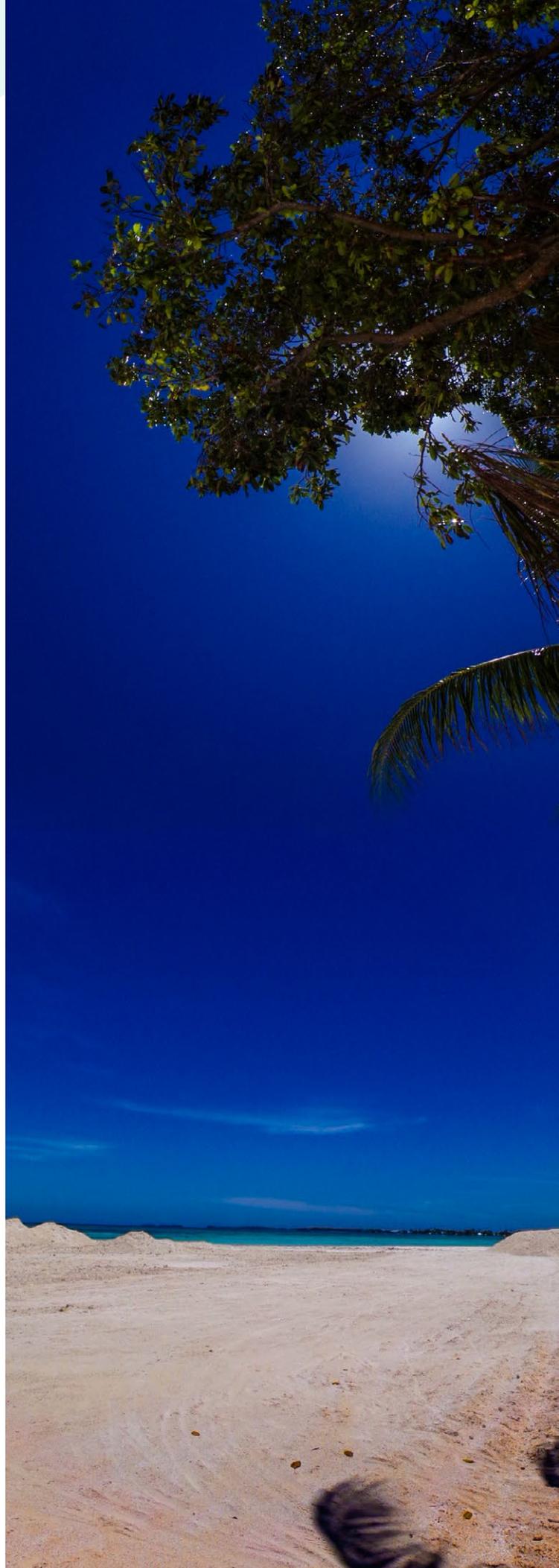
Ministry of Foreign Affairs, Trade, Tourism, Environment & Labour

Government of Tuvalu

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CONTENTS

SECT.	PAGE
ACKNOWLEDGEMENT	5
1. INTRODUCTION	7
2. THE TUVALU R2R BIORAP	8
3. BACKGROUND ON TUVALU AND FUNAFUTI ATOLL	11
4. RICHNESS AND THREATENED STATUS OF TUVALU'S ATOLL AND OCEAN BIODIVERSITY INHERITANCE: AN OVERVIEW	21
5. ECOSYSTEM SERVICES AS A BASIS FOR SUSTAINABLE LIVELIHOODS	24
6. RICHNESS AND THREATENED STATUS OF FUNAFUTI'S BIODIVERSITY AND ECOSYSTEM SERVICES: AN OVERVIEW OF BIORAP RESULTS	26
7. BIORAP RESULTS OF MARINE BIODIVERSITY AND ECOSYSTEM SERVICES	29
8. BIORAP RESULTS OF TERRESTRIAL BIODIVERSITY AND ECOSYSTEM SERVICES	48
9. MAJOR TRENDS OR CHANGES IN THE STATUS OF BIODIVERSITY AND ECOSYSTEM SERVICES	79
10. MAJOR THREATS TO BIODIVERSITY AND ECOSYSTEM SERVICES	81
11. ACTIONS TO ADDRESS LOSS OF BES	89
12. INDICATOR SPECIES OF CONSERVATION EFFECTIVENESS	93
13. PRIORITY SPECIES FOR FURTHER IN-DEPTH BIODIVERSITY SURVEYS	101
14. TWELVE (12) COMMANDMENTS FOR THE CONSERVATION OF ATOLL AND OCEAN BES IN TUVALU	102
APPENDIX	105



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To those of you that we have failed to mentioned, please accept our sincere apologies.

Fakafetai lasi kia koutou katoa

Sincerely

Mataio Tekinene

Project Coordinator

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Ministry of Foreign Affairs, Trade, Tourism, Environment & Labor.



1

INTRODUCTION

This report presents the results of the 2016 Funafuti Community-Based Ridge-to-Reef (R2R) Rapid Biodiversity Assessment (BIORAP) of biodiversity and ecosystem services (BES), hereafter referred to as the BIORAP. In this context the Tuvaluan translation for BES is ***“meola mo vaega mea aoga kia tatou i te fenua mo te tai”*** (literally “living things and those things that are useful to us from our land and sea. This reflects the central theme of the Tuvalu R2R Project of “Connecting People & Ecosystems to Sustain Livelihoods” and reflects the Millennium Ecosystem Assessment (MA) (2005) definition of: “the benefits people obtain from ecosystems (MEA 2005).

The balance of this report on the results of the Funafuti BIORAP includes:

- Section 2.** The methodology and rationale behind the Tuvalu R2R BIORAP.
- Section 3.** Background on the environmental, social and economic environment of Tuvalu and Funafuti Atoll.
- Section 4.** An overview of the richness and threatened status of Funafuti's BES based on the BIORAP results.
- Section 5.** Ecosystem services as a basis for sustainable livelihoods in Tuvalu
- Section 6.** Richness and threatened status of Funafuti's biodiversity and ecosystem services: An overview of the Funafuti BIORAP results.
- Section 7.** BIORAP results of the status of marine biodiversity and ecosystem services
- Section 8.** BIORAP results of the status of terrestrial biodiversity and ecosystem services.
- Section 9.** Major trends or changes in the status of biodiversity and ecosystem services.
- Section 10.** Major threats to biodiversity and ecosystem services
- Section 11.** Actions to address losses of biodiversity and ecosystem services
- Section 12.** Indicator species of conservation effectiveness
- Section 13.** Priority species for further in-depth biodiversity surveys
- Section 14.** Twelve commandments for the conservation of atoll and ocean BES in Tuvalu

2.1 BIORAP Process

Most BIORAPs (Rapid Biodiversity Assessments) for other Pacific Islands (e.g., the Nauru and Vava'u, Tonga BIORAPs) have been "biological inventories" conducted by consultant scientists working with local counterparts to rapidly assess the status of terrestrial, freshwater and nearshore marine biodiversity in a broad range of highly diverse terrestrial, freshwater and marine habitats as a basis for recommending to "governing communities" appropriate policies and actions to address or manage threats to and protect "remaining examples of biodiversity of national or international significance" (SPREP 2013, 2014).). Emphasis has also been placed on building capacity among local counterparts to carry out biodiversity assessments, to identify priority sites for conservation and to develop appropriate biodiversity conservation and enrichment activities that could feed into National Biodiversity Strategy and Action Plans (NBSAPs).

2.2 The Tuvalu R2R BIORAP

Although the Tuvalu Ridge to Reef (R2R) BIORAP (referred to hereafter as the BIORAP) has most of the same objectives, the Project Inception Workshop held in Suva in August 2016 decided that the Tuvalu BIORAP should be a local community based-assessment of the conservation status of "their" ecologically and culturally important plants and animals, those that are under threat, the nature of the threats and what should be done to address them. This approach was chosen, rather than the more costly expert-driven biological inventories, because, unlike most of the larger Pacific Island countries: 1) Tuvalu has virtually no endemic species of international scientific interest, with most of its species not being considered under serious global threat on the IUCN Redlist (the types of species that have often been highlighted as threatened and of conservation concern in other Pacific Island BIORAPs); 2) published scientific data are available from recent in-depth surveys of Tuvalu's nearshore marine biodiversity, birdlife and plants (Job *et al.* 2009, 2012; Watling 1998; Thaman 2016; Thaman *et al.* 2013); 3) almost all indigenous and recently introduced plants, fish and other animals have well-known local Tuvaluan vernacular names, have well-recognised cultural utility and, as stressed by IPBES, local communities are often the only groups that can accurately assess the long-term and changing status of BES for building synergies between indigenous and local knowledge (ILK) and up-to-date Western scientific knowledge (WSK) as a basis for informed conservation policy and enriching national biodiversity strategy and action plans (NBSAPs); and, finally, 4) a high percentage of these terrestrial and marine plants and animal are now rare, threatened or in declining numbers and in need of appropriate community based-conservation action.

In the context of employing a community-based indigenous approach to an assessment of the conservation status of biodiversity and ecosystem services (BES), as stressed in the introduction, BES has been defined in Tuvaluan as "**meaola mo vaega mea aoga kia tatou i te fenua mo te tai**" ("living things and those things that are useful to us from our land and sea.")

2.3 BIORAP Methodology

The Funafuti BIORAP was a community-based survey conducted using a detailed questionnaire in the Tuvaluan language to find out what local Funafuti community members (including long-term Funafuti residents), considered to be:

1. the diversity of ES that are critical to the environmental, economic and cultural survival of Tuvalu in the face of global change
2. organisms and terrestrial and marine ecosystems or habitats of particular cultural and ecological importance for the continued delivery of ecosystem services (ES);
3. organisms and distinct ecosystems or habitats and organisms that are under greatest threat and require some form of protection (conservation), enrichment (adding new species) or restoration (replanting, restocking, re-establishing);
4. the main threats or drivers responsible for the loss of these organism and associated biodiversity and ecosystem services (BES);
5. priority activities/strategies that can be best used to conserve, enrich or restore BES, with particular emphasis on identifying activities that a) can be carried out by local communities themselves and b) those that require some outside technical, organisational or financial assistance.
6. organisms that could serve as good indicators of the health of different ecosystem and the success of R2R conservation interventions, with particular emphasis on organisms that are threatened and well-known to and could be monitored by local communities.
7. types of biodiversity (organisms or ecosystems) that should be prioritized for further in-depth biodiversity studies or re-surveys based on the preliminary results of the Funafuti BIORAP and comparison with findings of past biodiversity studies.
8. Sectoral opportunities for the marriage of indigenous and local knowledge (ILK) and modern scientific knowledge (MSK) as a basis for R2R conservation and sustainable of BES in Tuvalu
9. A 12 Commandments for R2R Atoll Conservation that summarises the overall emphases of activities that will conserve, enrich and restore atoll terrestrial, freshwater and nearshore marine BES.

The actual BIORAP was conducted by administering a detailed 82-question questionnaire survey in Tuvaluan (Appendix I) to separate groups of senior men and women. The questionnaire was tested September 2016 during a preliminary survey of 13 separate male and female respondent groups from Funafuti Atoll, averaging 3 to 5 person per group. The results were compiled in a spreadsheet, analysed, discussed and the questionnaire modified and finalised for administration during the November 2016 Funafuti BIORAP which administered to 19 separate male and female respondent groups from Funafuti Atoll, again averaging 3 to 5 person per group. These groups included 4 groups of long-term residents and traditional land and resource owners of Funafuti and 15 groups composed of long-term Funafuti residents originally from the other atolls.

As stressed above, the questionnaire survey asked informant groups to discriminate between different categories of organisms, e.g. large trees, small trees and shrubs and other small plants; large and small finfishes and nearshore and deep water finfishes, eels, shellfishes, crabs, turtles or other organisms in an effort to get people to think about the diversity of different "important" taxa within different R2R ecosystems, e.g., in lagoons, open ocean, mangrove or coastal forest, food gardens, villages, etc. It also asked questions to identify organisms considered important for delivering particular ecosystem services (e.g., food crops and cultivars, animal food, medicinal plants, fertilizer or mulching plants, important food fish, shellfish used in handicrafts, etc.). Within



these categories, respondents were requested to list or provide the names of specific numbers important named species or groups of named species (e.g. 20 large finfish) and specific numbers within that category that are considered to be locally extinct (have disappeared), rare or declining in abundance, the reasons for their disappearance and actions that could conserve them

The analysis of the results was challenging, because of the different names given for the same species by communities from the outer atolls who live on Funafuti and because some informants used generic (general) names for different species instead of their original, more, discriminating names, e.g., **gatala** or **ulafi**, although names for specific species also generally refer to other species within the grouper and parrotfish families, respectively. There are also problems related to people using the English or common names rather than the Tuvaluan names; as well as to interviewers not writing or recording the names clearly or correctly, thus resulting in some unidentified species. When the different names for the same species were given they have been combined under that species with the Funafuti names listed first. Similarly, when respondents commonly put the same species in one or more categories (e.g., under both small and large finfishes or shellfishes, or under both large and small coastal tree species, duplication or double counting was eliminated during analysis of the data by aggregating the results and placing a given species within the most appropriate category. Where it was unclear what a certain name was, or when both the Funafuti and other island names were mentioned for a given species, these were combined to eliminate duplication. The survey also recorded a number of new names, some of which is was not possible to connected to a given species, which indicates the depth of the indigenous knowledge and adaptability of the local taxonomies.

Despite these issues, the overall results give a good indication of the richness of the biodiversity and associated knowledge and the nature of species that are considered by local communities to be rare or endangered and in need of some form of conservation. During the Funafuti BIORAP attempts were made to rectify these issues and correctly identify and/or group different species. The analyses of both the preliminary 16 Funafuti sample survey questionnaires and the final 19 Funafuti BIORAP questionnaires have shown the effectiveness of the community-based assessment process for the Tuvalu BIORAP, and the particular relevance of interviewing older men and women who are possibly the only ones who have seen the changing abundance or disappearance of different organism, the possible reasons for this and what could be done to restore them. The older people are also the only ones who actually know the original "specific" names rather than the more recently adopted general ("generic") names.

3

BACKGROUND ON TUVALU AND FUNAFUTI ATOLL

This section provides background information on Tuvalu and Funafuti Atolls that are important in relation to understanding the nature, conservation status and actions that are required to understand the results of the Funafuti BIORAP and how these might be applied to the conservation, restoration and enrichment of biodiversity and ecosystem services (BES) in Tuvalu.

3.1 Geography and Demography

Tuvalu became an independent nation state in 1978, a member of the United Nations in 2000 and ratified the Convention on Biological Diversity (CBD) in 1993. It is a group of nine small low-lying limestone islands or atolls with a total land area of only 25.9 km² spread over an ocean area of about 1.3 million km² between 5° and 10.5° S latitude and 176° and 179.5° E longitude (Carter 1984)(Fig. 1). Tuvalu's Exclusive Economic Zone (EEZ) covers an oceanic area of approximately 900,000 km² (Fig. 1).

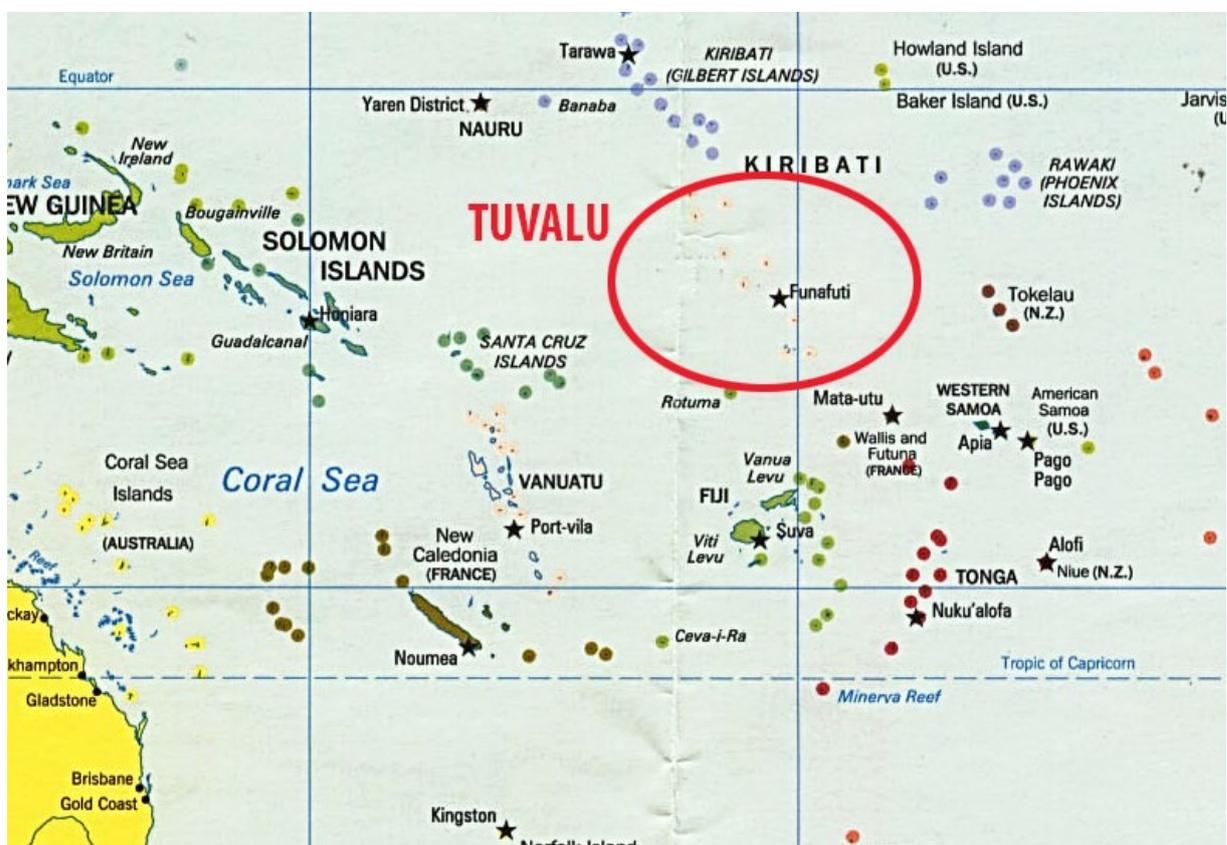


Figure 1 Map of the Pacific Islands showing the locations of the Tuvalu in relation to the nearby island groups (Source: Adapted from Google Maps).

The nine atolls, which extend over a distance of about 570 km from Nanumea in the northwest to Niulakita in the southeast (Fig. 2a), include five classic “true atolls” consisting of varying numbers of reef islets or **motu** surrounding or bordering a central lagoon or lagoons (Nanumea, Nui, Nukufetau, Funafuti and Nukulaelae)(Fig 2b); three single raised limestone islets with no central lagoon, but with small remnant landlocked “fossil” lagoons (Niutao, Nanumaga and Niulakita); and one, Vaitupu, the island with greatest land area of 5.6 km² which is intermediate to these and which is a broad, pear-shaped limestone island with two small relatively land-locked internal lagoons (Fig. 3) Most of the islands of Tuvalu have an average elevation of only 1 to 2 m above sea level with only limited areas rising above 3 m (Carter 1984; Rogers 1991; Thaman *et al.* 2013).

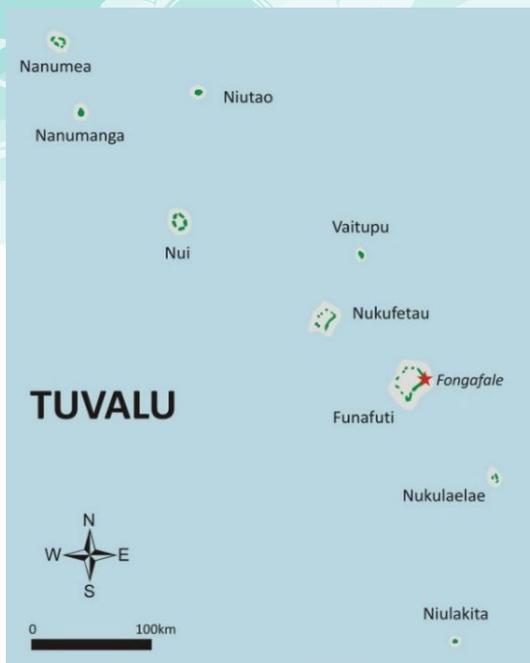


Figure 2. a) map of Tuvalu showing the locations of the nine atolls from Nanumea in the northwest to Niulakita in the southeast (left) (Source: www.nowshoptime.com); and b) map of Funafuti Atoll showing the central lagoon and the individual reef islets (**motu**), including Fongafale Islet, the largest and most populated islet and capital of Tuvalu, along the eastern side of the Lagoon (Source: TuvaluIslands.com)



Figure 3. Aerial photos of Fongafale Islet, Funafuti Atoll (left) showing the open ocean on the left and the central lagoon on the right; and Vaitupu Atoll (right) with two small almost landlocked lagoons (far left and centre right)(Photos: Thaman 2003).

Funafuti, the most highly populated atoll and capital, has 33 islets encircling a lagoon with a land area of about 275 km². One-third of the total area of Fongafale has historically been unavailable to development until late 2015 due to the presence of the airstrip and the highly-degraded “borrow pits” from which soil, sand and aggregate were excavated to build the airstrip during World War II (Carter 1984; Smith 1995). In 2015-16 the barrow pits were reclaimed by infilling with marine sediments dredged from Funafuti’s central lagoon.

The estimated population of Tuvalu in March 2016 was 10,157, and population densities are about 425 per km² for Tuvalu and over 2000 per km² for Funafuti, where over half of the population now lives, almost all on increasingly urbanised Fongafale Islet (Index Mundi 2014; Country Meters 2014).. The people are almost all indigenous Polynesians. About 95% of the land in Tuvalu is indigenous customary land owned by individuals.

3.2 Economy

Most Tuvaluans practice subsistence fishing, farming and the harvest of a range of wild, mainly plant, products. This is especially true outside Funafuti, where people depend on fish, shellfish and other sea foods, coconut, breadfruit, bananas, taro, pandanus, a limited number of other crops, pigs, chickens, seabirds and some wild plants as the main locally produced foods. The limited number of plants are also the main local sources of medicines, fuel, construction and boatbuilding materials, handicrafts, garlands and perfumes and a wide range of other products. Only about one-quarter of the population participates in the formal wage economy and employment is almost exclusively within the public (government) sector. There is only limited tourism, with most visitors being consultants, officials of international and regional organizations and business people (Carter 1984; Thaman *et al.* 2013).

3.3 Geomorphology and Topography

From the ocean to the lagoon side of a typical atoll islet there is usually an uplifted fringing limestone reef in the wave zone, which may be covered by sandy beach or beach rock (Fig. 4). The beach then becomes a raised rampart of coral rubble deposited during storms. This is commonly the highest portion of the islet and normally no more than 4 m above mean sea level (MSL) (Fig. 5a). Inland from the rampart and extending toward the lagoon are areas of windblown sand and a thin layer of soil. Limestone outcrops or pavements with little or no soil and low-lying swampy areas, mangroves (Fig. 5b) or areas that are periodically inundated are also common. With an average elevation of only one metre above mean sea level (MSL), Tuvalu's atolls are all highly vulnerable to cyclones, tsunamis, king tides and other extreme tidal or weather events. Fogafale Islet, Funafuti, where nearly half of the country's population is concentrated, is on average less than 100 metres wide, making it extremely susceptible 1971 (Fosberg 1949; Fitchett 1987; Kayanne *c.* 2007; Thaman *et al.* 2012)

3.4 Climate

Tuvalu is located in the Southeast Tradewinds belt of the South Pacific Ocean and has a tropical maritime climate. The annual temperature range is between a daily maximum of 31° C and a daily minimum of 25° C. Two seasons are recognized, a cooler season, between April and October and a warmer rainier season from November to March. Annual rainfall ranges from about 2000 mm in the drier northern islands to 3500 mm in the wetter southern atolls, such as Funafuti (Rodgers 1991). Severe tropical cyclones periodically affect Tuvalu causing serious damage, the most recent of which was Tropical Cyclone Pam in March 2015, the strong winds and storm surge of which coincided with a high spring tide, inundated most atolls of Nui and Nukufetau causing serious damage to agriculture and biodiversity and forcing more than 300 people to evacuate their homes (Malakai and North 2015). And, again in December 2015, gale force winds and rain during Tropical Cyclone Ula destroyed homes and uprooted trees (Pacific Beat 2015).

These events cause: 1) coastal erosion and the loss of coastal plants and vegetation, 2) inundation of areas with saltwater, saltwater contamination (incursion) of the freshwater lens, and increased salt spray, all of which can kill or affect the growth and reproduction of non-coastal plants and crops on atolls, and can worsen the impact of periodic droughts. ENSO-related severe droughts (usually during La Niña phases) periodically affect Tuvalu, especially the northern atolls, and constitute a major limiting factor on the long-term survival of plants, particularly introduced non-coastal plants (Vula 2011; Duncan 2012).



Figure 4. Aerial view looking west across south Fogafale Islet, Funafuti Atoll, Tuvalu showing the Raised ocean side fringing reef encrusted with red coralline algae, the intertidal reef flat, beach and upraised coral rampart, inhabited and vegetated zone and the central lagoon (Source: Thaman 2016).



Fig. 5. Coral rubble rampart caused by tropical cyclone waves and surge the most recent serious event being Tropical Cyclone Bebe in 1971 (left); back-beach basin bordered by mangroves, togo (*Rhizophora stylosa*), east Fogafale Islet, Funafuti (Photos: R. Thaman 2010, 2016).

3.5 Hydrology and Freshwater Resources

There are no surface freshwater resources in Tuvalu and the only natural freshwater resource is groundwater in the form of a lens of often slightly brackish freshwater, hydrostatically floating on higher density saltwater beneath it. The location and degree of development of the groundwater influences the health of the vegetation and associated wildlife, as well as the location of village wells and excavated taro pits. Replenishment of the lens is dependent on rainfall. On Funafuti the

freshwater lens is most extensive and highly developed on the largest islet, Fogafale, although the freshwater resources are extremely limited in relation to the population size. As a result, much of Fogafale is dependent on household and community rainwater catchment systems, with periodic droughts limiting the ability to replenish rainwater catchments (SOPAC 2007; Duncan 2012; Thaman et al. 2012).

3.6 Substrates and Soils

The substrates and soils of Tuvalu are among the poorest in the world. They include exposed limestone rock, beach or reef rock, sand and gravel, loamy sands, acid peat soils, swamp or hydromorphic organic soils or muds created in excavated taro pits, and artificial soils. The natural soils are normally shallow, porous, alkaline, coarse-textured, and have carbonate mineralogy and high pH values of up to 8.2 to 8.9 and are usually deficient in most of the important nutrients needed for plant growth (Morrison 1987; SOPAC 2007). In late 2015, the reclamation and infilling of extensive areas of borrow pits with dredged lagoon sediments was completed on both north and south Fogafale Islet adding a significant area of mainly biogenic sand of foraminiferous origin along with varying proportions of calcareous algae, coral and shells remains (Fig. 6).



Figure 6. Former borrow pits north of the garbage dump reclaimed in 2014 and infilled with lagoon sediment dredged from Funafuti Lagoon (left); and the extensive reclaimed area on the lagoon side of the Tuvalu Government Building and Vaiaku Lagi Hotel, which was formerly opened as Queen Elizabeth II Park in early 2016 (Source: Thaman 2016).

3.7 Flora

The indigenous terrestrial flora of Tuvalu is very poor, highly disturbed and now numerically dominated by introduced exotic species. This has been due to the selective removal of indigenous species and vegetation for growth of settlements, construction, boatbuilding, firewood, medicine, tools and handicrafts and other purposes; and the deliberate and accidental introduction of a wide range of non-indigenous plants, some of which have important cultural plant and some invasive weeds. The resultant total number of terrestrial vascular plants reported present, at some time in Tuvalu is about 362 species, or distinct varieties, of which only about 59 (16%) are possibly indigenous (Table 1.) The remaining 303 species (83% of the flora) are non-indigenous species that have been introduced by humans, some of which may have been at one time or another early aboriginal introductions by Pacific Islanders into Tuvalu. The total recorded flora of Funafuti is about 356, with 7 additional indigenous species having been reported from the other atolls (Thaman et al. 2012; Thaman 2016).

There are no endemic plant species that are unique to Tuvalu, with almost all of the indigenous plants being widespread, easily-dispersed pan-tropical or pan-Pacific coastal species that have the ability to cope successfully in environments with loose shifting sands, soil-less limestone and rock outcrops, high wave action, high salinity and sea spray, periodic flooding, strong sunlight, strong winds and drought, all conditions common on the atolls of Tuvalu. The low number of indigenous species is an indication of the lack of habitat diversity on atolls compared with larger high islands, the difficulty of cross-ocean dispersal by plants, and the difficulty of long-term survival in the harsh atoll environment which is dominated by high salinity.

Table 1. Assumed origin of vascular plants reported present on Funafuti Atoll and Tuvalu (Note: 1) some species may no longer be present and are now locally extinct; 2) there are undoubtedly some species that have not been recorded; 3) some species have probably been incorrectly classified because of the difficulty of determining their true origin; and, 4) the numbers in parentheses indicate the totals including additional species recorded from other atolls in Tuvalu, but not from Funafuti).

Class	Indigenous	Aboriginal	Recent	Total
Ferns and Fern Allies	6	-	3	9
Gymnosperms	-	-	2	2
Monocotyledons	11	8	81	103
Dicotyledons	42	6	200	248
Total	59	14	289	362

3.8 Terrestrial Fauna

The indigenous terrestrial vertebrate fauna of Tuvalu includes no indigenous land mammals, amphibians or freshwater fishes. There are some of terrestrial reptiles, all lizards, one of which is Tuvalu's only recorded endemic vertebrate, the Tuvalu forest gecko (*Lepidodactylus tepukapili*, which was found on Tupuka Islet, Funafuti). Of particular importance are 28 species of indigenous birds, approximately 20 of which are sea birds and a few are migratory species. Birds are also a very important traditional food source and a wide range of birds have been traditionally hunted. Notable terrestrial invertebrates include land or shore crabs, including the coconut crab, with most of the smaller crabs being used as preferred fish bait. Also important are a range of land snails that are used to make shell leis and handicrafts, and four endemic land snails and two jumping spiders were reported from Hedley's expedition in the late 1800s. There is also a range of largely unassessed other invertebrates.

3.9 Marine Biodiversity

Tuvalu's marine environment is the main local source of animal protein, products, such as shells, for handicraft production and revenue from licensing agreements with foreign fishing nations fishing within Tuvalu's EEZ. Exploitation at the local level is mainly for subsistence use, although there has been limited local commercial fishing of finfish and shellfish for local sale and limited export on Funafuti.

Studies of Tuvalu's finfish resources, including sharks, rays and eels, suggest that the total number of inshore fish and offshore species could be 900 or more, about 500 of which are recognized by Tuvaluan names (Thaman et al 2015). The marine invertebrate fauna includes an incredible but threatened diversity of bivalve, gastropod and cephalopod molluscs, crustaceans, echinoderms, corals and other marine invertebrates. Almost of these species have been overfished or in declining numbers.

3.10 Terrestrial Ecosystem Diversity

Despite Tuvalu's small land area and limited nearshore marine area, considerable ecosystem diversity is recognized by local communities. The main 'natural' vegetation types, of which there are also many combinations and shared species, have been discussed in detail by Woodrooffe in his "Vegetation of Tuvalu" (1991), whereas Table 2 shows the main vegetation or land cover types, including highly modified agricultural areas, village gardens and ruderal sites that constitute the main terrestrial ecosystems or land cover types found in Tuvalu.. Table 3 shows the estimated land use or land cover types as presented in the 4th Tuvalu NBSAP Report which roughly correspond to those listed in Table 2, although there are no updated figures on the present areas of vegetation and land cover types available. The areas of beaches, coral rubble and beach rock, which overlap with and grade into the coastal littoral forest and scrub, mangroves and intertidal flats (which is discussed above) are an important cover type on the interface between the land and sea that protect Tuvalu's atolls from coastal erosion and saltwater incursion. The main ecosystems or land cover types are discussed briefly below

Table 2. Main vegetation and land cover types found on the main inhabited and uninhabited islets (motu) of Funafuti and other the atolls of Tuvalu (Thaman et al. 2012).

1	Inland Broadleaf Forest and Woodland
2	Coastal Littoral Forest and Scrub
3	Mangroves and Wetland
4	Coconut Woodland and Agroforest
5	Excavated Taro Gardens
6	Village Houseyard and Urban Gardens
7	Intensive Vegetable and Food Gardens
8	Constantly Disturbed Ruderal Vegetation
9	Beaches, coral rubble and coastal beach rock

Unvegetated recently reclaimed areas infilled with lagoon sediment

Table 3. Estimated areas of different land use/land cover types presented in the 4th Report based on information collected in the late 1990s

Cover/Vegetation	Area (ha)	%
Coconut woodland	1, 619	53.9
Broadleaf woodland	122	4.1
Coconut & broadleaf woodland	51	1.7
Scrub	419	13.9
Pandanus	10	0.3
Mangroves	515	17.1
Pulaka pits & pulaka basins	65	2.2
Village, buildings	172	5.7
Other (i.e. low ground cover)	33	1.1
Total	3, 006	100

Despite severe habitat degradation, selective removal and harvesting of high-value trees and plants and increasing dominance of introduced species, there remains a significant amount of indigenous inland and coastal littoral vegetation in various stages of disturbance which constitute the main terrestrial ecosystems. This ranges from small stands of inland and coastal forest to mangroves and more extensive areas of scrub or shrub land. On uninhabited reef islets and areas away from the main settlements, indigenous species are still largely the dominant species, although impoverished by selective removal of some species and the planting of coconut palms. In villages and built-up and disturbed areas introduced, often invasive, species are more



dominant, many of which have important ecological and cultural value (Thaman *et al.* 2012). The main terrestrial ecosystems, including highly modified areas are discussed briefly below.

3.10.1 Inland Broadleaf Forest and Woodland: Relatively undisturbed areas of inland broadleaf forest and woodland are rare on Funafuti, limited in area or represented by scattered remnant trees on most of the other main inhabited atolls, and now found mainly in small stands or scattered trees on uninhabited reef islets (**motu**) off the main inhabited atoll islets. These areas, particularly areas with the trees, **puka** (*Pisonis grandis*) and **tausunu** (*Tournefortia argentea*), are particularly important rookery areas for Tuvalu's declining seabird populations.

3.10.2 Coastal Littoral forest and Scrub: The least disturbed areas of coastal littoral forest and scrub (those plants that grow on the outer coastline directly facing the sea) are also found on uninhabited islets, in less populated rural areas of the inhabited islets. They are found on both the more exposed ocean coasts and on the lagoon coasts of most islets and are critical turtle nesting, habitats for hermit crabs and protect coastlines and beaches from coastal erosion. The dominant species include **gie** (*Pemphis acidula*) and **gasu** (*Scaevola taccada*).

3.10.3 Mangroves and Wetlands: Although limited in extent, mangroves and limited areas of swampy wetlands are found on all Tuvalu's atolls except Nukulaelae, in all cases, along protected intertidal lagoon flats or in back-beach basins. The only two true mangrove species present in Tuvalu are the common mangrove, **togo** (*Rhizophora stylosa*), which is found on all atolls except Nukulaelae, and the red-flowered mangrove, **sagale** or **hagale** (*Lumnitzera littorea*), which is currently reported present only on Nanumaga, Niutao, Nui, and Vaitupu. On Funafuti, **togo** (*Rhizophora stylosa*) is locally abundant and forms dense thickets to the northeast of the airfield where it surrounds the lagoon or back-beach intertidal basin landward of the ocean-coast coral rubble and shingle rampart along the east coast of Fogafale Islet (Fig. 5 above). An 1896 geological map of Fogafale Islet shows that this back beach swamp area covered a much more extensive area of the east-central part of the islet in the past before the construction of the airstrip in 1942 and the expansion of the government settlement. **Sagale** or **hagale**, although now only found on Niutao, Nui, Vaitupu and Nanumaga, was reportedly present on Funafuti and Nukulaelae in the past where it was known as **tokotū**, but has long since been brought to extirpation (local extinction) due to land conversion and overuse of its very useful wood (Thaman *et al.* 2012)

3.10.4 Coconut Woodland and Agroforest: The most widespread vegetation type in Tuvalu is coconut-dominated agroforest or woodland. The term agroforest is used to describe those agricultural lands dominated by deliberately planted or protected useful trees, in this case almost exclusively the coconut palm, **niu** (*Cocos nucifera*), although other useful indigenous trees, such as **pua** (*Guettarda speciosa*), **fao** (*Neisosperma oppositifolium*) and **nonu** (*Morinda citrifolia*) are often protected and allowed to remain, and pandanus, breadfruit and other useful trees are planted, sometimes as small tree groves, in more favourable sites, usually near villages, residences or around excavated taro pits.

3.10.5 Excavated Taro Pits: Excavated taro pits (**pela**) are a unique, specialized and highly modified communal garden areas found in the central parts of the larger atoll islets, normally near the main settlements. The pits have been excavated to the level of the freshwater lens through the limestone bedrock to depths of 1.5 to 2 m. The artificial soils in these pits are fertile, swampy and rich in organic material and have been formed over many years by adding mulch or compost, known as **kaiao**, which is composed of leaves of trees and other plants and other organic materials. On Funafuti, the only remaining extensive taro pit is located in Vaiaku, just north of the airport to the west of the runway. The main crop planted in the **pela** is giant swamp taro, **pulaka** (*Cyrtosperma chamissonis*) although common taro, **talo** (*Colocasia esculenta*) is also common on Funafuti, often planted in slightly raised beds bordering the **pulaka** (Fig. 7). Bananas and plantains (*Musa* cultivars) are planted in contiguous stands bordering the pits, the name Funafuti meaning the place of the **futi**, the general word for bananas and plantains.



Fig. 7. Excavated taro pits on Fogafale Islet with the taller giant swamp taro, **pulaka** (*Cyrtosperma chamissonis*) in back and true taro, **talo** (*Colocasia esculenta*) in the front (Source: Thaman 2010, 2016)

3.10.6 Village Houseyard and Urban Gardens: Due to increasing population and urbanization, houseyard and urban gardens are one of the most widespread vegetation types, especially on Fogafale Islet, Funafuti and in villages and government centres on the other atolls. These include houseyard gardens around family dwellings and workplaces; landscaping at hotels, schools, and government and non-government developments; and lawns, hedges and living fencing and street trees and other roadside plantings. Houseyard and urban gardens contain a mixture of a wide range of deliberately planted indigenous and non-indigenous trees, shrubs, vines and other perennials and some short-term annual plants, plus many non-planted wild or weedy species. Over the past ten years or so home gardening including the planting of ornamentals at homes has been promoted via competitions.

3.10.7 Intensive Vegetable and Food Gardens: Intensive vegetable and food gardens, originally growing mainly non-traditional short-term seed crops and some other recently introduced perennial shrub and tree food plants, are increasingly important on Funafuti on some other atolls, such as Vaitupu. This has been in response to a number of initiatives, over the past 20 years or more, to improve nutrition and increase production and consumption of vitamin-rich vegetables and fruits in an effort to reduce the dependence on nutritionally inferior, highly-processed imported foods and drinks that are the main causal factor in the rapid increase in obesity, diabetes, cardiovascular and dental disease and a range of other “lifestyle diseases” in Tuvalu. The soils of these gardens have been enriched by adding organic materials, such as pulverized coconut husk or decaying logs, animal manure, sand or soil from more fertile sites and imported fertilizers and manures. Pesticides are also reportedly used in these gardens.

Most recently there are a number of initiatives promoting agriculture systems to promote food security and build resilience against climate change. These include the Tuvalu Department of Agriculture Nursery for Utilising Climate Resilient Crops” and a number of demonstration agroforestry plots in North and South Fogafale Islet that incorporate mainly traditional tree crops, such as coconut palms, pandanus, breadfruit, bananas and native figs (*Ficus tinctoria*) along with staple root crops such as cassava, sweet potato, taros (*Colocasia*, *Cyrtosperma* and *Xanthosoma* spp.) and yams, plus a number of other introduced plants. The main funders have been the European Union and its Global Climate Change Alliance (GCCA), along with the SPC, FAO, ACIR (Australian Centre for Agricultural Research).

3.10.8 Disturbed Ruderal Vegetation: Increasing urbanization and the development of roads and airports and other facilities have created extensive areas of continually disturbed “ruderal” vegetation, especially on Fogafale Islet. These include roadsides, path sides, waste places, open



lots, sports grounds, limited areas of lawns and grassy areas, unpaved areas around parking lots, areas bordering airports and landing strips and other areas that are continually disturbed and/or not maintained or weeded. The dominant plants in these areas are a wide range of easily-dispersed, fast-growing herbaceous weedy species (grasses, sedges and other herbs) (mostly referred to as **mouku**, the general term for small weeds) and some weedy shrubs. Some of these weeds, such as *Sphagneticola trilobata*, have become extremely invasive and constitute a threat to ecologically and cultural important indigenous species throughout much of the atoll and small island Pacific (Thaman 1999, 2008, 2011; Thaman et al. 2012).

3.11 Marine Ecosystem Diversity

The marine environment comprises of five main ecosystems or ecological zones; these include intertidal flats, subtidal lagoon areas, subtidal oceanside reefs and oceanic and open water, with mangroves included as both terrestrial and marine ecosystems (Table 4). Within each of these often overlapping zones are many combinations of habitat types, including algal flats, coral reefs, channels or reef passes, soft sandy and hard substrates or bottoms and seamounts, each with their own characteristic biological communities. Within each of these often overlapping marine ecosystems there are many combinations of habitat types, including algal flats, coral reefs, channels or reef passes, soft sandy and hard substrates or bottoms and seamounts, each with their own characteristic communities of phytoplankton (microalgae), zooplankton, seaweeds (macro-algae), corals, molluscs, crustaceans, other marine invertebrates, a rich finfish fauna, sea turtles and sea birds. Most of these marine species have life cycles or stages that move or migrate between two or more of these habitats. These marine biological communities also produce the biogenic sand and sediments required for island building and beach and lagoon maintenance and replenishment. All of these zones are important fisheries with the intertidal flats and shallow subtidal areas being among the most important, over exploited, and increasingly vulnerable traditional fisheries. The nearshore fishery is particularly important for women who have practiced reef gleaning for fishes, shellfishes, crustaceans and other invertebrates since the first arrival of Tuvaluans on the atolls (Koch 1983).

Table 4. Main marine ecological zones, ecosystems or habitat types that constitute important sources of biodiversity and ecosystem services

Mangroves*
Intertidal flats
Subtidal Lagoon areas
Subtidal Oceanside reefs
Oceanic and open water

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4

RICHNESS AND THREATENED STATUS OF TUVALU'S ATOLL AND OCEAN BIODIVERSITY INHERITANCE: AN OVERVIEW

The Funafuti R2R BIORAP results show that for even a small low-lying atoll such as Funafuti, the diversity of terrestrial and nearshore marine plants and animals and associated ecosystem services that are known by name and valued by local communities is remarkably rich. As can be seen from Table 1S, well over 1000 species were mentioned which, as stressed in the table caption, probably represents far more than this number because a given name will often represent many more than one species, especially in the marine environment where, for example, one vernacular Tuvaluan name may represent many different finfish or shellfish from the same genus, family or taxon. By the same token, however, many of the plant names are probably double counted because a majority of the plants are multipurpose plants and the cultivar names for major crop species such as coconuts, breadfruit, pandanus and taros, are also listed. Finally, because respondents were limited by the number of a given taxa they were, as stressed in the detailed discussion of each taxa below, the real numbers of species is far greater that the table suggests.

*Table 1SS. Estimated total named plants or animals recorded as important in: 1) different R2R ecosystems or habitats; and/or 2) for the delivery of specified ecosystem goods and services on Funafuti Atoll, Tuvalu, based on surveys of 19 respondent groups on Funafuti Atoll in November 2016 (Notes: 1) *some of the names, especially for marine organisms, refer to two or more, often many species (e.g., **pule** and **fakamili** both refer generally to many different species of cowries and cone shells; **malau**, **kamuta**, **sakulā** and **palu**, often with modifiers, refer to many soldierfishes, parrotfishes, billfishes and deepwater fishes, respectively; **lautagitagi** refers to at least 4 different *Polyscias* species or hedge plants; and **Puafiti** or **melia** refers to two species and many distinct cultivars of frangipani (*Plumeria*); 2) many of the plant names are probably double counted because a majority of the plants are multipurpose plants that are count in more than one category; 3) counts for some groups, especially some of the lesser known marine species, e.g., corals, echinoderms, sea worms may be inflated because of use of different names for the same species or the lack of knowledge of these species); 4) threatened or short supply includes those types that were considered rare or in short supply by some informants; and 5) rare refers to species mentioned by at least 20% of the respondents as being rare or extirpated.*

Quest No.	Types/Taxa	Tuvaluan Equivalent	Total named Species*	No. Threatened	Rare or Extirpated
1	Small nearshore fishes	Ika foliki o te papa	40	19	3
2	Large inshore fishes	Ika lasi o te papa	30	12	4
3	Deepwater fishes	Ika o te moana	17	13	3
6	eels	Pusi, tuna	7	6	3
7	sharks	mangō	13	10	5
8	rays	Fai	7	5	3
9	Dolphins or whales	tafolā	5	4	3
10	turtles	fonu	2	2	2
11	Small shellfish	Fingota foliki	16	10	5
12	Large shellfish	Fingota lasi	11	8	5
13	Crabs and hermit crabs	Paka, uga	19	12	3
14	Lobsters and shrimps	Ula	12	9	3
15	Sea cucumbers, bêche-de-mer	Loli, funafuna	19	12	3

16	Octopus and squid	Feke, nufekle	7	6	2
17	Sea urchins, starfish	Vana, magamagātai	13	11?	1
18	Sea worms	Anufe o te tai	8	5	2
19	Hard and soft coral	vaega kamu	25	16	5
20	jellyfishes	kapikapi	15	10	4
21	seaweeds	Vaega limu	14	12	3
22	Organisms eating/controlling algae	Ika mo te manumanu o te tai fakalavelave o te limu	32	18	2
23	Fishing bait	poa	24	11	3
24	Shells used in making necklaces and handicrafts	Fingota fakaoga ki hh tui misa	25	13	4
25	Mangrove trees and other associated plants	lakau lasi and nisi lakau l te vai ogo	20	16	6
26	Lagoonside trees and large plants	Lakau lasi i tafatai o te namo	20	16	4
27	Lagoonside small plants and vines	mouku foliki mo e lakau tolotolo i tafatai o te namo	21	10	3
28	Oceanside trees and large plants	lakau lasi fakaoga ki tu mo aganu kola e ola i tafatai o te tua fenua	17	13	5
29	Oceanside small plants/vines	a lakau foliki/ solo/ mouku i tafatai o te tua fenua	21	15	2
30	Inland trees/large plants	lakau ote vao (ite togavao ote fenua)	24	8	3
31	Inland Small plants/vines	lakau solo/mouku solo i manafa o tino ote fakai	28	12	3
32	ferns	Vaega sulufe/maile	7	5	1
35	Cultivated food plants	Vaega lakau kaina	24	20	10
36	Coconut palm cultivars	Vaega niu	19	13	4
37	Pandanus cultivars	Vaega fala kai	19	12	3
38	Breadfruit cultivars	Vaeg mei	12	11	5
39	Banana or plantain cultivars	Vaega futi	10	9	6
40	Giant swamp taro cultivars	Vaega pulaka	19	10	3
41	Taro cultivars	Vaega talo	15	11	4
44	Animal food/fodder	lakau mo fagia manu	19	12	5
45	Garland and body ornamentation	lakau manogi gali taua mo fai a fou/ fau	28	17	4
46	Ornamental plants	lakau fakagaligali fale	29	19	6
47	Fence/hedge plants	lakau puipui matagi/pui	23	16	4
48	Medicinal plants	Lakau fait te vailakau	39	26	8
49	Animal Medicines	vailakau moo manu	11	8	3

50	Construction/house-building	fai te fale	16	11	5
51	Woodcarving/toolmaking	tofi mo nisi mea faigaluega	14	10	4
52	Canoe or boatbuilding	fai a vaka/ pooti	10	7	3
53	firewood	fafie	13	7	4
54	Weaving and handicrafts	laga	12	8	4
55	Cordage, string, rope	kolokolo	4	3	2
56	Fishing equipment	mea faika	13	8	3
57	Necklaces and beads	Mea tulima	9	8	4
58	Toys and games	mea taulima	8	6	4
59	Wrapping/parcelling	Saisai meakai	15	13	3
60	Perfumes/scenting coconut oil	Sinu manogi	23	15	5
61	Dye or paint	peeni	2	2	2
62	Fertilizer/mulching plants	kaiao	12	10	3
65	Magic/black magic plants	Vailakau fakaltaulaitu	10	8	3
66	Land and seabirds	Manu lele	18	12	3
67	Migratory/non-resident birds	Manulele Malaga mai nisi fanua	19	17	4
69	Edible sea birds	Manulele fakaaonga mo fai meakai	4	4	2
71	Seabird nesting trees	Lakau fai ofaga i ei a manu	6	6	2
72	Domestic animals	Manu fagai	5	3	2
73	lizards	Moko, pili	7	4	4
74	Coconut crabs	Ū	1	1	1
75	Insects and arthropods	manufofiki aofia	10	?	0
76	weeds	lakau fakamataku/fakamasei	10		
77	Animal pests	manu fakamataku	3	0	0
78	diseases	masaki fakamataku	2	?	?
	TOTAL		1063	666	229

Sadly, this biodiversity inheritance and the associated wealth of knowledge, which constitutes the main foundation for environmental, energy, food, livelihood, health and cultural security of the Tuvaluan people in the face of global change is now highly threatened with a very high percentage of these species now considered to be rare, threatened or in low numbers, the exploitation of which is no longer sustainable on Funafuti with some-two thirds of all species (666/1063) considered to be threatened or in shorts supply and almost one-quarter (229/1069) considered rare or locally extinct by informants.

This diversity, which in many ways constitutes the human face or heart of biodiversity, an aspect of biodiversity that is rarely well-understood by "natural scientists" and perhaps, only understood and appreciated by local communities, themselves, and some practicing ethnobotanists and ethno-biologists, such ethno-ichthyologists or bio cultural anthropologists is discussed in detail in the flowing sections.

5

ECOSYSTEM SERVICES AS A BASIS FOR SUSTAINABLE LIVELIHOODS

In Tuvalu, food, health, livelihood, environmental and cultural security (sustainable livelihoods) ultimately depend on the conservation, restoration and enrichment of biodiversity and ecosystem services (BES), with ecosystem services being defined by the Millennium Ecosystem Assessment (MA) (2005) as: "the benefits people obtain from ecosystems, which are broken down into four categories: provisioning, regulating, cultural and supporting services, with the supporting services being necessary for the provision of the first three categories (de Groot *et al.* 2002; MA 2005). As stressed in the introduction, the Tuvaluan translation for BES is "**mea ola mo te vaega mea aonga kia tatou mo fenua no tai**" (literally "living things and those things that are useful to us from our land and sea." Table 5 attempts to show the diversity of ES provided by Tuvalu's terrestrial, freshwater and marine biodiversity, roughly broken down into natural and cultural ecological services, some of which could fall into one or more of the four above MA categories.

Table 5. Natural and cultural ecological services provided by terrestrial, freshwater and marine biodiversity (ecosystems, species populations, genetic and biocultural diversity (Source: Adapted from Thaman and Clarke 1987; Thaman 1992, 2002, 2004, 2014; Thaman et al. 2012; Duffy 2006; Worm et al. 2012)

NATURAL ECOLOGICAL SERVICES

Climate Regulation	Erosion Control	Coastal Protection
Wind Protection	Shade/UV Protection	Flood/Runoff Control
Wave control/reduction	Temperature Regulation	Water/Moisture Regulation
Water Purification	Carbon Sequestration	Nutrient Recycling
Pollination/Fertilization	Dispersal Pathways	Soil Formation/Improvement
Sand/sediment Provision	Pollution Control	Algae control
Bioremediation	Weed/Pest/Disease Control	Wild Animal Food
Animal/Plant Habitats	Refugia/Homes/Shelter	Spawning/Breeding Grounds
Nurseries/Nursing Grounds		

CULTURAL ECOLOGICAL SERVICES

Timber (commercial)	Broom	Prop or Nurse Plants
Timber (subsistence)	Parcelisation/Wrapping	Staple foods
Fuelwood	Abrasives	Supplementary Foods
Boatbuilding (canoes)	Illumination/Torches	Wild/Snack/Emergency foods
Sails	Insulation	Animal Foods/Fodder
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/paints/colour	Masticants/Chewing Gum
Toys	Plaited Ware	Meat Tenderizers
Switch/Whips/Discipline	Hats/Sunshades	Preservatives
Mats	Medicines	Brush/Paint Brush Baskets
Aphrodisiacs	Musical Instruments/Drums	Commercial/Export Products
Cages/Roosts	Scents/Perfumes	Abortifacients Fertility Control
Tannin	Ritual Exchange	Rubber/Elastic
Poisons/Pesticides	Recreation	Oils/Lubricants
Insect Repellents	Magico-religious	Toothbrush
Deodorants/purifiers	Totems	Toilet Paper
Embalming Corpses	Subjects of Mythology	Fire Making
Lovemaking Sites	Fertilizers	Secret Meeting Sites
Refuges/Safe Havens	Educational/Resources	Tourism/Scenic

Many of these ES, which have been deliberately targeted in the Funafuti BIORAP, are discussed under the NBSAP results for marine and terrestrial BES.

6

RICHNESS AND THREATENED STATUS OF FUNAFUTI'S BIODIVERSITY AND ECOSYSTEM SERVICES: AN OVERVIEW OF BIORAP RESULTS

The Funafuti R2R BIORAP results show that for even a small low-lying atoll such as Funafuti, the diversity of terrestrial and nearshore ecosystems and marine plants and animals and associated ecosystem services (BES) that are known by name and valued by local communities is remarkably rich.

Table 6 show that well over 1000 named species were known to respondent which, as stressed in the table caption, probably represents far more than this number because a given name will often represent many more than one species, especially in the marine environment where, for example, one vernacular Tuvaluan name may represent many different finfish or shellfish from the same genus, family or taxon. By the same token, however, many of the plant names are double counted because a majority of the plants are multipurpose plants and the cultivar names for major crop species such as coconuts, breadfruit, pandanus and taros, are also listed. Finally, because respondents were limited by the number named taxa they were asked for under a given category, as stressed in the detailed discussion of each taxa below, the real numbers of species is far greater that the table suggests.

*Table 6. Estimated total named plants or animals recorded as important in: 1) different R2R ecosystems or habitats; and/or 2) for the delivery of specified ecosystem goods and services on Funafuti Atoll, Tuvalu, based on surveys of 19 respondent groups on Funafuti Atoll in November 2016 (Notes: 1) *some of the names, especially for marine organisms, refer to two or more, often many species (e.g., pule and fakamili both refer generally to many different species of cowries and cone shells; malau, kamuta, sakulā and palu, often with modifiers, refer to many soldierfishes, parrotfishes, billfishes and deepwater fishes, respectively; lautagitagi refers to at least 4 different Polyscias species or hedge plants; and pua Fiti or melia refers to two species and many distinct cultivars of frangipani (Plumeria); 2) many of the plant names are probably double counted because a majority of the plants are multipurpose plants that are counted in more than one category; 3) counts for some groups, especially some of the lesser known marine species, e.g., corals, echinoderms, sea worms may be inflated because of use of different names for the same species or the lack of knowledge of these species); 4) threatened or short supply includes those types that were considered rare or in short supply by some informants; and 5) rare refers to species mentioned by at least 20% of the respondents as being rare or extirpated.*

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2	Large inshore fishes	Ika lasi o te papa	30	12	4
3	Deepwater fishes	Ika o te moana	17	13	3
6	eels	Pusi, tuna	7	6	3
7	sharks	mangō	13	10	5
8	rays	Fai	7	5	3
9	Dolphins or whales	tafolā	5?	4	3
10	turtles	fону	2	2	2
11	Small shellfish	Fingota foliki	16	10	5
12	Large shellfish	Fingota lasi	11	8	5
13	Crabs and hermit crabs	Paka, uga	19	12	3

14	Lobsters and shrimps	Ula	12	9	3
15	Sea cucumbers, bêche-de-mer	Loli, funafuna	19	12	3
16	Octopus and squid	Feke, gufeke	7	6	2
17	Sea urchins, starfish	Vana, magamagātai	13	11?	1
18	Sea worms	Anufe o te tai	8	5	2
19	Hard and soft coral	vaega kamu	25	16	5
20	jellyfishes	kapikapi	15	10	4
21	seaweeds	Vaega limu	14	12	3
22	Organisms eating/controlling algae	Ika mo te manumanu o te tai fakalavelave o te limu	32	18	2
23	Fishing bait	poa	24	11	3
24	Shells used in making necklaces and handicrafts	Fingota fakaoga ki he tui misa	25	13	4
25	Mangrove trees and other associated plants	lakau lasi and nisi lakau i te vai ogo	20	16	6
26	Lagoonside trees and large plants	Lakau lasi i tafatai o te namo	20	16	4
27	Lagoonside small plants and vines	mouku foliki mo e lakau tolotolo i tafatai o te namo	21	10	3
28	Oceanside trees and large plants	lakau lasi fakaoga ki tu mo aganu kola e ola i tafatai o te tua fenua	17	13	5
29	Oceanside small plants/vines	a lakau foliki/ solo/mouku i tafatai o te tua fenua	21	15	2
30	Inland trees/large plants	lakau ote vao (ite togavao ote fenua)	24	8	3
31	Inland Small plants/vines	lakau solo/mouku solo i manafa o tino ote fakai	28	12	3
32	ferns	Vaega sulufe/maile	7	5	1
35	Cultivated food plants	Vaega lakau kaina	24	20	10
36	Coconut palm cultivars	Vaega niu	19	13	4
37	Pandanus cultivars	Vaega fala kai	19	12	3
38	Breadfruit cultivars	Vaega mei	12	11	5
39	Banana or plantain cultivars	Vaega futi	10	9	6
40	Giant swamp taro cultivars	Vaega pulaka	19	10	3
41	Taro cultivars	Vaega talo	15	11	4
44	Animal food/fodder	lakau mo faga manu	19	12	5
45	Garland and body ornamentation	lakau manogi gali taua mo fai a fou	28	17	4
46	Ornamental plants	lakau fakagaligali fale	29	19	6
47	Fence/hedge plants	lakau puipui matagi/pui	23	16	4
48	Medicinal plants	Lakau fait te vailakau	39	26	8
49	Animal Medicines	vailakau moo manu	11	8	3
50	Construction/housebuilding	fai te fale	16	11	5
51	Woodcarving/toolmaking	tofi mo nisi mea faigaluega	14	10	4
52	Canoe or boatbuilding	fai a vaka/ pooti	10	7	3
53	firewood	fafie	13	7	4
54	Weaving and handicrafts	laga	12	8	4
55	Cordage, string, rope	kolokolo	4	3	2
56	Fishing equipment	mea faika	13	8	3
57	Necklaces and beads	Mea tulima	9	8	4
58	Toys and games	mea taulima	8	6	4
59	Wrapping/parcelling	Saisai meakai	15	13	3

60	Perfumes/scenting coconut oil	Sinu manogi	23	15	5
61	Dye or paint	peeni	2	2	2
62	Fertilizer/mulching plants	kaiao	12	10	3
65	Magic/black magic plants	Vailakau fakaltaulaitu	10	8	3
66	Land and seabirds	Manu lele	18	12	3
67	Migratory/non-resident birds	Manulele Malaga mai nisi fanua	19	17	4
69	Edible sea birds	Manulele fakaaonga mo fai meakai	4	4	2
71	Seabird nesting trees	Lakau fai ofaga i ei a manu	6	6	2
72	Domestic animals	Manu fagai	5	3	2
73	lizards	Moko, pili	7	4	4
74	Coconut crabs and land crabs	Ū, uga	3	3	1
75	Insects and arthropods	manufoliki aofia	10	?	0
76	weeds	lakau fakamataku/fakamasei	10		
77	Animal pests	manu fakamataku	3	0	0
78	diseases	masaki fakamataku	2	?	?
	TOTAL		1065	668	229

This biodiversity inheritance, including associated local knowledge is now highly threatened, with about two thirds of all named species (666/1063) considered to be locally extinct, rare, threatened or in low numbers, the exploitation of which is no longer sustainable on Funafuti. This "named" biodiversity constitutes the human face or heart of biodiversity, an aspect of biodiversity rarely well-understood by most "natural scientists" and perhaps, only understood and appreciated by local communities, and some practicing ethnobotanists and ethnobiologists, such ethno-ichthyologists or biocultural anthropologists. This diversity, its cultural significance and conservation status is discussed below in the flowing sections.

7

BIORAP RESULTS OF MARINE BIODIVERSITY AND ECOSYSTEM SERVICES

Marine species assessed included: 1) finfishes; 2) eels; 3) sharks and rays; 4) dolphins and whales; 5) turtles; 6) small and large shellfish; 7) octopus and squid; 8) crabs and hermit crabs; 9) lobsters and shrimps; 10) sea cucumbers or bêche-de-mer; 11) echinoderms; 12) sea worms; 13) corals; 14) jellyfishes; 15) seaweeds; and, 16) organisms that eat or control seaweed or algae. Although eels, sharks and rays are commonly included along with finfishes, they are discussed separately based on the Tuvaluan classification which clearly distinguishes them by name.

7.1 Finfishes (Vaega Ika)

All together there were over 40 named small finfishes, 30 large finfishes and 20 offshore or deepwater finfishes, which probably really represent as many as up to 900 different named species of finfish, based on previous studies (Thaman et al. 2013), a high percentage of which were overfished or had reportedly disappeared from fishing grounds where they were formerly caught (Tables 7–9).

7.1.1 Small Nearshore Finfishes (Ika Foliki)

About 40 different named species were considered among the 9 most important “small” fish (Table 7). Because most names refer to a numbers of species within the same family, these possibly refer to as many as 100 or more individual species, many of which were reported to be increasing rare or in declining abundance and could be good indicator species for determining the effectiveness of conservation or management interventions.

Table 7. Survey results of the 9 most important small nearshore finfish species and 3 small finfish species that are considered to be locally extinct, rare or in need of conservation, based on questionnaire surveys of 19 male and female informant groups permanently residing in Funafuti Atoll, Tuvalu conducted in November, 2016 (ulafi is a misused general term for parrotfishes used by many people who no longer know the diversity of names for different species and growth stages).*

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total x/19	Total Threatened x/19
manini	convict surgeonfish	<i>Acanthurus triostegus</i>	15	4
gatala	rockcods, groupers (small)	<i>Epinephelus merra</i> and <i>E. spp.</i>	14	2
maiava	rabbitfishes	<i>Siganus argenteus</i> and <i>Siganus spp.</i>	12	6
manini lakau, umalei	orangespine unicornfish	<i>Naso literatus</i>	12	6
ponelolo	striped surgeonfish	<i>Acanthurus lineatus</i>	11	3
*ulafi, laea, kamutu	parrotfishes	Scaridae	11	2
mutumutu	sergeants	<i>Abudefduf spp.</i>	9	1
kanase, kanae	fringelip mullet	<i>Crenimugil crenilabis</i>	9	4
patuki	hawkfishes	Cirrhitidae	9	0
kalo, vete, kaivete	small goatfish	<i>Mulloidichthys spp.</i>	8	7

savane	common bluestripe snapper	<i>Lutjanus kasmira</i>	8	2
gatala liki, tuitui gatala	dwarf spotted grouper	Epinephelis merra	8	0
maono, api	white-spotted surgeonfish	<i>Acanthurus guttatus</i>	7	2
salala	big-eye scad	<i>Selar crumenophthalmus</i>	6	7
tā malau	sabre squirrel fish	<i>Sargocentron spiniferum</i>	5	1
tanutanu	emperors (sm)	<i>Lethrinus harak and L. obsoletus</i>	5	0
pone uli, pone	bristletooths, dark surgeon-fishes	<i>Ctenochaetus and Acanthurus spp.</i>	5	0
taiva	dory snapper, one-spot snapper	<i>Lutjanus fulviflamma, L. monostigma</i>	5	2
malau, talakisi	squirrelfishes	<i>Neoniphon and Sargocentron spp.</i>	4	1
lupo, fua'ala'ala, fuaika	small trevallys	<i>Carangoides and Caranx spp. (sm.)</i>	4	0
tagau/takape	yellow-margin snapper	<i>Lutjanus fulvus</i>	3	0
sumu, humu	triggerfishes (sm)	<i>Balistapus undulatus, Rhinecanthus spp.</i>	3	0
manoko, kalapa	sandperch	<i>Parapercis clathrata</i>	3	0
matu	silver biddys	<i>Gerres spp.</i>	2	1
uloulo	wrasses (sm.)	Labridae	2	0
noto	variegated emperor	<i>Lethrinus variegatus</i>	2	0
nofu	stonefishes and scorion-fishes	<i>Scorpaenopsis diabolus, Scorpaenidae</i>	1	1
moimoi, takuku	damselfishes, gregories	Pomacentridae	1	0
pula	red coral trout	<i>Cephalopholis spp.</i>	1	1
salii	silversides, herring, sprats	Atherinidae, Clupeidae	1	0
kafakafa	diamond-scale mullet	<i>Liza vaigiensis</i>	1	0
tute, ise	halfbeaks	Hemiramphidae	1	1
tifitifi	butterflyfishes	Chaetodontidae	1	0
eve	hexagon rockcod/grouper	<i>Epinephelus hexagonatus</i>	1	0
mu gutuloa	yellowspot emperor	<i>Gnathodentex aureolineatus</i>	1	0
tuitui gatala	small groupers	<i>Epinephelus spp.</i>	1	0
mataele	red rockcods, coral trout	<i>Cephalopholis spp</i>	1	0
pave	?	?	1	0

The most commonly recorded small inshore finfish species included: 1) surgeonfishes and bristletooths, **manini**, **pone**, **pone lolo**, **pone uli**, **maono** or **api** (*Acanthurus* and *Ctenochaetus* spp.); 2) small rockcods or groupers, **gatala**, **gatala liki**, **eve**, **pula**, **mataele** (*Epinephelus* spp.); 3) rabbitfishes, **maiava** (Siganidae); 4) parrotfishes, **ulafi** (Scaridae); 5) unicornfishes, **manini lakau** or **uma lei** (Nasinae); 6) sergeants, **mutumutu** (*Abudefduf* spp.); 7) mullets, **kinase** and **kafakafa** (Mugillidae); 8) hawkfishes, **patuki** (Cirrhitidae); 9) goatfishes, **vete** (Mullidae); 10) snappers, **savane**, **taiva**, **tagau** or **takape** (*Lutjanus* spp.); 11) big-eye scads, **salala**, **atule** (*Selar crumenophthalmus*); 12) soldierfishes, **malau**, **tā malau**, **talakisi** (Holocentridae); and 13) emperors, **tanutanu**, **notō** (*Lethrinus* spp.) 8); and 9) drummers or chubs, **nanue** (Khyphosidae) (Table 7).

Those that were considered to be locally extinct (have disappeared), rare or increasingly in short supply by the highest number of informants were: **manini**, convict surgeonfish (*Acanthurus triostegus*); **maiava**, rabbitfishes (*Siganus* spp.); **salala** or **atule**, big-eye scad (*Selar crumenophthalmus*), **vete** or **kalo**, small schooling goatfishes (*Mulloidichthys* spp.). Of particular concern was the disappearance of **maiava**, fork-tail rabbitfish (*Siganus argenteus*), a favoured foodfish, which used to arrive in the lagoon in huge seasonal post-larval fish aggregations which reinstalled themselves after an annual oceanic pelagic larval phase. These small post-larval fish were probably known as *ō* in some parts of Tuvalu and elsewhere in Polynesia.

Other small finfishes reportedly overfished, rare or in short supply include: 1) surgeonfishes and unicornfishes (Acanthuridae), **ponelolo** (*Acanthurus lineatus*), **maono** or **api** (*Acanthurus guttatus*) and **manini lakau** (*Naso literatus*); 5) mullets, **kanase** (*Crenimugil crenilabis*); 6) snappers (Lutjanidae), **savane** (*Lutjanus kasmira*), **tagau** or **takape** (*Lutjanus fulvus*) and **taiva** (*Lutjanus fulviflamma*); and 7) small rockcods or groupers (Serranidae), **gatala**, **gatala liki** (*Epinephelus* spp.). Other species said to be overfished by some informants, and/or that seem to be decreasing in numbers include: sergeants, **mutumutu** (*Abudefduf* spp.), 2) soldierfishes or squirrelfishes, **malau**, **tāmalau** or **talakisi** (Holocentridae); silver biddys, **matu** (*Gerres* spp.); stonefishes or scorpionfishes, **nofu** (Scorpaenidae), and halfbeaks, **tue** or **ise** (Hemiramphidae) (Table 7)

The main driver for the loss of these fish was overfishing, particularly net fishing and night fishing, with the most commonly suggested responses being the need to enact catch restrictions, regulate the use of nets and to establish a system of marine managed areas.

7.1.2 Large Nearshore Finfishes (Ika Lasi o te Papa)

Some 30 named species or groups of species were considered among the 9 most important "large" nearshore fish species (Table 8), which probably represent over 50 different individual species, a large number of which were reportedly increasing rare and could be good indicator species to determine the effectiveness of conservation or management interventions.

The most commonly recorded important large lagoon or nearshore finfish species included: 1) unicornfishes, **ume**, **kosotu** or **tātivi** and **pokapoka** (*Naso* spp.); 2) trevallies, **ulua**, **aseu**, **teu**, **tafauli** (*Caranx* spp.) and **filu** (*Gnathanodon speciosus*); 3) large parrotfishes, **ulafi**, **laea**, **taona** (*Bolbometopon muricatum*, *Hipposcarus longiceps* and *Scarus* spp.); 4) drummers or chubs, **nanue** (*Khyphosus* spp.); 5) groupers or rock cods, **gatala**, **munua**, **fapuku**, **tonu** (*Epinephelus* and *Plectropomus* spp.); 6) barracudas, **ono**, **nunua**, **taotao**, **pauea** (*Sphyaena* spp.); 7) emperors, **filoa**, **gutu'ula**, (*Lethrinus* spp.); 8) humphead or giant wrasse, **tagafa** or **malatea** (*Cheilinus undulatus*); and 9) humpback snapper, **taea** (*Lutjanus gibbus*).

Those most often reported to be rare or overfished were; 1) unicornfishes, **ume** (*Naso unicornis* and *Naso* spp.); 2) drummers or chubs, **nanue** (*Khyphosus* spp.); 3) humphead wrasse, **tagafa** or **malatea** (*Cheilinus undulatus*); 4) trevallies, **ulua** and **tafauli** (*Caranx* spp.); 5) groupers, **fapuku** or **munua** (*Epinephelus fuscoguttatus* and *F. polyphkadion*); 6) large parrotfishes, **ulafi**, **laea** and **taona**; and large barracudas, **ono**, **nunua** (*Sphyaena* spp.).

Table 8. Survey results of the 9 most important large finfish found on the reef and 3 large species that are considered to be increasingly rare or in need of management based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total x/19	Total Rare x/19
Ume	Bluespine unicornfish, unicornfishes	Naso unicornis, Naso spp.	13	8
Ulua	giant trevally, large trevallys	Caranx ignobilis, Caranx spp.	11	2
Ulafi	longnose parrotfish, other parrotfishes	Hipposcarus longiceps	11	2
Nanue	drummers, chubs	Khyphosus spp.	11	6
Gatala, Munua	Malabar grouper	Epinephelus malabaricus	8	5
Filoa, gutu'ula	Longface emperor	Lethrinus olivaceus	8	0
Fapuku/Feata/Palati	Brown marbled grouper	Epinephelus fuscoguttatus	7	3
Ono, nunua	Large barracudas	Sphyraena spp.	7	2
Aseu, ulua	Bluefin trevally	Caranx melampygus	7	1
Tagafa, Malatea	Humphead wrasse, Napoleon wrasse	Cheilinus undulatus	7	6
Taea	humpback snapper	Lutjanus gibbus	7	2
Laea,	Large bluish parrotfishes	Bolbometopon muricatum, Chlorurus and Scarus spp.	6	2
Taufauli	Black trevally	Caranx lugubris	4	1
Taotao, Pauea,	Small barracudas	Sphyraena spp.	4	1
Tonu gatala	Giant grouper/Queensland grouper	Epinephelus lanceolatus	3	0
Ava	milkfish	Chanos chanos	2	0
Kapalagi, ma	Large surgeonfishes	Acanthurus spp.	2	1
Kosotu, tativi	Whitemargin unicornfish	Naso annulatus	2	1
Pokapoka	Slender unicornfishes	Naso lopezi	2	1
Teu	Bigeye travelly	Caranx sexfasciatus	2	0
Utu	Green jobfish	Aprion virescens	2	0
Umu, humu	trigger fish (lg)	Balistoides and Pseudobalistes spp.	2	0
Tonu, tonu pula	large coral trout	Plectropomus spp.	2	0
Fagamea	Red seabass	Lutjanus bohar	1	0
Filu	Golden trevally	Gnathanodon speciosus	1	0
Galiolio	Crocodile longtom	Tylosurus crocodilus	1	0
Gutula	Yellowlip emperor	Lethrinus xanthochilus	1	0

7.1.3 Deepwater Fishes (Ika o e Moana)

Some 20 deep water fishes, including a range of commercially important pelagic and benthic, bottom dwelling species, were considered important by respondents, a significant number of which are overfished (Table 9). The most commonly reported included: 1) a range of tunas (Scomberidae), including yellowfin, bigeye, skipjack, mackerel and dogtooth tunas, known, respectively as **takua**, **kasi**, **atu**, **atualo** and **valu**, and wahoo, **paala**; 2) oilfish, **palu**, which is considered a delicacy and requires sophisticated fishing skills to catch; 3) billfishes, known generally as **sākula**, that include marlins, spearfishes and swordfishes, and the sailfish which is known **ūlau**; 4) rainbow runner, **kamai** and mahimahi, **masimasi**; 5) deepwater snappers and jobfishes, **palau malau**, **palu sega** and **palu savane** (*Etelis*, *Aphareus* and *Pristipomoides* spp.); and deepwater groupers or rockcods, **palu gatala** (*Epinephelus* spp.) (Table 3). Also listed in the category of larger deepwater fishes were sharks and dolphins which are discussed in separate categories

Those considered to be rare or increasingly rare or clearly declining in numbers and size are: 1) yellowfin and bigeye tunas, **takua** and **kasi**; 2) wahoo, **paala**; skipjack tuna, **atu**; 3) all billfishes, **sākula** and **ūlau**; 4) mahimahi, **masimasi**; 5) deepwater snappers and jobfishes, **palu malau**, **palu sega**, **palu savane**; and, 5) flying fishes **isave**. Although some respondents suggested climate change might be a driver of decline, overfishing seem to be the main cause, especially fishing by foreign longline vessels within Tuvalu's EEZ and the push over the past 20 years or more to exploit, sometimes for export, the deepwater snapper resources as a means of taking pressure off declining inshore fisheries stocks.

Table 9. Survey results of the 6 most important deepwater finfish found off the atoll and 2 species of deepwater finfish that are considered to be increasingly rare or in need of management based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total	Total Rare
Takua	yellowfin and big-eye tunas	<i>Thunnus albacares</i> , <i>T. obesus</i>	16	3
Paala	Wahoo, kingfish	<i>Acanthocybium solandri</i>	16	6
Atu	Skipjack tuna	<i>Katsuwonus pelamis</i>	15	6
Palu	Oilfish, castor cod	<i>Ruvettus pretiosus</i>	14	1
Sakula	Marlins, billfishes	<i>Istiompax indicus</i> , <i>Makaira</i> spp., <i>Kajikia audax</i> , <i>Tetrapturus angustirostris</i> , <i>Xiphias gladius</i>	11	3
Kasi	Yellowfin tuna (small)	<i>Thunnus albacares</i>	10	1
Kamai	Rainbow runner	<i>Elagatis bipinnulata</i>	9	1
Masimasi	mahimahi	<i>Coryphaena hippurus</i>	9	4
Palumalau	Deepwater snappers	<i>Etelis coruscans</i> , <i>E. spp.</i>	7	2
Ulau	Indo-Pacific sailfish	<i>Istiophorus platypterus</i>	7	4
Mago	Sharks (gen.)	<i>Carcharhinus</i> spp.	5	2
Atualo	Mackerel tuna	<i>Euthynnus affinis</i>	2	0
Valu/Kahikahifua	Dogtooth tuna	<i>Gymnosarda unicolor</i>	2	1
Palu sega	Deepwater jobfishes	<i>Aphareus</i> , <i>Pristipomoides</i> spp.	2	2
Palu gatala	Deepwater groupers	<i>Epinephelus</i> spp.	1	0
Palusavane	Obliquebanded snapper	<i>Pristipomoides zonatus</i>	1	0
Isave	flyingfishes	<i>Cypselurus</i> , <i>Cheilopogon</i> , <i>Exocoetus</i> spp.	1	6
Tafola	Bottlenose dolphin	<i>Tursiops aduncus</i>	1	3

7.2 Eels

The general name for eels is **pusi** or **puhi**, or in the case of eared eels, **tuna**, both Pan-Polynesian cognates. Although eaten, eels are not as highly regarded in Tuvalu as they are in Kiribati and Samoa, where eel is considered a delicacy and eel fishing, commonly using sophisticated systems of traps and baits, is a very secretive and respected art (Thaman *et al.* 2016). It is estimated that there are at least 13 eel species present in Tuvalu, as many as 7 of which are distinguished on Funafuti, although some names are somewhat confused. The best known eels include the more distinctive eels such as the peppered, whitemouth, giant, snowflake, darkspotted, undulated and yellow margin moray eels and the nocturnal black-edged conger eel. Those eels that are considered to be increasingly rare or threatened include the peppered, white-mouth, giant and snowflake moray eels and the nocturnal conger eels (Table 10).

Morays and other eels are top carnivores with few predators, and their presence could be good indicators species of the health of the marine environmental and food chains. They are mainly nocturnal remaining hidden in the reef during the day. Depending on the species, morays feed on a range of small fishes, cephalopods, crustaceans and molluscs. Their flat transparent leptocephalus larvae, which can number in the thousands, feed mainly on small marine detritus

known as “marine snow” and can remain in the plankton between three months to a year (Randall 2005; Mie Prefecture Fisheries Research Institute 2013;). These larvae along with the juvenile glass eel stage into which they metamorphose are probably important elements in food webs, of most healthy lagoons.

Table 10. Survey results of the 3 most important eels and 3 that are considered to be rare or increasingly rare based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAME	SCIENTIFIC NAMES	Total	Total Rare
pusi kena, puhi tea	peppered moray eel	Gymnothorax pictus	15	10
pusi uli	whitemouth moray eel	Gymnothorax meleagris	10	5
pusi ulaula, puhi gatala	giant moray eel	Gymnothorax javanicus	7	4
puleva	snowflake or starry moray	Echidna nebulosa	6	3
pusi uli, puhi	darkspotted moray	Gymnothorax fimbriatus	4	3
pusi pulepule	undulated moray	Gymnothorax undulatus	3	1
tuna	black-edged conger eel	Conger cinereus	2	1
pusi kula	yellowmargin moray eel	Gymnothorax flavimarginatus	2	1
pusi moana	deepwater conger eel	Conger macrocephalus	1	0

7.3 Sharks

Sharks, which are known generally as **magō** in Tuvalu, include a range of nearshore reef sharks, offshore or pelagic species and some deepwater species, about 20 of which have been reported from Tuvalu (Thaman et al. 2016). Of these 13 were mentioned by respondents, although some sharks are known by different names in different atolls and sharks were not well-known to all informants. The most well-known sharks include the hammerhead (**magō samala**), whitetip reef shark (**malu**), tawny nurse shark (**moemoeao**), blacktip reef shark (**kili**), silvertip shark (**alavafenua**), tiger shark (**lokea** or **uniuni?**), sicklefin lemon shark (**alava**) and grey reef shark (**magō** or **lālāila?**), although some of these identifications have to be verified (Table 11). Only four sharks, whitetip, blacktip and grey reef sharks and sicklefin lemon shark, the four most common nearshore reef sharks, were surveyed by Alofa Tuvalu (Job et al 2012).

Most of the sharks were identified as being in need of some degree of protection, both by Job et al. (2012) and the informants. Those sharks considered most threatened were the hammerhead shark, blacktip, whitetip and grey reef sharks (**kili**, **malu** and **magō** or **lālāila**), tawny nurse shark (**moemoeao**) and the sicklefin lemon shark (**alava**), mostly due to overfishing, much of which is attributed to longline vessels fishing in Tuvalu waters, although hammerheads appear to be naturally rare. The very low abundance of reef sharks is of concern from an environmental perspective, indicating either serious direct overfishing or overfishing of their prey species.

Table 11. Survey results of the 6 most important sharks and 3 sharks that are considered to be rare or increasingly rare based on questionnaire surveys of 169 male and female informant groups on Funafuti Atoll, Tuvalu conducted on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total	Total Rare
Mago Samala, mago fuasu, mago faitaliga	Scalloped hammerhead shark	Sphyrna lewini	13	12
Malu	Whitetip reef shark	Triaenodon obesus	10	5
Moemoeao	Tawny nurse shark	Nebrius ferrugineus	10	4
Kili	Blacktip reef shark	Carcharhinus melanopterus	11	6
Alavafenua, tapapa?	silvertip shark	Carcharhinus albimarginatus	8	2

Lokea, uniuni?	Tiger shark	Galeocedo cuvier	8	3
Alava	sicklefin lemon shark	Negaprion acutidens	7	5
Mago, lālāila?	Grey reef shark	Carcharhinus amblyrhynchos	7	3
Palu mago	Smalltooth thresher shark, deep water sharks	Alopias pelagicus, Heptranchias perlo	3	1
Tanifa, mago tafolā	Sea monster/whale shark?	Rhincodon typus	2	0
Mago Fakaulu	Sandbar shark	Carcharhinus plumbeus	1	1
Mago Fisi	?	?	1	0
Mago Vikiviki	?	?	1	0

7.4 Rays

Previous studies (Job *et al.* 2013; Thaman *et al.* 2014) indicate that as many as five rays have been reported from Tuvalu, the general name for rays being **fai**, the Proto-Polynesian name. Those most commonly reported during the current survey include the manta ray (**fai fālua** or **fai pulou**), spotted eagle ray (**fai manu**); Tahitian stingray (**fai**) (which might be known by some of the other names reported during the survey, such as **faifota** or **fai kula**) and the rare porcupine ray (**fai kili**); and a deepwater ray, probably the pelagic stingray (*Pteroplatytrygon violacea*) known as **palu fai** (Table 12). The results are hard to interpret due to a confusion of names, possibly because many sting rays are now uncommon and most people do not know their names. Only the eagle ray and the manta ray were reported during the Alofa Tuvalu study (Job *et al.* 2012). Most rays seem to be considered rare, reportedly due to overfishing or lack of shellfish and crustacean resources.

Table 12. Survey results of the 3 most important rays (fai) and 2 rays that are considered to be rare or increasingly rare based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total	Total threatened
Faifalua/Faipulou	Manta ray	Manta birostris	19	15
Faimanu	Spotted eagle ray	Aetobatus narinari	9	8
Faikili	Porcupine ray	Urogymnus asperrimus	9	4
Fai, fai fota, fai kula?	Tahitian stingray	Himantura fai	5	2
Palu fai	Pelagic stingray	Pteroplatytrygon violacea	3	2
Faiuli	?	?	1	0
Faikena	?	?	1	0

7.5 Dolphins and Whales (Tafolā)

There are reportedly up to as many as ten dolphins or whales (cetaceans), both known as **tafolā**, that have been recorded as present within Tuvalu's waters, although little is written on them (Miller 2009). The current survey indicated that at least two dolphins, **tafolā** and **tafolā masani**, possibly spinner dolphin and Indo-Pacific bottlenose dolphin, may be the dolphins most commonly seen in nearshore waters (Table 13), although it was difficult to know exactly what species they referred to. The 2003 marine species workshop indicated that there were also the names **punua** or **punualika** and **pungapunga** (Nanumaga), which could refer to dolphins, and **tafolā pulepule**, which might refer to the whale shark or another spotted or striped species. Records also exist of sightings of other cetacean species and there is a report of a dead sperm whale being found on one of the atolls (Miller 2009). Dolphins are culturally important in Tuvalu and Tuvaluan legends and have been featured in two issues of Tuvalu stamps in 1998 and 2013 and on a coin in 2013. All species are considered to be increasingly rare and in need of protection both within and outside of the lagoons, with the main threat to dolphins in Tuvalu waters probably

being longline fishing vessels.

Table 13. Survey results of the 3 most important dolphins or whales or (**tafolā**) and 2 that are considered to be rare or increasingly rare based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total x/19	Total Rare
Tafolā	Spinner Dolphin	Stenella longirostris	11	10
Tafolā masani	Indo-Pacific Bottlenose Dolphin	Tursiops aduncus	11	6
Tafolā Moana	Pantropical spotted dolphin	Stenella attenuata?	6	3
Tafolā Fagu	Sperm whale	Physeter microcephalus?	5	4
Tafolā?	?	?	3	0

7.6 Turtles (Vaega Vonu)

Although four turtle species have been reported present in Tuvalu waters (Job et al 2013), only two could be verified as present during the survey (Table 14), something confirmed by Alefaio et al. (2009). These included the green turtle, maybe **fonu masani** (*common turtle*) and the hawksbill turtle, **fonu una**, both of which are reportedly threatened. As stressed by Alefaio et al., the green turtle is highly threatened in Tuvalu because of its status as a chiefly delicacy, which is often harvested by poachers. The other two turtles and names that may apply to them were reported during a 2003 Workshop on traditional knowledge of marine species.

Table 14. Survey results of the 3 most important turtles (**fonu**) and 2 that are considered to be rare or increasingly rare based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total x/19	Total Rare
Fonu masani	Green turtle	Chelonia mydas	16	5
Fonu una	Hawksbill turtle	Eretmochelys imbricata	15	10
Fonu taka	Loggerhead turtle?	Caretta caretta	*	
Foun solo?	Leatherback turtle	Dermochelys coriacea	*	

7.7 Shellfish (Vaega Fingota)

About 20 small and 10 large named species or groups or families of similar species of shellfishes (**vaega fingota**) were named by respondents (Tables 15 and 16), with many groups or families, such as the cone shells, **fakamili** (Conidae), cowries, **pule** (Cypraeidae) and mitres and auger shells, **muliuga** (Mitridae and Terebidae) having 20 or more species. Some such as giant clams (**vasua**) and cone shells (**fakamili**) are also cross-listed in both categories because there are species that are considered in both size classes. Some crabs and lobsters were also listed under the category of **fingota**, but have been transferred to crustaceans which are discussed below. Many of these shellfish are important food and/or handicraft species, a large number of which are reportedly rare on in short supply, a finding supported by Job et al. (2012).

Sauni et al (2008)'s surveys in 2004–5b showed that the most commonly harvested shellfish by weight were the small cowries, **pule kena** (*Cypraea annulus* and *C. moneta*)¹, with other

¹ The genus name *Cypraea* has been retained for cowries or ease of comparison with previous published results, despite the fact that the genera of most cowries has been revised as reported in the World Register of Marine Species (WORMS). For example, the common ring and money cowries (*Cypraea annulus* and *C. moneta*) are now known by the accepted names *Monetaria annulus* and *M. moneta*, with the previous names remaining as synonyms.

commonly harvested species, depending on the atoll, including snakeshead cowrie, **pule uli** (*C. caputserpentis*), giant clams, **fasua** (*Tridacna* spp.), giant spider conch, **kalea** (*Lambis truncata*), Mauritius cowrie, **pule uli lasi** (*C. mauritiana*), turban snails, **alili** (*Turbo setosus*), asaphis clams, **kasi** (*Asaphis violascens*), and to a lesser extent, rock shells and vase shells, **kivikivi** (*Thais* and *Vasum* spp.) and ark shells, **kohi** or **koki** (*Anadara* or *Barbatia* spp.?).

Shellfish most commonly reported to be rare or in short supply, due mainly to over-exploitation, include the smaller shellfish: 1) asaphis and tellin clams, **kasi** or **kahi** (*Asaphis* and *Tellina* spp.); 2) bloodmouth conch, **panea** (*Strombus luahanus*); 3) turban snails **alili** (*Turbo* spp.); 4) surf clams, **lii** or **asule** (*Actotodea striata*); 5) thorny oysters and jewelbox shells, **sōpu** and **sōpu nifo** (*Chama* and *Spondylus* spp.); 6) nerite snails, **sipō**, (*Nerita* spp.); 7) worm snails, **tio** or **ugakoa**, (*Dendropoma maximum*); and cowries, **pule** (*Cypraea* spp.)(Table 10); and among larger shells: 8) the giant spider conch **kalea** (*Lambis truncata*); 9) large giant clams **fasua nao** and **fasua taka** (*Tridacna* spp.); 10) triton trumpet and helmet shells, **pū** (*Charonia tritonis* and *Cassis cornuta*); 11) blacklip pearl oyster, **tifa** (*Pinctada margaritifera*); 12) trochus and top shells, **mulikao** (*Trochus niloticus*, *Trochus* spp. and *Tectis pyramis*); and 13) some cones shells, **fakamili** (*Conus* spp.) (Tables 15 and 16). These shells are particularly overexploited on Funafuti due to fishing pressure and well as pollution and habitat degradation. Species known to be present and rare but not mentioned by name include the endive murex (*Chicoreus chichoreum*), which is known as **matakivikivi**. The overexploitation and increasing rareness of these shells is supported by Job *et al.* (2013) who said only two species, *Turbo petholatus* and *T. setosus*, were recorded during their surveys and both were rare.

Table 15. Survey results of the 9 most important small sea shells/shellfish (**figota foliki**) and 3 small shellfish that are considered rare or increasingly rare based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total x/19	Total Rare
kasi, kahi	pacific asaphis, tellin clams	<i>Asaphis violascens</i> , <i>Tellina</i> spp.	15	12
panea	bloodmouth conch	<i>Strombus luahanus</i>	14	7
lii , asule, ahule	striate beach clam	<i>Atactodea striata</i>	14	6
alili, pō hina, tupu	turban snails	<i>Turbo</i> spp.	13	6
soopu	thorny oyster, jewel box shell	<i>Spondylus</i> , <i>Chama</i> sp.	11	3
sipoo, sipō	nerite snails	<i>Nerita</i> spp.	10	2
kivikivi, nimakaka (lg.)	rock shells and vase shells	<i>Thais</i> and <i>Vasum</i> spp.	10	2
tio, ugakoa	great worm snail	<i>Dendropoma maximum</i>	9	4
pule	cowries	<i>Cypraea</i> spp.	6	3
fasua foliki	giant clams (sm)	<i>Tridacna maxima</i>	3	0
fakamili, mili	cone shells	<i>Conus</i> spp.	3	1
muliuga	Mitre, auger and planaxis shells	<i>Mitra</i> , <i>Terebra</i> and <i>Planaxis</i> spp.	3	1
sokomani	?	?	3	0
matapoto	vase shell (lg.)	<i>Vasum turbinellus</i>	1	0
mili	leopard cone	<i>Conus leopardus</i>	1	0
kohi, koki	ark shells	<i>Barbatia</i> sp.	1	0
tugage	ark clam	<i>Anadara</i> sp.	1	1

Table 16. Survey results of the 9 most important large sea shells/shellfish and 3 that large shellfish that are considered to be rare or increasingly rare based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total x/19	Total Rare
Kalea	Seba spider conch	<i>Lambis truncata</i>	16	13
Fasua Nao	Giant clam	<i>Tridacna spp. (large)</i>	15	12
Pu	Triton snail, helmet shell,	<i>Charonia tritonis, Cassis cornuta</i>	11	8
Fasua Taka	Giant clam	<i>Tridacna spp. (large)</i>	10	8
Tifa	Blacklip pearl oyster	<i>Pinctada margaritifera</i>	11	6
Mulikao	Trochus and top shells.	<i>Trochus spp., Tectis pyramis</i>	7	3
Fakamili, Mili	Leopard cone	<i>Conus leopardus</i>	2	0
Muliuga	Mitre and Auger shells	<i>Mitra and Terebra spp.</i>	2	2
Sipo	Polished nerite	<i>Nerita polita</i>	1	0
Tumio	?	?	1	0
Hopunifo	Thorny oyster	<i>Spondylus</i>	1	1

7.8 Octopus and Squids (Feke and Gukeke)

The results for octopus and squids show that the most well-known species are the common day octopus (**feke** or **feke papa?**) and bigfin reef squid (**gufeke**), the both of which are considered to be increasingly rare and overexploited (Table 17), a fact supported by the 2010 surveys on Nanumea, Nukulaelae and Funafuti that recorded only one octopus in Nanumea Lagoon (Job *et al.* 2013). It is unclear whether the other names provided refer to different size classes, color forms or habitats in which some octopus are found. Interestingly, neither Job *et al.* (2009, 2013) nor Sauni *et al.* (2008) mentioned squid at all. Importantly, octopus may be one of the best indicators that could be used to assess the effectiveness of marine conservation, given experiences in marine conservation elsewhere where the establishment of even short-term MPAs can bring about rather dramatic rapid returns in octopus populations and possibly squid populations as well.

Table 17. Survey results of the 3 most important octopus or squids (feke and gufeku) and 2 that are considered rare or threatened based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total x/19	Total Rare
gufeku	bigfin reef squid	<i>Sepioteuthis lessoniana</i>	14	12
feke, feke papa, feke masani	common day octopus	<i>Octopus cyanea</i>	13	12
feke moana	?	?	7	4
feke uli	?	?	2	1
feke talava	?	?	1	1
feke kula	?	?	1	0
feke po	?	?	1	1

7.9 Crabs (Paka)

Some 20 crabs were known to the informants, most of which are eaten or used as bait, although the nomenclature is somewhat confusing and some names have not been identified as to the exact species (Table 18). Also, because the question asked about types of **paka**, the general name for regular crabs, the responses in relation to the importance and conservation status of

the coconut crab, **uu** and hermit crabs, **uga**, have not been adequately addressed. The crabs that seem to be increasingly rare are the ghost crab, **kaviki**; the land crabs, **paieka** and **tupa**; and some reef crabs, **matamea**, **paka** and **paka pulepule**, all reportedly due to overfishing or climate change (Table 18).

Job et al. (2009) reported as many as 41 species of crabs, but provided no local names, and many were small reef crabs that probably have no known names or uses; and Sauni et al. (2008) only reported on coconut crabs and a mangrove crab, probably **tupa** (*Cardisoma carniflex*), which are common on Niutao, was reportedly present in the mangroves of Fogafale Islet, Funafuti in the past and recently seen and identified in 2015 one of the recently reclaimed borrow pits on North Fogafale Islet.

Table 18. Survey results of the 6 most important crabs (**paka**) and 2 crabs that are considered to be rare or increasingly rare based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total x/19	Total Rare
matamea	smooth red-eyed crab	<i>Eriphia sebana</i>	17	2
kamakama	shore or rock crab	<i>Grapsus albolineatus</i>	13	0
kaviki	ghost crab	<i>Ocypode cerophthalma</i>	10	4
paka	convex reef crab	<i>Carpilius convexus</i>	10	2
kalemisa	yellow land crab	?	5	1
pakapulepule	spotted reef crab	<i>Carpilius maculatus</i>	5	2
kaiepa, paieka	mouthless land crab	<i>Cardisoma crassum</i>	5	3
pakakena	grapsid land crab?	<i>Geograpsus crinipes</i>	4	1
pakauli	?	?	4	0
vaeuli	dark-finger coral crab	?	4	0
tupa	brown land crab	<i>Cardisoma carnifex</i>	4	1
pakamoana	?	?	3	0
uu, ū	coconut crab	<i>Birgus latro</i>	2	1
pakakula		?	2	1
ii	?	?	2	1
pakafulufulua	?	?	2	0
pakakaimatau	?	?	1	0
Uga	Hermit crabs	<i>Coenobita</i> and <i>Dardanus</i> spp.	1	0

7.10 Lobsters and Shrimps (ula)

There are about 10 recognised species of lobsters (**ula**), slipper lobsters (**tapatapa**), mantis shrimps (**valo**), prawns or other shrimp-like animals, although the exact names of individual species still need to be confirmed or may not exist (Table 19). Job et al. (2009) reported in her literature survey that as many as 24 species of shrimp and four lobster species had been reported present in Tuvalu, the lobsters being *Panulirus ornatus*, *P. penicillatus* and *P. versicolor*, but doesn't mention slipper lobsters (*Parribacus* spp., **tapatapa** in this report), but reports that one **tapatapa** was found in Nanumea Lagoon during their 2011 survey; whereas Sauni et al. 2008 reported only one lobster species, *Panulirus penicillatus* from their surveys. Those that have been identified as increasingly rare are the slipper lobsters, **tapatapa** (*Parabacus* spp.) and spiny lobsters, **ula** (*Panulirus* spp.), a finding supported by surveys by Job et al. (2012) and Sauni et al. (2008) during which no *Panulirus* or *Parribacus* lobsters were recorded on reef-benthos survey stations or during night searches for nocturnal sea cucumber species. Sauni et al (2008)

report that the sculptured slipper lobsters (*Parribacus antarcticus*), known there as **tuatuaula**, were harvested in significant numbers.

Table 19. Survey results of the 6 most important lobsters or shrimps (**ula**) and 2 lobsters or shrimp that are considered to be rare or increasingly rare based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total	Total
Tapatapa, tuatuaula	slipper lobsters	<i>Parribacus</i> spp.	13	11
Ula Masani	spiny lobsters	<i>Panulirus</i> spp.	8	7
Ulakula	?	?	5	4
Ula Namu	?	?	4	0
Ulamio	?	?	3	2
Ula Green	?	?	3	3
valo	Common banded mantis shrimp	<i>Lysiosquilla maculata</i>	4	1
Uluvai	?	?	1	1
Pronghorn Spiny lobster	?	?	1	1
Painted spiny lobster	?	?	1	0
Tuaula	?	?	1	0
Prawns	?	?	1	1

7.11 Sea Cucumber or Bêche-de mer (Funafuna and Loli)

Some 20 different named species of sea cucumber or bêche-de mer (**funafuna** or **loli**) were known to the informants, although there is a need to confirm the correct names for different species, some of which probably referred to the same species and some of which have been adopted from the names given to them by commercial bêche-de-mer traders (Table 20). Job *et al* 2009 listed 15 species from their literature survey, most of which were assessed in Sauni *et al.* (2009)'s study. **Loli** seems to be the name used for the smaller black or other-colored species, such as the loli fish (*Holothuria atra*) and the edible sea cucumber (*H. edulis*), whereas **funafuna** seems to apply to most of the other bigger, thicker high-value species that are targeted for export, such as white teatfish (*Holothuria fuscogilva*) and black teatfishes (*H. nobilis* and *H. whitmaei*), both of which are listed as endangered on the IUCN Red List. The named species that are considered to be most endangered include a range of **funafuna** and **loli**, due mainly to overharvesting, with surveys in 2010 Job *et al.* 2010 survey (2013) finding few sea cucumbers apart from common loli (*Holothuria atra*).

Table 20. Survey results of the 6 most important bêche-de-mer or sea cucumbers, **funafuna** and **loli** and 3 that are considered to be rare or increasingly rare based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total	Total
Loli	bêche-de mer	<i>Holothuria</i> spp.	14	6
Funafuna Faimatau	?	?	11	9
Funafuna Kena	?	?	8	2
Funafuna Fatu	?	?	6	2
Funafuna Kula	?	?	5	2
Funafuna One	?	?	4	0
Funafuna Uli	Black teatfish	<i>Holothuria nobilis</i>	4	3
Brown Sand Fish	?	?	3	1

Funafuna Talatala	?	?	3	0
Funafuna	?	?	3	3
Funafuna Pulepule	Leopardfish?	<i>Bohadschia argus</i>	2	0
Loli Pukupuku	?	?	2	1
Funafuna Patapata	?	?	1	0
Funafuna Piki	?	?	1	1
Hairly Black Fish	?	?	1	1
Funafuna Malulu	?	?	1	0
Loli Loaloa	White threadfish?	<i>Holothuria leucospilota</i>	1	0
Funafuna Elefane	?	?	1	0
Funafuna Kai	?	?	1	1

7.12 Sea urchins and starfishes (Vana, magamagātai, etc.)

Over ten names were given for sea urchins (**vana**) or starfishes (**magamagātai**), most of which refer to sea urchins, some of which may refer to the same species (Table 21). Job *et al.* (2009) report some eight species of sea urchin as being present, of which **vana uli** may apply to the blue-black sea urchin (*Echinothrix mathei*), which is edible, and **vana pukupuku** to the smaller burrowing urchin, which is the most common urchin on most atolls (Sauni *et al.* 2008). Sea urchins provide important ecosystem services as prey of many fishfish, such as triggerfishes (**humu, umu**), emperors (**filoa, gutula**) and some wrasses (**tagafa**) (Randlall 2005); in controlling algae; and as bioeroders in producing sand and are normally more abundant outside MPAs where fish predator numbers are lower (Tyrrell 2014).

Table 21. Survey results of the 3 most important types of sea urchins (**vana**) or starfishes (**magamagātai**) and the 2 that are considered rare or increasingly rare based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total	Total
Vana uli	blue-black urchin	<i>Echinothrix diadema</i>	16	11
Vana pukupuku	burrowing urchin	<i>Echinometra mathaei?</i>	6	2
Vana Se makaikai	?	?	4	0
Vana Kula	?	?	4	3
Vana	?	?	3	3
Vana Brown	?	?	2	2
Vana kena	?	?	1	1
Magamagātai	starfish	<i>Linkia</i> spp.	1	0
Vana Violet	?	?	1	1
Vana Felia	?	?	1	1
Vanamakaikai	?	?	1	1
Tuituivana	?	?	0	1
Vanaloa	?	?	0	1

7.13 Seaworms (Anufe o te Tai)

A number of seaworms are known to the informants, the most well-known of which is the famous **ponuponu** of Nanumea, which is used to perfume coconut oil (**sinu ponuponu**), which Passfield (1998) had identified as an acorn worm from class Enteroneusta; and **kalemutu** and **ipo** which could both be peanut worms and are reportedly eaten. The former two are considered to be

rare or in short supply (Table 22). There is also a **molokau**, the same name that is given to the centipede, which could be the palolo worm (*Eunice viridis*) which was reported present in Tuvalu in the past (Job. et al. 2009).

Table 22. Survey results of the 3 most important types of sea worms (**anufe o te tai**) and 2 that are considered rare or increasingly rare based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total	Total
Kalemutu	peanutworm	<i>Siphonosoma australe?</i>	16	10
Ponuponu	acornworm	Class Enteropneusta	12	11
Ipo	peanut worm	<i>Sipunculus cf nudus</i>	6	3
Molokau	Palolo worm?	<i>Eunice viridis?</i>	3	2
Fulutaveli	?	?	3	2
Tiapolo	?	?	2	0
Sutelia	?	?	2	0
Potii	?	?	1	0

7.14 Corals (Kamu)

Informants had over 20 different names for corals, many of which were adapted from the English common names, e.g. "kamu mushroom", with there being no known previous study that puts Tuvaluan names to individual species or that links any specific names with coral species that are considered to be particularly threatened (Table 23). Job *et al.*'s 2010 survey showed that the mean hard coral cover was low in all 3 atolls studied (15%, 11% and 6%, respectively, in Funafuti, Nanumea and Nukulaelae) with the higher coral cover in Funafuti probably due to better water flow through the large reef passes (**ava**) and greater habitat diversity. It was found, however, that the coral cover in Funafuti was highly variable, ranging from 0.1% to 58%, with a mean cover of 15% across all sites. They suggested that coral cover appears to have declined since 2004, when average cover was estimated at between 20 and 30% (Lovell *et al.*, 2004). They found that coral cover was not significantly different inside and outside the FCA, but tended to be slightly higher outside the FCA, with mean values of 11% and 19% respectively inside and outside the FCA. The highest coral cover estimates were recorded on reef slopes off the reef islets of Tepuka (58%), Fualefeke (35%) and Fuafatu (34%). The dominant hard coral growth form was *Acropora* staghorn branching corals, along with some plate-forming corals and massive corals (Job *et al.* 2012).

Table 23. Survey results of the 3 most important types of hard and soft corals (**kamu**) and 2 that are considered rare or increasingly rare based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total	Total
kamu malu	soft coral	?	8	3
kamu makaikai	hard coral	?	7	5
kamu pukupuku	?	?	7	3
kamu fatu	?	?	6	4
kamu laulakau	?	?	5	1
kamu molemole	?	?	4	1
kamu pakeke	?	?	4	4
kamu kena	?	?	3	1
kamu taipola	?	?	2	0
kamu lanulannu	?	?	2	0

kamu sama	?	?	2	1
kamu papa	?	?	2	0
kamu mushroom	?	?	2	0
lapalapa	?	?	1	1
kamu brown	?	?	1	1
kamu blue	?	?	1	0
kamu kula	?	?	1	1
kamu naatoka	?	?	1	1
kamu uli	?	?	1	0
kamu laulu	?	?	1	0
kamu fale	?	?	1	1
kamu omomi	?	?	1	0
kamu poolo	?	?	1	0
kamu laulu	?	?	1	1
kamu fatifati	?	?	1	1

7.15 Jellyfishes

A number of jellyfishes were known but there is a need to find what scientific names correspond to which Tuvaluan name before the data can be analysed (Table 24).

Table 24. Survey results of the 3 most important types of jellyfishes (**kapikapi**) and 2 that are considered rare or increasingly rare based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total	Total
faiamalu	?	?	7	5
kapikapi sega	?	?	6	3
kapikapi kena	?	?	6	4
kapikapi blue	?	?	6	4
kapikapi fai kavei	?	?	5	2
kapikapi kilaasi	?	?	5	2
tesema	?	?	5	5
kapikapi poisini	?	?	4	2
kapikapi purple	?	?	3	3
pakipaki	Portuguese man-of-war	<i>Physalis physalis</i>	1	1
kapikapi pukupuku	?	?	1	0
sipa	?	?	1	0
kapikapi molemole	?	?	1	0
kapikapi faifakamalu	?	?	1	0
kalikali	?	?	1	0

7.16 Seaweeds or Macroalgae (Vaega Limu)

Some 20 names were given for seaweeds or marine algae, the common name for which is **limu** (Table 25). None of these indicate what species the Tuvaluan names refer to, although **limu pukupuku** may refer to seagrapes (*Caulerpa racemosa*), the most widely known and eaten seaweed in western Polynesia. Job *et al.* (2009) reported that a total of 59 species of algae

were recorded in the literature, with green algae (Chlorophyta) being the most diverse group, accounting for 46% of the total number of species, and *Halimeda* species (calcareous species that are responsible for a high percentage of sand and marine sediments) being the most speciose genus with 7 different species. Red algae (Rhodophyta), which also includes a number of coralline or calcareous specie, accounted for 30% of the total number of species; and brown and blue-green algae (respectively Fucophyceae and Cyanobacteria) accounted for 10% and 14% of the total assemblage.

Further analysis will be required to determine the perceived cultural and ecological value of seaweeds and which ones might best serve as positive or negative indicator species of the conservation status and health of nearshore marine areas. This is because seaweeds or macroalgae are important habitat and food sources for a wide range of fishes and other organisms and provide important keystone ecosystem services, such as the role coralline red algae plays in cementing together and reinforcing reefs and, along with calcareous algae, being major contributors to the marine sand and sediment budget, so critical to the health of atoll lagoons and beaches which are on the front line of defense against climate change and extreme weather and sea-state events, such as king tides and storm surge. On the other hand invasive algae, such as the brown algae *Sargassum polycystum*, caused massive algal blooms that competed with corals in the lagoon off the main settlement of Fogafale Islet in 2013 (De Ramon N'Yeurt and Iese 2015).

Table 25. Survey results of the 3 most important types of seaweeds (**limu**) that are known or eaten and what are 2 that are considered rare or increasingly rare based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total	Total
Limu Pukupuku	Sea grapes	<i>Caulerpa racemosa</i>	11	9
Limu	?	?	6	4
Limu Lanulauniu	?	?	6	4
Limu uli	?	?	4	1
Limu Kena	?	?	3	0
Limu loaloa	?	?	3	1
Limu kai	?	?	2	2
Limu Brown	?	?	2	2
Limu Papa	?	?	2	2
Limu Kula	?	?	2	1
Limu Makeke	?	?	1	1
sargasum	?	<i>Sargassum polycystum</i>	1	0
Limu Taka	?	?	1	1
Taliga o Aitu	?	?	1	1

7.17 Fish and other Organisms that Control Algae and Seaweed

Table 26 lists organisms that respondents said played important roles in controlling algae and cyanobacteria (formerly known as blue-green algae) in the marine environment, many of which are well-known for consuming algae and seaweeds. These include green turtles (**fonu**), sea cucumbers (**funafuna, loli**), rabbitfishes (**maiava**), surgeonfishes (**manini lakai, manini**)

parrotfishes (**ulfai, laea**), unicornfishes (**ume, pokapoka**), drummers or chubs (**nanue**), mullets (**kinase, kafakafa**) and damselfishes (**moimoi**). Those believed to be most threatened include green turtles, sea cucumbers, drummers and unicornfishes.

Table 26. Survey results of the 6 most important fish and other marine organisms that control algae and seaweeds (**limu**) and 2 that are considered rare or increasingly rare based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total	Total
Fonu	green turtle	<i>Chelonia mydas</i>	7	4
Maiava	rabbitfishes	<i>Siganus argenteus</i>	6	1
Manini lakau	orangespine unicornfish	<i>Naso literatus</i>	6	1
Ulafi	parrotfishes	<i>Scaridae</i>	6	1
Aseu	trevally	<i>Caranx spp</i>	5	1
Funafuna	sea cucumbers	<i>Holothuroidea</i>	5	4
Ume	unicornfishes	<i>Naso spp.</i>	5	2
Loli	sea cucumbers	<i>Holothuroidea</i>	4	2
Nanue	drummers, chubs	<i>Khyphosus spp.</i>	4	4
Ali	flounders	<i>Bothus spp.</i>	3	1
Laea	parrotfishes	<i>Scaridae</i>	3	1
Sumu	triggerfishes (sm)	<i>Balistapus undulatus, Rhinecanthus spp.</i>	3	1
Feke	octopus	<i>Octopus cyanea</i>	2	1
Gatala	rockcods, groupers (sm)	<i>Epinephelus merra and E. spp.</i>	2	0
Hafole	fiveband flagtail	<i>Kulia mugil</i>	2	1
Kanase	fringelip mull	<i>Mugilidae</i>	2	1
Manini	convict surgeonfish	<i>Acanthurus triostegus</i>	2	1
Moimoi	dsmselfishes	<i>Pomicentridae</i>	2	0
Pokapoka	unicornfishes	<i>Naso spp.</i>	2	0
Savane	snappers	<i>Lutjanus spp.</i>	2	2
Kafakafa	diamond-scale mullet	<i>Liza vaigiensis</i>	1	1
Kalo	small goatfish	<i>Mulloidichthys spp.</i>	1	0
Kapalagi	surgeonfishes	<i>Acanthurus spp.</i>	1	1
Kapikapi	jellyfish	<i>Scyphozoa</i>	1	0
Kosotuu	unicornfishes	<i>Naso spp.</i>	1	0
Lape	wrasses	<i>Labridae</i>	1	0
Taea	humpback snapper	<i>Lutjanus gibbus</i>	1	1
Tanutanu	emperors (sm)	<i>Lethrinus harak and L. obsoletus</i>	1	0
Tiftifi	butterflyfishes	<i>Chaetodon spp.</i>	1	0
Umalei	surgeonfish	<i>Acanthurus literatus</i>	1	0
Umu	trigger fish (lg)	<i>Balistidae</i>	1	1
Ponelolo	striped surgeonfish	<i>Acanthurus lineatus</i>	1	0
Pule	cowries	<i>Cypraea spp.</i>	1	0

7.18 Fishing Bait (Poa)

Fishing bait (**poa**) is particularly important in Tuvalu; and those that were considered the best baits included hermit crabs (**uga**), skipjack tuna (**atu**), a number of shore or land crabs (**kaviki, kamakama, kaiepa**), octopus and squid (**feke, gufeke**), flying fishes (**isave**), earthworms or polychaete worms (**kalemutu**), and small fishes including lizardfishes (**manoko**), big-eye scad

(**salala**) and small goatfishes (**kalo, kaivete**). Those that are considered to be overharvested and increasingly rare and in need of some form of protection are hermit crabs, shore or land crabs and squid and octopus (Table 27).

Table 27. Survey results of the 6 most important types of fishing bait (**poa**) that were mentioned by at least 2 respondents, and 2 that are considered rare or increasingly rare based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total x/19	Total Rare
Uga	hermit crabs	<i>Coenobita and Dardanus spp.</i>	14	10
Atu	skipjack tuna	<i>Katsuwonus pelamis</i>	13	2
Kaviki	ghost crabs	<i>Ocypode spp.</i>	11	5
Feke	octopus	<i>Octopus cyanea</i>	5	2
Kamakama	rock crabs	<i>Grapsus albolineatus</i>	5	3
Fulu	chicken feathers	<i>Gallus</i>	4	1
Gufeke, mufeke	squid	<i>Sepioteuthis lessoniana</i>	4	2
Kaipea	land crab	<i>Cardisoma crassum</i>	4	1
Salala	big-eye scad	<i>Selar crumenophthalmus</i>	4	0
Isave	flyingfishes	<i>Cheilopogon, Cypselurus and Exocoetus spp.</i>	3	0
Kalemutu	polychaete worms, earth-worms?	<i>Polychaeta and Oligochaeta</i>	3	0
Manoko	lizardfishes	<i>Synodus, Saurida spp.</i>	3	1
Falaoa	flour	?	2	0
Kaivete, kalo	small goatfishes	<i>Mulloidichthys spp.</i>	2	1
Kasi, kahi	Asaphis and tellin clams	<i>Asahis violascens, Tellina spp</i>	2	0
Tavatava	Doublelined mackerel	<i>Grammatorcynus bilineatus</i>	2	0

7.18 Shells Used in Shell Jewelry and Shell Craft (Tui Misa)

Shell craft, mostly in the form of making shell necklaces (**tui misa** or **tui pule**) is an important source of household income and gifts for departing or arriving family, guests, important people or families. Some 30 different named species used in shellcraft were mentioned, although some of these often refer to the same species on different atolls and, pending correct identification are not included here (Table 28). Shells most commonly used are melampis land snails, **misa** (*Melampis* spp.), which are found in shady wooded shores and limestone areas, and a wide range of cowries, some of which, such as the snakeshead, money and ring cowries, are overexploited and rare on Funafuti, but still quite common on outer islands, such as Vaitupu, where shell crafts

people often return temporarily to collect shells such as *Cypraea mauritiana*, *C. arabica*, *C. tigris*, *C. depressa*, *C. mapa*, *C. carneola*, *C. vitellus*, *C. lynx* (Pelosi 2016 pers. com.). **Misa pulepule** was also mentioned on the preliminary BIORAP of Funafuti.

Table 28. Survey results of the 9 most important types of shells used for making shell necklaces (**tui misa, tui pule**), jewelry, body ornamentation and shellcraft that were mentioned by at least 2 respondents; and 3 shells that are considered rare or increasingly rare based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total	Total
Misa uli	banded melampus	<i>Melampus faciatus</i>	15	4
Misa kena	Yellow Melampus	<i>Melampus luteus</i>	14	6
Pule uli	snakeshead cowrie	<i>Cypraea caputserpentis</i>	13	10
Pule kena	Ring cowry, rmoney cowrie	<i>Cypraea annulus</i> , <i>C. moneta</i> ,	13	11
Muli uga	sulcate planaxis	<i>Planax sulcatus</i>	7	1
Pule Sega	money cowrie (yellow)	<i>Cypraea moneta</i>	6	1
Pule fututu	cowrie	?	4	2
Misa sega	yellow melampus	?	4	1
Misa Seleseleuli	Melampis	?	4	0
Pule	cowrie	<i>Cypraea spp.</i>	3	1
Pule Lasi, pule uli lasi	humpback cowrie	<i>Cypraea mauritiana</i>	3	1
Pule Tagata	cowrie	?	2	1
Sipoo	Plicate nerite	<i>Nerita plicata</i>	2	0
Pule Fafine	cowrie	?	2	0
Pulepule	Cowrie?	?	2	0
Puleloaloa	cowrie	?	2	0
Lili	striped engina	<i>Engina mendicaria</i>	2	0
Pule Taaaulo	cowrie		2	1
Asule, lii	?		2	0

There are also some "new" shells, most of which were not reported during the BIORAP, that have been found in large numbers in the dredging spoils used in the reclamation of the borrow pits and lagoonside "new beach" (**kaune fou**) on Fogafale Islet. These include a range of miniaturized shells, including tapestry turban snail, **alili** (*Turbo pethiolatus*), fragile conch, **panea** (*Strombus fragilis*), surf clams, **asule** or **lii** (*Atactodea striata*), cone shells, **fakamili** (*Conus spp.*), olives shells, **pule** (*Oliva sp.*), small trochus, **mulikao foliki** (*Trochus sp.*), moon snails (*Polinices tumidus*), rough vertagus (*Rhinoclavus asper*) and Pacific grinning tun shells (*Malea pomum*) all of which are among the most common shells used in shell necklaces.

8

BIORAP RESULTS OF TERRESTRIAL BIODIVERSITY AND ECOSYSTEM SERVICES

Terrestrial biodiversity and ecosystem services (BES) includes a wide range of important plants and animals found in different atoll ecosystems and/or which delivers specific ecosystem services, e.g. coastal protection, food, medicine, construction materials and ornamentation and aesthetic benefits. These are discussed below.

8.1 Mangrove Plants

Over 20 plants were reportedly found in or associated with mangroves (Table 29), which are considered to be both a marine and terrestrial ecosystems. Those that are said by the most people to be increasingly rare or hard to find are the true mangroves, **togo** (*Rhizophora stylosa*) and **sagale or tokotū** (*Lumnitzera littorea*), the later which is now extirpated on Funafuti; and the mangrove-associated species, **fetau** (*Calophyllum inophyllum*), **kanava** (*Cordia subcordata*), **puka vaka** (*Hernandia nymphaeifolia*), **puka vaka** (*Pisonia grandis*), **milo** (*Thespesia populnea*) and **gie** (*Pemphis acidula*). The main reasons for loss of these are land clearance overuse and failure to replant and in the case of **tausunu**, mortality due to hurricanes and associated storm waves.

Table 29. Survey results of the 6 most useful or culturally important trees found in mangroves (**vai togo**) and 3 of these plants that are considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total x/19	Total
Fetau	Alexandrian laurel	<i>Calophyllum inophyllum</i>	16	8
Kanava	beach cordia	<i>Cordia subcordata</i>	14	5
puka vaka	Chinese lantern tree	<i>Hernandia nymphaeifolia</i>	12	6
Fala	pandanus	<i>Pandanus tectorius</i>	12	2
Niu	coconut palm	<i>Cocos nucifera</i>	10	0
Milo	Thespian's tree	<i>Thespesia populnea</i>	6	4
puka vai	bird-catcher tree	<i>Pisonia grandis</i>	6	4
Togo	spotted mangrove	<i>Rhizophora stylosa</i>	6	3
Futu, kafutu	fish poison tree	<i>Barringtonia asiatica</i>	6	1
Gie	Ironwood	<i>Pemphis acidula</i>	5	3
Sagale, tokotū	red-flowered black mangrove	<i>Lumnitzera littorea</i>	4	3
Gasu	half-flower	<i>Scaevola taccada</i>	4	0
Tausunu	beach heliotrope	<i>Tournefortia argentea</i>	3	4
Fao	double apple, yellow wood	<i>Ochrosia oppositifolia</i>	2	2
Fue	Morning-glory	<i>Ipomoea spp.</i>	2	1
Pua	beach gardenia	<i>Guettarda speciosa</i>	2	1
Fou	beach hibiscus, beach mulberry	<i>Hibiscus tiliaceus, Pipturus argenteus</i>	2	1
Nonu	Indian mulberry	<i>Morinda citrifolia</i>	1	0
Aloalo	Beach elderberry	<i>Premna serratifolia</i>	1	1
Talie	beach almond	<i>Terminalia samoensis</i>	1	0

8.2 Trees or larger plants found in the coastal forest on the lagoon side of the islets

About 20 trees or large plants were considered important in lagoon-side coastal forest and vegetation (Table 30). Those that are most commonly said to be increasingly rare or hard to find are **fetau** (*Calophyllum inophyllum*), **kanava** (*Cordia subcordata*), **falavao** (*Pandanus tectorius*) **tausunu** (*Tournefortia argentea*), **futu** (*Barringtonia asiatica*), **fao** (*Ochrosia oppositifolia*), **gie** (*Pemphis acidula*) and the mangrove, **togo** (*Rhizophora stylosa*), all of which had either been overexploited for the use of their timber, cleared for coastal development, or been lost because of coastal and beach erosion.

Table 30. Six important large trees or plants (*lakai lasi*) in coastal forest (**lakai tafatai**) on the lagoon (**namo**) side of the islets and 3 of these plants that are considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total x/19	Total Rare
Fetau	Alexandrian laurel	<i>Calophyllum inophyllum</i>	17	8
Kanava	beach cordia	<i>Cordia subcordata</i>	14	4
Fala	Pandanus	<i>Pandanus tectorius</i>	13	2
Tausunu	beach heliotrope	<i>Tournefortia argentea</i>	11	5
Niu	coconut palm	<i>Cocos nucifera</i>	10	1
futu	Fish-poison tree	<i>Barringtonia asiatica</i>	9	4
Togo	mangrove	<i>Rhizophora stylosa</i>	7	2
puka vaka	Chinese lantern tree	<i>Hernandia nymphaeifolia</i>	4	1
Gie	Ironwood	<i>Pemphis acidula</i>	4	2
puka vai	bird-catcher tree	<i>Pisonia grandis</i>	3	0
Gasu	half-flower	<i>Scaevola taccada</i>	3	1
Pua	beach gardenia	<i>Guettarda speciosa</i>	3	0
Fao	double apple, yellowwood	<i>Ochrosia oppositifolia</i>	2	3
fau	Beach hibiscus	<i>Hibiscus tiliaceus</i>	2	1
Milo	Thespian's tree	<i>Thespesia populnea</i>	2	1
Aloalo, valoalo	Beach elderberry	<i>Premna serratifolia</i>	2	1
talie	Beach almond	<i>Terminalia samoensis</i>	2	1
Lakai Kilisimasi	Flame tree	<i>Delonix regia</i>	2	0
tiale	Tahitian gardenia	<i>Gardenia taitensis</i>	1	0
sagale	Red-flowered black mangrove	<i>Lumnitzera littorea</i>	1	1

8.3 Small or Creeping plants found in lagoon-side coastal vegetation

Some 20 small or creeping plants (**mouku foliki mo te lakau tolotolo**) were said to be important, almost all of which are important sand-binding plants and of cultural importance as medicinal plants or for use in garlands and other purposes (Table 31). Those that are the most threatened include **tolotolo** (*Triumfetta procumbens*), **fetai** (*Cassytha filiformis*) and half-flower, **gasu** (*Scaevola taccada*), some of the major threats including habitat degradation, land clearance, coastal erosion, indiscriminate burning and free-ranging pigs.

Table 31. Six important smaller or creeping plants (**mouku foliki mot e lakau tolotolo**) large trees or plants (**lakai lasi**) found along the lagoon (**namo**) side of islets and 2 of these smaller plants that are considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total x/19	Total
Gasu	half-flower	<i>Scaevola taccada</i>	14	6
Saketa	beach bean, beach pes	<i>Canavalia cathartica</i> , <i>Vigna marina</i>	13	0
Tolotolo	beach burr	<i>Triumfetta procumbens</i>	13	10
Fetai	beach dodder	<i>Cassytha filiformis</i>	9	7
Tefue, fue	morning-glorys	<i>Ipomoea pes-caprae</i> and <i>I. macrantha</i>	9	2
Katuli	beach purslane	<i>Portulaca spp.</i>	5	1
Luna	beach nettle	<i>Laportea ruderalis</i>	3	1
Mouku	grass (general)	<i>Lepturus repens</i>	3	1
Mouku milimili taliga	tropical fimbry	<i>Fimbristylis cymosa</i>	3	1
Nonu	Indian mulberry	<i>Morinda citrifolia</i>	3	0
Ogoogo	Great acalypha	<i>Acalypha grandis</i>	3	1
Mouku filifou	marsh cypress	<i>Mariscus javanicus</i>	2	1
Mouku Kimoa	?	?	2	1
Tivoli	wild yam	<i>Dioscorea nummularia</i>	2	0
Muta	nut sedge	<i>Cyperus rotundus</i>	1	0
Mutia	grass general	<i>Lepturus repens</i> , <i>Thuarea involuta</i> , <i>Paspalum distichum</i>	1	0
Panikeni	pumpkin	<i>Cucurbita moschata</i>	1	0
Pateta	sweet potato	<i>Ipomoea batatas</i>	1	0
Pini	cape gooseberry	<i>Physalis angulata</i>	1	0
Saketa Lauliki	beach pea	<i>Vigna marina</i>	1	0
Sulufe	sword fern	<i>Nephrolepis spp.</i>	1	0

8.4 Trees or Large Oceanside Plants (lakau lasi fakaoga e ola i tafatai o te tua fenua)

Some 17 important trees or large plants are reportedly found in oceanside coastal forest and vegetation (Table 32). Those that are said by the most people to be increasingly rare or hard to find included **futu** or **kafutu** (*Barringtonia asiatica*), **fetau** (*Calophyllum inophyllum*), **tausunu** (*Tournefortia argentea*), **fao** (*Ochrosia oppositifolia*), **kanava** (*Cordia subcordata*) and pandanus, **fala** (*Pandanus* spp. The main reasons for the short supply or loss are clearance overuse and failure to plant,

Table 32. Important large trees or plants (**lakau lasi**) in coastal forest (**lakau tafatai**) on the OCEAN SIDE (**tua fenua**) of the islands and 3 of these plants that are considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total x/19	Total Rare
Fala	Pandanus	<i>Pandanus tectorius</i>	15	2
Fetau	Alexandrian laurel	<i>Calophyllum inophyllum</i>	13	4
Kafutu, futu	fishpoison tree	<i>Barringtonia asiatica</i>	11	6
Niu	coconut palm	<i>Cocos nucifera</i>	10	2
Kanava	beach cordia	<i>Cordia subcordata</i>	8	4
Tausunu	beach heliotrope	<i>Tournefortia argentea</i>	6	4
Pua	beach gardenia	<i>Guettarda speciosa</i>	6	0
puka vaka	Chinese lantern tree	<i>Hernandia nymphaeifolia</i>	4	1
Fao	twin apple, yellow-wood	<i>Ochrosia oppositifolia</i>	3	3

nonu	Indian mulberry	<i>Morinda citrifolia</i>	3	0
puka vai	bird-catcher tree	<i>Pisonia grandis</i>	2	1
Talie	coastal almond	<i>Terminalia samoensis</i>	2	2
Gie	Ironwood	<i>Pemphis acidula</i>	2	1
Milo	Thespian's tree	<i>Artocarpus spp.</i>	1	1
Valovalo	false elderberry	<i>Premna serratifolia</i>	2	1
Fou	beach hibiscus, native mulberry	<i>Hibiscus tiliaceus, Pipturus argenteus</i>	1	0
Mei	Breadfruit	<i>Artocarpus spp.</i>	1	0

8.5 Oceanside coastal vines, creeping and small plants found in vegetation

About 20 important vines, creeping or small plants are found in oceanside coastal forest and vegetation (Table 33). Those that are said by the most people to be increasingly rare or hard to find include **tolotolo** or **kasitolotolo** (*Triumfetta procumbens*), **fetai** (*Cassytha filiformis*), **akatā** (*Sida fallax*), **ogogo** (*Acalypha grandis*), **fue** (*Ipomoea pes-caprae*) and **katuli** (*Portulaca spp.*), due mainly to overuse or due to increasing severe wave erosion during storms and king tides.

Table 33. Results of the 6 most Important vines, creeping plants or small plants or shrubs found in the coastal vegetation on the OCEAN SIDE (tua fenua) of the islands and 2 of these plants that are considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total x/19	Total Rare
Tolotolo, Kasitolotolo	beach burr	<i>Triumfetta procumbens</i>	14	8
Saketa	Maunaloa bean, beach pea	<i>Canavalia cathartica, Vigna marina</i>	14	2
Fetai	beach dodder	<i>Cassytha filiformis</i>	12	5
Gasu	half-flower	<i>Scaevola taccada</i>	9	2
Fue	beach morning glory	<i>Ipomoea pes-caprae</i>	6	2
Mouku, mutia	grass (gen)	<i>Lepturus repens</i>	5	1
Maile	fragrant fern	<i>Microsorium grossum</i>	5	1
Mohuku milimili taliga	Tropical fimbry, sedge	<i>Fimbristylis cymosa</i>	4	0
Katuli	Portulaca	<i>Portulaca spp.</i>	3	2
Wedelia, mouku faipula?	wedelia	<i>Sphagneticola trilobata</i>	3	0
Nonu	beach mulberry	<i>Morinda citrifolia</i>	3	0
Ogogo	large acalpa	<i>Acalypha grandis</i>	2	2
Akatā	Golden mallow	<i>Sida fallax</i>	2	3
Sulufe	sword fern	<i>Nephrolepis spp</i>	2	1
Gie	Pemphis, ironwood	<i>Pemphis acidula</i>	2	1
Felo	Dyer's fig, antive fig	<i>Ficus tinctoria</i>	2	0
Mouku lau pukupuku	Kuroiwa grass	<i>Thuarea involuta</i>	1	1

Mouku toto	Beach spurge	<i>Chamaesyce atoto</i>	1	1
Laukatafa, laulu	Bird's-nest fern	<i>Asplenium nidus</i>	1	1
Mouku Matiotio	Sensitive grass	<i>Mimosa pudica</i>	1	0
Laukimoa	?	?	1	0

8.6 Inland large and small trees or plants (lakau ote vao kola e lasi, foliki kae taua ki tino ote fakai kola foki loa e maua ite togavao ote fenua)

Some 30 important trees or other plants found in inland areas. (Table 34). Those that are said by the most people to be increasingly rare or hard to find include **tausunu** (*Tournefortia argentea*), **puka vaka** (*Hernandia nymphaeifolia*), **felo** (*Ficus tinctoria*), and **puka vai** (*Pisonia grandis*). Also considered increasingly rare by some respondents were **milo** (*Thespesia populnea*) and some cultivars of coconut palms, **niu** (*Cocos nucifera*). The main reasons for the short supply or loss of these trees are land clearance, overuse and failure to plant.

Table 34. Survey results of the 9 most important trees or other plants found in inland areas and 3 plants in inland areas that are considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total x/19	Total
Niu	coconut palm	<i>Cocos nucifera</i>	11	3
Fetau	Alexandrian laurel	<i>Calophyllum inophyllum</i>	10	3
Tausunu	beach heliotrope	<i>Tournefortia argentea</i>	9	5
puka vaka	Chinese lantern tree	<i>Hernandia nymphaeifolia</i>	8	5
Felo	Dyer's fig	<i>Ficus tinctoria</i>	8	4
Fala	Pandanus	<i>Pandanus tectorius</i>	8	1
Pua	beach gardenia	<i>Guettarda speciose</i>	7	1
puka vai	bird-catcher tree	<i>Pisonia grandis</i>	6	3
Mei	Breadfruit	<i>Artocarpus spp.</i>	6	2
Gasu	half-flower	<i>Scaevola taccada</i>	5	2
Kanava	beach cordia	<i>Cordia subcordata</i>	5	1
valovalo, aloalo	beach elderberry	<i>Premna serratifolia</i>	5	1
Ogoogo, kalakalāpuhi	large acalypha	<i>Acalypha grandis</i>	5	0
Nonu	Indian mulberry	<i>Morinda serratifolia</i>	5	0
Talie	Beach almond	<i>Terminalia samoensis</i>	4	1
Futu	fish poison tree	<i>Barringtonia asiatica</i>	3	1
Milo	Thespian's tree	<i>Thespesia populnea</i>	2	2
Fao	Fao	<i>Ochrosia oppositifolia</i>	2	0
Fou, fau	Beach hibiscus, Pipturus	<i>Hibiscus tiliaceus, Pipturus argenteus</i>	2	0
kaipuaka	lantana	<i>Lantana camara</i>	2	0
kunikuni	Tropical almond	<i>Terminalia catappa</i>	1	1
Futi	bananas/plantain	<i>Musa cultivars</i>	1	0
Togo	Stilt mangrove	<i>Rhizophora stylosa</i>	1	0
Sagale	red-flowered black mangrove	<i>Lumnitzera littorea</i>	1	0

8.7 Inland small or creeping plants (lakau solo/mouku solo kola e ola i manafa o tino ote fakai)

About 30 different vines or small creeping plants found in inland areas were considered important (Table 35). Although most are indigenous species, some such as common purslane, **katuli** (e.g. *Portulaca oleracea*), pumpkin (**panikeni**), dayflower (**mohuku solo**), pink zephyr flower (**susana**) and wild yams (**tivoli**) are found naturalised or seemingly growing wild in inland site and wastelands. Those that are said by the most people to be increasingly rare or hard to find were **tolotolo** (*Triumfetta procumbens*), **katuli** (*Portulaca* spp.) and **mohulu talatala** (*Cenchrus echinatus*), while **akatā** (*Sida fallax*) and **lakau manogi** (*Wollastonia biflora*) and Polynesian arrowroot, **vatia** (*Tacca leontopetaloides*), were also rare and threatened by some people. The main reasons for their loss include overuse, land clearance, climate change, drought, naturally rare, indiscriminate burning and roaming pigs.

Table 35. Survey results of the 6 most important vines or small creeping plants found in inland areas and 2 of these plants that are considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total	Total
tolotolo, kasi tolotolo	beach bur	<i>Triumfetta procumbens</i>	9	6
Fetai	beach dodder	<i>Cassytha filiformis</i>	9	4
Saketa	Maunaloa bean, beach pea	<i>Canavalia cathartica</i> , <i>Vigna marina</i>	8	2
katuli	portulaca	<i>Portulaca</i> spp	7	4
Panikeni	pumpkin	<i>Cucurbita</i> spp.	6	1
mouku solo	dayflower	<i>Commelina diffusa</i>	5	0
Mouku	grass (gen.)		5	0
Susana	Pink zephyr flower	<i>Zephyranthes rosea</i>	4	3
mouku milimilitaliga	tropical fimbry	<i>Fimbristylis cymosa</i>	4	2
tivoli	Wild yam	<i>Dioscorea nummularia</i>	4	2
Muta	nut sedge	<i>Cyperus rotundus</i>	4	0
mutia	Bunch grass	<i>Lepturus repens</i>	3	1
Fue	beach morning-glory	<i>Ipomoea macrantha</i> , <i>I. pes-caprae</i>	3	1
Sulufe	sword fern	<i>Nephrolepis hirsutula</i>	3	0
Piini	cape gooseberry	<i>Physalis angulate</i>	3	0
akatā	Beach mallow, ilima	<i>Sida fallax</i>	2	2
lakau manogi	Beach sunflower	<i>Wollastonia biflora</i>	2	1
mouku talatala	burr grass	<i>Cenchrus echinatus</i>	2	0
Maile	fragrant fern	<i>Microsorium grossum</i>	2	0
Laulu	bird's-nest fern	<i>Asplenium nidus</i>	2	0
mouku fai fou	marsh cypress?	<i>Mariscus javanicus</i>	1	0
mouku toto	beach spurge	<i>Chamaesyce atoto</i>	1	0
mouku laulikiliki	Beach bunchgrass?	<i>Lepturus repens</i>	1	0
mouku tagata	?		1	0
mouku fai sinu	Beach sedge?	<i>Cyperus stoloniferus</i>	1	0
Mouku lau pukupuku	Kuroiwa grass	<i>Thuarea involuta</i>	1	0
Lakau solo kenasiga	?	?	2	0
vatia	Polynesian arrowroot	<i>Tacca leontopetaloides</i>	1	1

8.8 Ferns or Fern-like Plants (Sulufe and Maile)

There were up to eight ferns known by the informants, although some are probably duplications or names for varieties or forms of the same species (Table 36). Those that are said by the most people to be increasingly rare or hard to find were **maile** (*Microsorium grossum*), which is used for making garlands (**fou**) and scenting coconut oil (**sinu**), and **laukatafa** or **laulū** (*Asplenium nidus*), the young leaves of the latter of which are cooked as one of the only local green spinaches. The main reasons for the loss of these ferns was overuse, land clearance and free ranging pigs, with the main remaining populations of laukatafa being on uninhabited islets (**motu**) which are free of pigs.

Table 36. Survey results for the 3 most important ferns or fernlike plants in areas owned by the village and 2 of these ferns that are considered to be rare or increasingly hard to find based on questionnaire surveys of 16 male and female informant groups on Funafuti Atoll, Tuvalu conducted in September 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total	Total Rare
Maile	fragrant fern	<i>Microsorium grossum</i>	14	9
Sulufe	sword fern	<i>Nephrolepis acutifolia</i> , <i>N. hirsutula</i>	10	1
maile tagata		?	4	1
maile fafine		?	9	0
laukatafa, laulu	bird's-nest fern		4	3
lau kimoa	whisk fern	<i>Psilotum nudum</i>	4	0
lautolo, lakau sauga	lacy fern, sword brake	<i>Pteris tripartita</i>	2	1

8.9 Animals Found on Uninhabited Islets around Funafuti Lagoon

Fourteen (14) small and large animals were reportedly present on the uninhabited reef islets (**motu**) of Funafuti, most of which are no longer found on main Fogafale Islet (Table 37). This was based mainly on the knowledge of people originally from Funafuti and who have land rights to these islets, whereas most of the respondents originally from the other atolls do not know the animals found there. The animals that were reportedly present included mainly seabirds, a lizard (**pili**) and the coconut crab (**uu**), most of which were all still present on Tepuka Islet, whereas number of the seabirds were also present on other uninhabited islets such as Fualopa. Most of the respondents said that most birds, such as **kanapu** (*Sula sula*), **katafa** (*Fregata*), **talaliki** (*Onychoprion fuscatus*), **gogo** (*Anous stolidus*) and **lupe** (*Ducula pacifica*) are commonly found on most of the islets of Funafuti but not on Fogafale. The endemic lizard or skink, **tepukepili** (*Lepidodactylus tepukapili*) has only been reported from Tepuka (Table 34b).

Table 37. Small and large animals reported present on the 16 uninhabited reef islet (**motu**) of Funafuti Lagoon showing the number of times which a given organism was reported present on different islets, based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total x/19
Kanapu/tapuka	Red-footed booby	<i>Sula sula</i>	10
Katafa/katokula	Frigate birds	<i>Fregata spp.</i>	10
Talaliki	Sooty tern	<i>Onychoprion fuscatus</i>	9
Gogo	Brown noddy	<i>Anous stolidus</i>	8
Lupe	Pacific pigeon	<i>Ducula pacifica</i>	8
Lakia	Black noddy	<i>Anous minutus</i>	5
Tavakelau	White-tailed tropicbird	<i>Phaethon lepturus</i>	4
Uu	coconut crab	<i>Birgus latro</i>	2
Kanopatau/kanapu	brown booby	<i>Sula leucogaster</i>	2

Kolili	Turnstone	<i>Arenaria interprets</i>	2
Pukapili	Tepukapili	<i>Lepidodactylus tepukapili</i>	1
Taki	Domestic duck	<i>Anas platyrhynchos domesticus</i>	1
Kovee	bristle-thighed curlew	<i>Numenius tahitiensis</i>	1
Toloo	gray duck, Pacific black duck	<i>Anas superciliosa</i>	1

8.10 Staple and Nonstaple Food Crops (Lakau Kaina)

Some 25 different food crops were considered important (Table 38), with papaya, **olesi** (*Carica papaya*), edible pandanus, **falakai** (*Pandanus* cultivars), bananas and plantains, **futi** (*Musa* cultivars), breadfruit, **mei** (*Artocarpus* spp.), pumpkins, **panikeni** (*Cucurbita* spp.), giant swamp taro, **pulaka** (*Cyrtosperma chamissonis*), cabbages, **kapisi** (*Brassica* spp.), watermelon, **meleni** (*Citrullus lanatus*), coconut, **niu** (*Cocos nucifera*) and sweet potato, **pateta** (*Ipomoea batatas*) being most commonly mentioned. Many of these were considered to be in short supply due to overexploitation, land clearance, land shortage, climate change, failure to replant and shortage or unavailability of seeds or planting materials for replanting seasonal annual plants, such as cabbages. Particular concern was expressed over the shortage of pumpkins, edible pandanus (**falakai**), giant swamp taro cultivars (**pulaka**) and Dyer's fig (**felo**).

Table 38. Survey results of the 12 most important FOOD PLANTS that are cultivated and 5 that are considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total x/19	Total Scarce
Olesi	papaya, pawpaw	<i>Carica papaya</i>	17	5
Falakai	edible pandanus	<i>Pandanus cultivars</i>	16	6
Futi	bananas, plantains	<i>Musa cultivars</i>	16	5
Mei	breadfruit	<i>Artocarpus</i> spp.	15	5
Panikeni	pumpkin	<i>Cucurbita</i> spp.	14	8
Pulaka	giant swamp taro	<i>Cyrtosperma chamissonis</i>	11	6
Kapisi	cabbage	<i>Brassica</i> spp.	11	3
Meleni	water melon	<i>Citrullus lanatus</i>	11	3
Niu	coconut palm	<i>Cocos nucifera</i>	10	0
Pateta, kumala	sweet potato	<i>Ipomoea batatas</i>	10	8
Tomato	tomato	<i>Solanum lycopersicon</i>	10	3
Talo	taro	<i>Colocasia esculenta</i>	9	5
kukama	cucumber	<i>Cucumis sativus</i>	9	4
Felo	Dyer's fig	<i>Ficus tinctoria</i>	7	6
Laupele	hibiscus spinach	<i>Abelmoschus manihot</i>	6	2
Tapioka	cassava, manioc	<i>Manihot esculenta</i>	5	2
Tamu	giant taro	<i>Alocasia macrorrhizos</i>	2	2
Polofeuu	chili peppers	<i>Capsicum frutescens</i> , <i>C. annum</i> vars.	2	0
Painapolo	pineapple	<i>Ananas comosus</i>	1	1
Pateta Magalo	Sweet potato variety	?	1	1
Pepa	sweet capsicum	<i>Capsicum annum</i> var. <i>annuum</i>	1	1
Tivoli	climbing yam	<i>Dioscorea nummularia</i>	1	1
Kapisikamu	head cabbage	<i>Brassica oleracea</i> var.	1	0
Nonu	Indian mulberry	<i>Morinda citrifolia</i>	1	0

8.11 Coconut Cultivars (Vaega Niu)

There were traditionally a high number of coconut palms cultivars with different characteristics, tastes and uses, plus a number of more recently introduced varieties, such as the Malayan dwarf coconut palm that was introduced into many areas of the Pacific almost 50 years ago. The survey results listed just under 20 named cultivars, some of which might be the same, but have different names on different atolls (Table 39). Those that are considered to be rare or in short supply are **uto**, **niu kula**, **niu alava** and the dwarf coconut.

Table 39. Survey results of the 6 most important coconut palm varieties or cultivars (vaega niu) and 2 that are considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	Total	Total
Dwarf	15	5
Uto	13	13
Ui	13	4
Alava	13	3
Kula	11	4
Fuausi	4	3
Niu Pelona	2	1
Tekefu	2	0
Fakamauganiu	2	0
Palm	2	2
Kita	1	1
Niusega	1	0
Niu fai Poi	1	1
Niu fai Pii	1	0
Niu fai Kafa	1	0
Niu Solomona	1	0
Niu fai kolokolo	1	1
Teui	1	1
Nuifiti	1	1

8.12 Edible pandanus cultivars (Vaega Fala Kai)

There were about 6 named edible pandanus (**fala kai**) cultivars, some of which were introduced to Tuvalu from Kiribati or other areas within the British Empire, such as **tinakaleve**, which is reportedly a Kiribati name, and **fala Nui**, which indicates that it was introduced from Nui Atoll where the language is Kiribati. Some informants also mentioned the names of wild pandanus (**fala vao**) and **kie**, a variety used in weaving fine mats, hats, baskets, roofing and other platted materials, as being edible. Some names may also be names for the same varieties from different atolls (Table 40). Edible pandanus cultivars that are considered to be rare or in short supply include **fala keti**, **tinakaleve**, **fala nui**, **falatamuko** and **utogau**. The main causes of the shortage are land clearance, land shortage felling of trees, failure to replant, loss of knowledge of the nutritional importance of fala kai and climate change.

Table 40. Survey results of the 6 most important edible pandanus varieties or cultivars (**vaega fala kai**) and 2 that are considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	Total x/19	Total Rare
Tinakaleve	17	4
Falaketi/Falainu	16	11
Magatalo	10	4
Fala Vao	9	0
Falakai	8	1
Tinatina	7	1
Fala Nui	6	2
Pukumakali	3	0
Fala Tamuko	2	2
Pakalolo	2	1
Uto Gau	2	2
Leikahala	1	0
Ikata	1	0
Fenuamuli	1	1
Penu	1	1
Kie	1	0
Fala Poloseni	1	0
Ilipioga	1	1
sokotia	1	0

8.13 Breadfruit Cultivars (**vaega mei**)

Results indicated that there are about 10 breadfruit cultivars, although some may be names for the same varieties from different atolls (Table 41). The most common cultivars are **mei Niutao**, **pokeke**, **fuatega** or **meitatou (matua mei?)**, **māfalā** and **laumaile**. Most of these were considered to be in short supply by some respondents, mostly for the same reason as the other food crop cultivars

Table 41. Survey results of the 6 most important breadfruit varieties or cultivars (**vaega mei**) and 2 that are considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	Total	Total
Mei Niutao	15	7
Pokeke	15	3
Meitatou/Faiitega	13	7
Vailuaa	13	4
Mai Mafala	12	7
Laumaile	8	5
Meivao	2	2
Aviloa	2	2
Matua Mei	2	0
Mei laumasaesae	2	2
Pukilua	1	1
Mei maile	1	1

8.14 Banana and Plantain Cultivars (Vaega Futi)

There are about 10 named banana or plantain cultivars (*Musa* cultivars) (Table 42), the most common of which are **kefu**, **pata**, **fuamaulalo**, **taemani**, and **vudi**, which is a plantain cultivar introduced from Fiji where it is known by the same name. A number of these are in short supply, especially **pata**, again due to land clearance, failure to plant, lack of planting material, damage by free-ranging pigs and climate change.

Table 42. Survey results of the 6 most important banana or plantain cultivars (vaega futi) and 2 that are considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	Total x/19	Total Rare
Kefu	16	7
Pata, kaupata	16	17
Fuamaulalo	15	8
Taemani	13	7
Inisi	12	4
Vundi	8	5
Fuamaluga	7	2
Misiluki	2	1
Tekula	2	1
Futi Tuofu	1	0

8.15 Giant Swamp Taro Cultivars (Vaega Pulaka)

Some 20 giant swamp taro cultivars (**vaega pulaka**) were mentioned by respondents, many of which may refer to the same cultivars on different atolls or for different respondents (Table 43). The most commonly mentioned cultivars were **ikaloi**, **peipeitaliga**, **pulaka kula** or **ikaulaula**, **ikamaava** and **suetena**. Most of these cultivars, and **pulaka** in general, are considered to be threatened and in short supply on Funafuti. The main reasons for this were said to be overuse, land reclamation, failure to plant, abandonment and failure to maintain the excavate **pulaka** garden areas (**pela**), lack of planting materials, and shortage of proper mulch or composting plants.

Table 43. Survey results of the 6 most important giant swamp taro cultivars (vaega pulaka) and 2 that are considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	Total	Total
Ikalaoi	16	13
Peipeitaliga	16	7
Pulaka Kula/Ikaulaula	11	2
Ikamaava	11	7
Suetena	7	3
Meauli	3	2
Ikataatala	3	2
Imakini	3	1
Matua Pulaka	2	1
Ika uli	2	2
Tuatiti	1	0

Taamu	1	0
Tina pulaka	1	0
Ika Kilipati	1	0
Mataitaliga	1	0
Ikaluki	1	0
Tumeiniku	1	0
Ufi	1	0
Ikakula	1	0

8.16 Taro Cultivars (Vaega Talo)

There were almost 20 named taro cultivars, although some may represent the same cultivars on different atolls or for different respondents; and some like **talotana** and **taamu** refer to two different taro species, cocoyam or American taro (*Xanthosoma* spp.) and giant taro (*Alocasia macrorrhizos*), respectively, rather than to true taro, **talo** (*Colocasia esculenta*) (Table 44). The most commonly mentioned cultivars were **talo tana** (*Xanthosoma* cultivars), a name probably derived from the Fijian name **dalo ni tana**; the true taro cultivars, **talo kena**, **manua**, **Talouli**, **talo maluu** and **talo kula**; and **taamu**, which is the name for giant taro. Most of these cultivars, and **pulaka** in general, are considered to be threatened and in short supply on Funafuti, the main reasons being overuse, land reclamation, failure to plant and abandonment and failure to maintain the **pulaka** garden areas (**pela**), lack of planting material, shortage of proper mulch plants, prolonged drought, saltwater incursion, flooding during king tides and climate change.

Table 44. Survey results of the 6 most important taro cultivars (**vaega talo**) (*Colocasia*, *Xanthosoma* and *Alocasia* spp.) and 2 that are considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total	Total
Talotana	cocoyam, American taro	<i>Xanthosoma</i> spp.	17	4
Talokena	Taro	<i>Colocasia esculenta</i>	13	9
Manua	Taro	<i>Colocasia esculenta</i>	10	12
Talouli	Taro	<i>Colocasia esculenta</i>	5	4
Taamu	giant taro	<i>Alocasia macrorrhizos</i>	5	1
Talomaluu	Taro	<i>Colocasia esculenta</i>	4	3
Talokula	Taro	<i>Colocasia esculenta</i>	4	2
Talosega	Taro	<i>Colocasia esculenta</i>	3	1
Talo rotuma	Taro	<i>Colocasia esculenta</i>	3	1
Talo Nui	Taro	<i>Colocasia esculenta</i>	2	2
Suliga	Taro	<i>Colocasia esculenta</i>	1	1
Talopalagi	cocoyam, American taro	<i>Xanthosoma</i> spp.	1	1
Talo Fiiti	Taro	<i>Colocasia esculenta</i>	1	1
Pula manua	Taro	<i>Colocasia esculenta</i>	1	1
Tulee	Taro	<i>Colocasia esculenta</i>	1	1
Talo Kefu	Taro	<i>Colocasia esculenta</i>	1	0
Talo kula	Taro	<i>Colocasia esculenta</i>	1	0
Matuatalo	Taro	<i>Colocasia esculenta</i>	0	0

8.17 Animals Foods/Fodder

There are about 20 plants, the leaves, fruits or other parts of which are used as fodder or animal food, mainly pig feed (Table 45). The most important of these are the leaves and/or other parts and fruit of **futi**, bananas and plantains (*Musa cultivars*), **felo** (*Ficus tinctoria*), **puka vai** (*Pisonia grandis*), **ogoogo** (*Acalypha grandis*), **togo** (*Rhizophora stylosa*), **kanava** (*Cordia subcordata*), **niu**, coconut (*Cocos nucifera*), **saketa** (*Canavalia cathartica* and *Vigna marina*), **lautagitagi** (*Polyscias* spp.), breadfruit, **mei** (*Artocarpus[us altilis]*), giant swamp taro leaves (*Cyrtosperma chamissonis*), **bele** (*Abelmoschus manihot* or *Cnidosculus chayamansa* and **fau** or **fou** (*Hibiscus tiliaceus* or *Pipturus argenteus*). Those that are considered in short supply, largely due to overuse for feeding pigs, land clearance, failure to plant and drought, include **futi**, **kanava**, **togo**, **puka vai**, **felo**, **ogoogo** and **mei** (Table 45). The reservation and expanded planting of these plants is particularly important given the high cost of imported animal foods.

Table 45. Results of the 4 most important plants used for feeding animals (**lakau mo fagai manu**) and 2 of these plants that are considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total x/19	Total Scarce
Futi	Bananas	<i>Musa cultivars</i>	13	7
Felo	Dyer's fig	<i>Ficus tinctoria</i>	9	3
Pukavai	bird-catcher tree	<i>Pisonia grandis</i>	8	4
Ogoogo	great acalypha	<i>Acalypha grandis</i>	8	3
Togo	mangrove	<i>Rhizophora stylosa</i>	8	5
Kanava	beach cordia	<i>Cordia subcordata</i>	7	7
niu	Coconut	<i>Cocos nucifera</i>	7	0
Saketa	beach beans and peas	<i>Canavalia cathartica</i> and <i>Vigna marina</i>	7	0
Lautagitagi	hedge panax	<i>Polyscias</i> spp.	6	4
Mei	Breadfruit	<i>Artocarpus</i> spp.	6	2
Lau Pulaka	giant swamp taro leaves	<i>Cyrtosperma chamissonis</i>	4	0
Bele	hibiscus spinach	<i>Abelmoschus manihot</i>	4	1
Katuli	Purslane	<i>Portulaca</i> spp.	4	1
Fou, fau	beach hibiscus, beach nettle	<i>Hibiscus tiliaceus</i> , <i>Pipturus argenteus</i>	3	2
Olesi	papaa, pawpaw	<i>Carica papaya</i>	3	0
Fetau	Alexandrian laurel	<i>Calophyllum inophyllum</i>	2	1
Tausunu	Beach heliotrope	<i>Tournefortia argentea</i>	2	1
gie	Pemphis, ironwood	<i>Pemphis acidula</i>	1	0
Puka vaka	Chinese lantern tree	<i>Hernandia nymphaeifolia</i>	1	0

8.18 Fragrant and Sacred Garland plants (Vaega Lakau Manogi Gali)

The flowers, leaves and fruits of some 30 plants are used to make head garlands (**fou/fau**) and other body ornamentation and decoration (Table 46). Those that are said to be increasingly hard to find or are in short supply include Tahitian gardenia (**tiale**), common hibiscus (**'aute**), crinum lily (**tapua, talotalo**), Arabian jasmine (**pitaasi**), and beach gardenia (**pua**). The main reasons for the short supply or loss of these are overuse for garlands, failure to replant or lack of planting material and in the case of hibiscus, a disease that has killed these plants in most gardens.

Table 46. Results of the 12 most important fragrant or colourful plants used making garlands and for body ornamentation (**vaega lakau manogi gali taua mo fai a fou/fau**) and 3 of these plants that are considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total	Total
Puafiti, melia	frangipani, plumeria	<i>Plumeria rubra</i> , <i>Plumeria</i> spp. (gen)	16	1
Tiale	Tahitian gardenia	<i>Gardenia taitensis</i>	15	7
Gasu	half-flower	<i>Scaevola taccada</i>	14	2
Pua	beach gardenia	<i>Guetarda speciosa</i>	14	4
Valovalo, aloalo	false elderberry	<i>Premna serratifolia</i>	14	3
Fetau	Alexandrian laurel	<i>Calophyllum inophyllum</i>	11	1
Olesi	papaya, pawpaw	<i>Carica papaya</i>	10	3
Pitaasi	Arabian jasmine	<i>Jasminum sambac</i>	10	5
Akanta	Bougainvillea	<i>Bougainvillea</i> spp.	9	2
Sigano	pandanus male flower	<i>Pandanus tectorius</i>	9	0
Tapua, tolotalo	crinum lily	<i>Crinum asiaticum</i>	7	1
Aute	common hibiscus	<i>Hibiscus rosa-sinensis</i>	6	6
Fala	pandanus seeds/keys	<i>Pandanus tectorius</i>	6	0
Mili	sacred basil	<i>Ocimum tenuiflorum</i>	4	1
Puafiti Solomona	White frangipani	<i>Plumeria obtusa</i>	4	0
Kanava	beach cordia	<i>Cordia subcordata</i>	3	0
Maile	fragrant fern	<i>Microsorium grossum</i>	3	0
Sagale	red-flowered black man-grove	<i>Lumnitzera littorea</i>	3	1
Felo	Dyer's fig	<i>Ficus tinctoria</i>	2	1
Nikilailai	yellow bells	<i>Tecoma stans</i>	2	1
Tivoli	wild yam	<i>Dioscorea nummularia</i>	2	1
Tolotolo	beach burr	<i>Triumfetta procumbens</i>	2	1
Futi	Banana	<i>Musa cultivars</i>	1	0
Tala	?	?	1	0
Fala faifou	Pandanus?	?	1	0
Inato	Beach privet	<i>Clerodendrum inerme</i>	1	0
Peteli	Madagascar periwinkle	<i>Catharanthus roseus</i>	1	0
Kaipuaka	lantana	<i>Lantana camara</i>	1	0

8.19 Ornamental Plants (Lakau Fakagaligali Fale)

Over 30 ornamental plants that are planted around houses and buildings in villages were mentioned in the surveys (Table 47). A number of these, including **'aute**, common hibiscus; **tiale**, Tahitian gardenia; **pitaasi**, Arabian jasmine; some types of **pua Fiti** or **pua melia**, frangipani; **akanta**, bougainvillea; **tapua** or **tolotalo**, crinum lilies; **pua**, beach gardenia; **mili**, sacred basil and lantana, **kaipuaka** are in short supply, mostly due to overuse and failure to replant. A concerted effort to promote the propagation and replanting of these plants with the support of an annual village or institutional garden competition should be instituted as an incentive and from raising awareness of the conservation status and cultural importance of houseyard and village gardens and these plants.

Table 47. Results of the 6 most important ornamental plants planted around houses or buildings to beautify the village (**vaega lakau fakagaligali fale**) and 2 of these plants that are considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total	Total
Pitaasi	Arabian jasmine	<i>Jasminum sambac</i>	13	4
Aute	common hibiscus	<i>Hibiscus rosa-sinensis</i>	12	7
Peteli, losa	Madagascar periwinkle	<i>Catharanthus roseus</i>	12	5
Tiale	Tahitian gardenia	<i>Gardenia taitensis</i>	11	5
Puafiti, melia, puafiti kula	Frangipani, red frangipani	<i>Plumeria rubra, Plumeria obtusa</i>	11	2
Susana	pink zephyr lily	<i>Zephyranthes rosea</i>	11	1
Tapua, talotalo,	giant crinum lily	<i>Crinum asiaticum</i>	11	3
Pua	Beach gardenia	<i>Guettarda speciosa</i>	10	2
Gasu	Half-flower	<i>Scaevola taccada</i>	8	0
Kaipuaka	Lantana	<i>Lantana camara</i>	8	6
Sun Flower	wedelia, trailing daisy	<i>Sphagneticola trilobata</i>	8	1
Valovalo, aloalo	False elderberry	<i>Premna serratifolia</i>	7	2
Akanta	Bougainvillea	<i>Bougainvillea spp.</i>	7	4
Sigano, fala	Pandanus	<i>Pandanus cultivars</i>	7	0
Puafiti Solomona	White frangipani	<i>Plumeria obtusa</i>	7	1
Olesi	Papaya	<i>Carica papaya</i>	7	0
Mili	sacred basil	<i>Ocimum tenuiflorum</i>	7	2
Sinia, makelita?	Zinnia	<i>Zinnia elegans</i>	7	1
Fetau	Alexandrian laurel	<i>Calophyllum elegans</i>	5	0
Talotalo Sega	yellow crinum lily	<i>Crinum xanthophyllum</i>	5	2
lautagitagi	Hedge panax	<i>Polyscias spp</i>	5	0
Inato	Beach privet	<i>Clerodendrum inerme</i>	3	0
Lili	Barbados lily, spider lily	<i>Hippeastrum puniceum, Hymenocallis pedalis</i>	3	0
Lakau kena	False eranthemum	<i>Pseuderanthemum carruthersii</i>	2	0
Nikilailai	Golden bells	<i>Tecoma stans</i>	2	1
Maile	Fragrant fern	<i>Microsorium grossum</i>	1	0
Kanava	Beach cordia	<i>Cordia subcordata</i>	1	1
fuatausaga	Flame tree	<i>Delonix regia</i>	1	1
Tea'aua	Marvel of Peru	<i>Mirabilis jalapa</i>	2	1

8.20 Fence, Hedge and Windbreak Plants (Vaega Lakau Puipui Matagi/Pui)

At least 20 plants are planted in villages as living fencing, hedges or windbreaks to provide protection from wind, saltspray and dust and to provide privacy and valuable by-products such as flowers and leaves for garlands, medicines and other benefits. These include a range of wind- and salt-tolerant shrubs as hedge panax (**lautagitagi**), copper leaf acalypha (**ogoogo kula** or **kalakalāpusi**), half-flower or salt-bush (**gasu**), false eranthemum (**lautagitagi palagi**), common hibiscus (**'aute**) and Tahitian gardenia (**tiale**); large herbs, such as crinum lilies (**tapua** and **talotalo**); and large trees such as the very wind- and salt-resistant coastal trees, **fetau**, **kanava**, **fala**, **milo**, **niu** and **valovalo** (Table 48). The main reasons for planting these plants include fencing to delineate boundaries, protection from wind and saltspray, including keeping houses warm and dry during strong cold winds and rain, protection from dust and sand from nearby roads or open areas and to keep houses and facilities clean and for ornamental or decorative purposes, with many of the hedge plants having colourful bright-coloured red, yellow or variegated leaves.

Table 48. Results of the 6 most important plants planted around houses or in villages as hedges or protection (**vaega lakau puipui matagi/pui**) and 2 of these plants that are considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total	Total
Lautagitagi	hedge panax	Polyscias spp.	13	2
Fetau	Alexandrian laurel	Calophyllum inophyllum	12	8
Gasu	half-flower, saltbush	Scaevola taccada	12	7
Kanava	beach cordia	Cordia subcordata	11	6
Lakau Kalakala, ogoogo kula, kalakalapuhi	copper leaf, acalypha	Acalypha wilkesiana	11	3
Fala	Pandanus	Pandanus cultivars	11	2
Talotalo, tapua	Crinum lily	Crinum spp.	11	1
Lautagitagi Palagi?, laku pula kena	False eranthemum	Pseuderanthemum carruthersii	9	1
'aute	Common hibiscus	Hibiscus rosa-sinensis	7	5
Tiale	Tahitian gardenia	Gardenia taitensis	6	3
Milo	Thespian's tree	Thespesia populnea	6	1
Niu	coconut palm	Cocos nucifera	6	1
Inato	Beach privet	Clerodendrum inerme	4	2
Pitaasi	Arabian jasmine	Jasminum sambac	4	2
Valovalo	false elderberry	Premna serratifolia	3	0
Fuatausaga	Flame tree	Delonix regia	2	1
Nikilailai	Yellow bells	Tecoma stans	2	1
Futi	Bananas	Musa cultivars	2	0

8.21 Medicinal Plants (lakau mo Mouku Fakaoga mo Vailakau)

Some 50 medicinal plants were considered important, over 40 of which were mentioned by at least 2 respondent groups (Table 49). Given the lack of health services in rural areas, the high cost or unavailability of drugs in Tuvalu and the proven efficacy of many local herbal medicines, this constitutes an irreplaceable and extremely important health resource. Those most commonly thought to be rare or in short supply were **tolotolo** (*Triumfetta procumbens*), **fetau** (*Calophyllum inophyllum*), **valovalo** (*Premna serratifolia*), **inato** (*Clerodendrum inerme*), **futu** (*Barringtonia asiatica*), **nonu** (*Morinda citrifolia*), **tausunu** (*Tournefortia argentea*), **talie** (*Terminalia samoensis*), **talotalo** or **tapua** (*Crinum asiaticum*), **pini** or Cape gooseberry (*Physalis angulata*), and some varieties of **fala** (*Pandanus cultivars*) due mainly to overuse, land clearance, or failure to replant?

Table 49. Results of the 12 most important medicinal plants (**vaega lakau fai vailakau**) and 4 of these plants that are considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total x/19	Total Scarce
Katuli	Purslane	<i>Portulaca spp.</i>	13	0
Tolotolo	beach bur	<i>Triumfetta procumbens</i>	12	6
Saketa	Mauna Loa bean, beach pea	<i>Canavalia cathartica, Vigna marina</i>	12	0
Fala	Pandanus	<i>Pandanus tectorius</i>	12	4
Gasu	half-flower	<i>Scaevola taccada</i>	12	2
Mouku	grass (general), beach bunchgrass	<i>grasses or weeds, Lepturus repens</i>	12	0

Fetai, tanini	beach dodder	<i>Cassytha filiformis</i>	12	2
Nonu	Indian mulberry	<i>Morinda citrifolia</i>	12	4
Valovalo, Aloalo	false elderberry	<i>Premna serratifolia</i>	11	5
Niu	coconut palm	<i>Cocos nucifera</i>	11	2
Pua	beach gardenia	<i>Guettarda speciosa</i>	10	1
Puka	Lantern tree, birdcatcher tree	<i>Hernandia nymphaeifolia</i> , <i>Pisonia grandis</i>	10	0
Fetau	Alexandrian laurel	<i>Calophyllum inophyllum</i>	9	6
Kafututu/Futu	fish-poison tree	<i>Barringtonia asiatica</i>	9	4
Kanava	beach cordia	<i>Cordia subcordata</i>	9	2
Maile	fragrant fern	<i>Microsorium grossum</i>	9	1
Puafiti	frangipani, plumeria	<i>Plumeria spp.</i>	9	1
Olesi	Papaya	<i>Carica papaya</i>	8	0
Mouku solo	Dayflower	<i>Commelina diffusa</i>	8	2
Mei	Breadfruit	<i>Artocarpus spp.</i>	8	2
Tausunu	beach heliotrope	<i>Tournefortia argentea</i>	7	3
Talie	beach almond	<i>Terminalia samoensis</i>	7	3
Futi	Bananas	<i>Musa cultivars</i>	7	0
Inato	Beach privet	<i>Clerodendrum inerme</i>	5	5
Talotalo, tapua	crinum lily	<i>Crinum spp.</i>	5	3
Tiale	Tahitian gardenia	<i>Gardenia taitensis</i>	4	1
Piini	Cape gooseberry	<i>Physalis angulata</i>	4	4
Gie	Pemphis, ironwood	<i>Pemphis acidula</i>	3	0
Togo	spotted mangrove	<i>Rhizophora stylosa</i>	3	1
ogoogo	Great acalypha	<i>Acalypha grandis</i>	3	1
Felo	dyer's fig	<i>Ficus tinctoria</i>	2	2
Sulufe, Laukimoa (Nui)	Sword fern	<i>Nephrolepis spp.</i>	2	0
mile-a-minute, saketa lauliki	Mile-a-minute	<i>Mikania micrantha</i>	2	0
Luna	Beach boerhavia	<i>Boerhavia tetrandra</i>	2	1
Puka vai	Birdcatcher tree	<i>Pisonia grandis</i>	2	1
Lakau kula	Copperleaf acalypha	<i>Acalypha wilkesiana</i>	2	0
Muta	Nutsedge	<i>Cyperus rotundus</i>	2	0
Mouku talatala	Burgrass	<i>Cenchrus echinatus</i>	2	0

8.22 Medicinal Plants for Animals (Vaega Lakau Fai Vailakau moo Manu)

There were over 11 medicinal plants used for animals (**vaega lakau fai vailakau moo manu**) mentioned by respondents. The main animals that were treated were mainly pigs, but also dogs and cats. Those that were considered to be in short supply, due mainly to overuse for feeding livestock, land clearance or lack of planting were breadfruit (**mei**), papaya (**olesi**), dyer's fig (**felo**), beach heliotrope (**tausunu**) and acalypha (**ogoogo**) (Table 50).

Table 50. Results of the 6 most important medicinal used for animals and 2 of these plants that are considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total	Total
Mei	Breadfruit	Artocarpus spp.	13	9
Ogoogo	grand acalypha	Acalypha grandis	8	3
Olesi	Papaya	Carica papaya	7	6
Felo	Dyers fig	Focus tinctoria	7	4
Niu	Coconut	Cocos nucifera	6	2
Futi	Bananas	Musa cultivars	5	1
Tausunu	beach heliotrope	Tournefortia argentea	4	3
Nonu	Indian mulberry	Morinda citrifolia	3	1
Sagale	red-flowered black man-grove	Lumnitzera littorea	3	0
Tapua, talotalo	crinum lily	Crinum asiaticum	1	0
Fetau	Alexandian laurel	Calophyllum inophyllum	1	0

8.23 Plants Used for Construction, Woodcarving, Toolmaking, Fishing Equipment, Boatbuilding, Toymaking and Firewood

Tables 50–55 show that there are over 20 multipurpose plants, mainly trees, that are used in construction of houses and other structure in the villages, for woodcarving and toolmaking, toymaking, fishing equipment, boatbuilding and firewood, all important provisioning services in Tuvalu. Many of the most important multipurpose species, which are used for most of these purposes, are said to be in short supply on Funafuti, reportedly due to land clearance, overuse and climate change, which may be associated with coastal erosion causing many trees to die or fall into the sea (Tables 50–55). The main responses are seen as protection of remaining trees or tree groves, reforestation and replanting and building awareness of the cultural importance of these trees.

Table 50. Results of the 6 most important most important plants used for construction of houses or other structures in the village (lakau fai te fale) and 2 of these plants that are considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total x/19	Total Scarce
Pukavai	bird-catcher tree	<i>Pisonia grandis</i>	15	5
Fala	Pandanus	<i>Pandanus tectorius</i>	13	6
Fetau	Alexandrian laurel	<i>Calophyllum inophyllum</i>	12	7
Pukavaka	Chinese lantern tree	<i>Hernandia nymphaeifolia</i>	11	1
Niu	Coconut palm	<i>Cocas nucifera</i>	10	4
Kanava	beach cordia	<i>Cordia subcordata</i>	9	6
Togo	spotted mangrove	<i>Rhizophora stylosa</i>	8	1
Pua	beach gardenia	<i>Guettarda speciosa</i>	8	1
Gie	pemphis, ironwood	<i>Pemphis acidula</i>	7	1
Milo	Thespian's tree	<i>Thespesia populnea</i>	6	2
Sagale	red-flowered black mangrove	<i>Lumnitzera littorea</i>	5	2
Mai/Mei	Breadfruit	<i>Artocarpus spp</i>	5	1
Nonu	Indian mulberry	<i>Morinda citrifolia</i>	5	0
Faro	double apple, yellow-wood	<i>Ochrosia oppositifolia</i>	4	0

Oleic	Papaya	<i>Carica papaya</i>	3	0
Katuli	Purslane	<i>Portulaca spp.</i>	3	0

Table 51. Results of the 6 most important most important plants used for woodcarving and toolmaking (**lakau e fakaaoga ki tofi mo nisi mea faigaluega**) and 2 of these plants that are considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total x/10	Total Scarce
Fetau	Alexandrina laurel	<i>Calophyllum inophyllum</i>	14	6
Gie	Ironwood	<i>Pemphis acidula</i>	12	10
Togo	Spotted mangrove	<i>Rhizophora stylosa</i>	11	4
Puka	Bird-catcher tree	<i>Pisonia grandis</i>	10	2
Pukavaka	Chinese lantern tree	<i>Hernandia nymphaeifolia</i>	9	5
milo	Thespian's tree	<i>Thespesia populnea</i>	9	1
Kanava	Beach cordia	<i>Cordia subcordata</i>	8	3
Sagale	Red-flowered black mangrove	<i>Lumnitzera littorea</i>	7	3
Pua	Beach gardenia	<i>Guettarda speciosa</i>	6	1
Tiale	Tahitian gardenia	<i>Gardenia taitensis</i>	6	0
Fala	Pandanus	<i>Pandanus tectorius</i>	6	0
Nonu	Indian mulberry	<i>Morinda citrifolia</i>	5	0
Fatu	coral rock or limestone	-	5	1
Faro	double apple, yellow wood	<i>Ochrosia oppositifolia</i>	2	0

Table 52. Results of the 6 most important plants used for used for canoe or boatbuilding and canoe or boat parts (**lakau taua kola e fakaaoga mo fai a vaka/ pooti**) and 2 of these plants that are considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total	Total
Fetau	Alexandrian laurel	<i>Calophyllum inophyllum</i>	11	10
Kanava	Beach cordia	<i>Cordia subcordata</i>	11	8
Pukavaka	Chinese lantern tree	<i>Hernandia nymphaeifolia</i>	11	0
Gie	Pemphis, ironwood	<i>Pemphis acidula</i>	10	4
Mai	breadfruit	<i>Artocarpus altilis</i>	8	2
Pukavai	Bird-catcher tree	<i>Pisonia grandis</i>	8	2
Milo	Thespian's tree	<i>Thespesia populnea</i>	5	1
Niu	Coconut palm	<i>Cocos nucifera</i>	5	0
Futu	Fish poison tree	<i>Barringtonia asiatica</i>	5	0
Tausunu	Beach heliotrope	<i>Tournefortia argentea</i>	1	1

Table 53. Results of the 6 most important plants used for making fishing equipment (**lakau fakaoga mo faite a mea faika**) and 2 of these plants that are considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total	Total
Gie	Pemphis, ironwood	<i>Pemphis acidula</i>	12	8
Fetau	Alexandrian laurel	<i>Calophyllum inophyllum</i>	10	7
Kanava	Beach cordia	<i>Cordia subcordata</i>	6	6
Niu	Coconut palm	<i>Cocos nucifera</i>	6	2
Sagale	Red-flowered black mangrove	<i>Lumnitzera littorea</i>	6	3
Milo	Thespian's tree	<i>Thespesia populnea</i>	4	2
Puka	Bird-catcher tree	<i>Pisonia grandis</i>	4	0
Pua	Beach gardenia	<i>Guettarda speciosa</i>	3	1
Fala	pandanus	<i>Pandanus tectorius</i>	3	1
Valovalu/Aloalo	False elderberry	<i>Premna serratifolia</i>	2	0
Bamboo	Polynesian bamboo	<i>Schizostachyum glaucifolium</i>	2	0
Togo	Spotted mangrove	<i>Rhizophora stylosa</i>	2	0
Nonu	Indian mulberry	<i>Morinda citrifolia</i>	2	0

Table 54. Results of the 3 most important plants used for making toys or used in games (**lakau fakaoga mo fai a mea tafao**) (**lakau fakaoga mo fai a tui mea taulima - tuipuka**) and 2 of these plants that are considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total	Total
Kanava	Beach cordia	<i>Cordia subcordata</i>	12	9
Fala	Pandanus	<i>Pandanus tectorius</i>	11	4
Fetau	Alexandrian laurel	<i>Calophyllum inophyllum</i>	11	9
Gie	Pemphis, ironwood	<i>Pemphis acidula</i>	8	8
Milo	Thespian's tree	<i>Thespesia populnea</i>	7	1
Tiale	Tahitian gardenia	<i>Gardenia taitensis</i>	5	3
Puka vaka	Chinese lantern tree	<i>Hernandia nymphaeifolia</i>	2	0
Nonu	Indian mulberry	<i>Morinda citrifolia</i>	1	0

Table 55. Results of the 6 most important plants used for firewood (**lakau taua kola e fakaoga mo fafie**) and 2 of these plants that are considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total	Total
Fetau	Alexandrian laurel	<i>Calophyllum inophyllum</i>	13	9
Kanava	Beach cordia	<i>Cordia subcordata</i>	13	8
Mai	breadfruit	<i>Artocarpus altilis</i>	10	3
Niu	Coconut palm	<i>Cocos nucifera</i>	10	2
Gie	Pemphis, ironwood	<i>Pemphis acidula</i>	9	8
Togo	Spotted mangrove	<i>Rhizophora stylosa</i>	6	4
Valovalu	false elderberry	<i>Premna serratifolia</i>	5	1
Fala	pandanus	<i>Pandanus tectorius</i>	5	0
Pua	Beach gardenia	<i>Guettarda speciosa</i>	4	0
Gasu	half-flower	<i>Scaevola taccada</i>	3	0

Taume	coconut flower spathe	<i>Cocos nucifera</i>	3	0
Sagale	Red-flowered black mangrove	<i>Lumnitzera littorea</i>	1	0
Pukavaka	Chinese lantern tree	<i>Hernandia nymphaeifolia</i>	1	0

8.24 Weaving and Handicraft Plants (Laakau Fakaoga mo Laga, Fai Mea Taulima)

Plants used for weaving and plating mats, baskets, blinds or curtains, roofing and other woven or platted handicrafts are among the most important cultural necessities and exchange items. Table 56 lists those plant considered to be most important for these purposes, the most important of which are the leaves processed of pandanus (**kie**, **fala** and **voivoi**) and the leaves or fronds of the coconut palm (**niu**), including the almost pure white juvenile leaves, known as **ta**, that are woven into very intricate fine baskets, fans and other handicrafts. Also considered important is the inner bark of **fou** or **fau** trees (*Hibiscus tiliaceus* and *Pipturus argenteus*), Some of the more preferred of these plants these are in short supply and in need of planting.

Table 56. Results of the 6 most important most important plants used for weaving and other handicrafts (**laakau fakaoga mo laga, fai mea taulima**) and 2 of these plants that are considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total	Total
Kie	weaving pandanus	<i>Pandanus cultivars</i>	13	13
Niu	coconut	<i>Cocos nucifera</i>	12	5
Fala	pandanus cultivars	<i>Pandanus tectorius</i>	10	7
Gie	pemphis	<i>Pemphis acidula</i>	7	4
Fetau	Alexandrian laurel	<i>Calophyllum inophyllum</i>	7	1
Fou	beach hibiscus, beach mulberry	<i>Hibiscus tiliaceus</i> , <i>Pipturus argenteus</i>	5	2
Sulu	cloth	?	5	3
Kanava	Beach cordia	<i>Cordia subcordata</i>	5	1
Voivoi	weaving pandanus	<i>Pandanus cultivar</i>	5	0
Togo	spotted mangrove	<i>Rhizophora stylosa</i>	4	0
Saketa	Canavalia cathartica	<i>Canavalia cathartica</i>	2	0
Nonu	Indian mulberry	<i>Morinda citrifolia</i>	2	0

8.25 Plants used for Cordage, String or Rope (Lakau mo Fai te Kolokolo)

Cordage, rope or string used for lashing houses, canoes and other things is one of the most important and widely used commodities in Tuvalu. The most important is braided sennit rope or twine (**kafa**) made from the husk fibres of the coconut, with the favoured coconut cultivar used for this purpose being known as **niu kafa**, a variety with long strong husk fibres. Also important, and pandanus leave (**lau fala**), and the bast (inner bark) fibres of **fou** or **fau** trees (*Hibiscus tiliaceus* and *Pipturus argenteus*), although it is unclear which one was referred to most in the survey. A majority of informants said that both were in short supply (Table 57).

Table 57. Results of the 3 most important most plants used for cordage, string or rope (**lakau mo fai te kolokolo**) and 1 of these plants that are considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total	Total
Niu	coconut palm leaves	<i>Cocos nucifera</i>	14	12
Fou, Fau (tama fou)	beach nettle, beach hibiscus	<i>Pipturus argenteus</i> , <i>Hibiscus tiliaceus</i>	13	6
Fala	Pandanus leaves	<i>Pandanus cultivars</i>	4	0

8.26 Plants used to make beads used in necklaces or handicrafts (vaega lakau fait e mea taulima)

The most important plant parts used to produce beads or other woody pieces used in necklaces, bracelets, jewelry and other beadwork (**mea taulima**) are the dark brown-black seeds of **puka** or **puka vaka** (*Hernandia nymphaeifolia*). The wood of a number of other plants is also carved into beads or other elements used to make jewelry (Table 58). Most informants said that **puka vaka** and a number of the other sources of these materials, as indicated in previous sections, are in short supply, again mainly due to land clearance, coastal erosion and failure to plant such trees..

Table 58. Results of the 6 most important plants used for making necklaces or to obtain beads used in necklaces, jewelry or handicrafts (**lakau fakaaoga mo fai a tui mea taulima - tuipuka**) and 2 of these plants that are considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total x/19	Total Sarce
Puka vaka, puka	Chinese lantern tree	<i>Hernandia nymphaeifolia</i>	14	11
Gie	Pemphis, ironwood	<i>Pemphis acidula</i>	9	6
Fetau	Alexandrian laurel	<i>Calophyllum inophyllum</i>	8	5
Fou, fau	Beach hibiscus	<i>Hibiscus tiliaceus</i>	7	2
Pukavai	Bird-catcher tree	<i>Pisonia grandis</i>	5	5
Sagale	Red-flowered black mangrove	<i>Lumnitzera littorea</i>	5	0
Kanava	Beach cordia	<i>Cordia subcordata</i>	4	1
Fala	pandanus	<i>Pandanus tectorius</i>	3	1
Togo	Spotted mangrove	<i>Rhizophora stylosa</i>	2	1

8.27 Plants used to wrap or parcel food (lakau mo saisai meakai)

The leaves of some 15 different plants are used to parcel food (Table 59), an important “organic” way of satisfying one of the main necessities of life, one which when plastics and other inorganic material are used contributes to one of the most significant waste streams, especially plastics, the disposal of which is problematic on the small atolls of Tuvalu. A number of plants these are in short supply due to overuse, failure to plant, land clearance and degradation and increasing dependence on imported substitutes. Those that should be planted for this use include breadfruit (**mei**), giant swamp taro (**pulaka**), giant taro (**taamu**), and banana cultivars (**futi**).

Table 59. Results of the 6 most important plants used to wrap or parcel food (**lakau mo saisai meakai**) and 2 of these plants that are considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total	Total
Lau mei	breadfruit leaves	<i>Artocarpus spp.</i>	12	8
Lau pulaka	giant swamp taro leaves	<i>Cyrtosperma chamissonis</i>	10	6
Lau futi	banana leaves	<i>Musa cultivars</i>	7	5
Lau fala	pandanus leaves	<i>Pandanus spp</i>	7	1
Lau niu	coconut leaves	<i>Cocos nucifera</i>	6	3
Lau fetau	Alexandrian laurel leaves	<i>Calophyllum inophyllum</i>	5	1
Moepulapula	young coconut leaves	<i>Cocos nucifera</i>	5	0
Lau tāmūu	giant taro leaves	<i>Alocasia macrorrhizos</i>	4	3
Lau kanava	Beach cordia leaves	<i>Cordia subcordata</i>	4	1
Lau gie	pemphis leaves	<i>Pemphis acidula</i>	4	1
Lau maile	fragrant fern leaves	<i>Microsorium grossum</i>	4	1
Lau nonu	Indian mulberry leaves	<i>Morinda citrifolia</i>	3	0
Lau talo	taro leaves	<i>Colocasia esculenta</i>	2	1
Lau fou	beach hibiscus leaves	<i>Hibiscus tiliaceus</i>	1	1
Lau katafa	bird's-nest fern leaves	<i>Asplenium nidus</i>	1	0

8.28 Plants used to perfume coconut oil (lakau taua kola e fakaoga mo fai a sinu manogi)

There are about 20 plants used to perfume coconut oil, which is known as **sinu manogi** (

Table 60). The most widely used plant parts are the flowers of beach gardenia (**pua**), Tahitian gardenia (**tiale**) and Alexandrian laurel (**fetau**); the male flower of the pandanus (**sigano**); the fragrant underground root tubers of nut sedge and possibly the beach sedge, **muta, mouku fai sinu?** (*Cyperus* spp.); and the flowers and young tender terminal leaves of the false elderberry (**valovalo, aloalo**). Others that were said to be important in group discussions were the leaves of fragrant fern (**maile**), crinum lily (**tapua, talotalo**), sacred basil (**mili**), beach privet (**inato**) and Arabian jasmine (**pitaasi**). A number of these are said to be in short supply due to overuse, coastal erosion and failure to replant,

Table 60. Results of the 6 most important plants used to perfume coconut oil (**lakau taua kola e fakaoga mo fai a sinu manogi**) and 2 of these plants that are considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total x/19	Total Scarce
Pua	beach gardenia	<i>Guettarda speciosa</i>	16	8
Tiale	Tahitian gardenia	<i>Gardenia taitensis</i>	16	4
Fetau	Alexandrian laurel	<i>Calophyllum inophyllum</i>	15	5
muta	nut sedge, beach sedge	<i>Cyperus spp.</i>	12	3
Fala, sigano	pandanus male flower	<i>Pandanus tectorius</i>	10	6
valovalo, Aloalo	false elderberry	<i>Premna serratifolia</i>	8	4
Nonu	Indian mulberry	<i>Morinda citrifolia</i>	8	7

Te Fou	beach nettle	<i>Pipturus argenteus</i>	6	1
Niu	coconut	<i>Cocos nucifera</i>	6	0
Maile	fragrant fern	<i>Microsorium grossum</i>	5	0
Tapua. Talotalo	crinum lily	<i>Crinum spp.</i>	5	0
Mili	basil	<i>Ocimum sanctum</i>	5	0
Pitaasi	Arabian jasmine	<i>Jasminum sambac</i>	4	2
inato	Beach privet	<i>Clerodendrum inerme</i>	3	1
fetai	beach dodder	<i>Cassytha filiformis</i>	1	0
melia	frangipani	<i>Plumeria spp.</i>	1	0
gasu	half-flower	<i>Scaevola taccada</i>	1	0
tolotolo	beach bur	<i>Triumfetta procumbens</i>	1	0

8.29 Dye plants (Vaega Lakau Faai a Peeni)

Only two plants were said to be used to make dye (**peeni**). These were **nonu** (*Morinda citrifolia*) and **togo** (*Rhizophora stylosa*). The most important is **nonu** the roots of which are used along with limestone to make a bright red dye used to dye pandanus leaves used in weaving mats and making garlands (Koch 1983). Both plants are said to be in short supply by some respondents (Table 61). Hedley (1897) reports the ash from the seed of **puka vaka** (*Hernandia nymphaeifolia*) was formerly used as pigment for tattoos in the late 1800s.

Table 61. Results of the 3 most important plants used to make dyes or paint (**faai a peeni**) and 1 of these plants that is considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016 (Note * = not mentioned in community-based survey, but the ash from the reportedly used as pigment for tattoos on Funafuti in the 1800s Hedley (1897).

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total x/19	Total Scarce
nonu	Indian mulberry, noni	<i>Morinda citrifolia</i>	12	9
togo	Spotted mangrove	<i>Rhizophora stylosa</i>	10	6
Puka vaka	Chinese lantern tree	<i>Hernandia nymphaeifolia</i>	*	

8.30 Mulching, Compost and Fertilizer

Over 14 plants that are used for mulching, compost or fertilizer to improve and protect soils, preserve soil moisture and control weed growth in gardens, most commonly in taro gardens or around banana or breadfruit trees (Table 62). This is a particularly important ecosystem service given the extremely, poor, dry and highly porous atoll soils of Tuvalu. Some of these same plants and other are also used along with soil in composting systems. A number of these are considered to be in short supply mainly due to overuse, land clearance or prolonged drought or climate change; and some of them, such as **fou tagata** and **fou fafine** (*Hibiscus tiliaceus* and *Pipturus argenteus*) are now rarely used because they have been in short supply for a long time.

Table 62. Results of the 6 most important plants that are used for fertilizer or mulch (**kaiao**) in gardens and 2 of these plants that are considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total	Total
Laumei	breadfruit leaves	<i>Artocarpus altilis</i>	13	8
Pukavai	bird-catcher tree	<i>Pisonia grandis</i>	12	9
Launiu	coconut palm	<i>Cocos nucifera</i>	11	2

Laufala	pandanus leaves	<i>Pandanus cultivars</i>	11	2
Ooogo, kalakalaapuhi	great acalypha	<i>Acalypha grandis</i>	8	2
Pini	Cape gooseberry, legumes	<i>Physalis angulata, legumes (gen.)</i>	7	1
Futi, lau futi	banana leaves	<i>Musa cultivars</i>	5	0
Kanava	beach cordia	<i>Cordia subcordata</i>	4	2
Lupus	beach gardenia	<i>Guettarda speciosa</i>	4	2
Lausaketa	beach pea, beach bean	<i>Vigna marina, Canavalia cathartica</i>	4	1
Lau Gasu	half-flower	<i>Scaevola taccada</i>	3	0
Lau fou fafine, fau tu	Beach hibiscus,	<i>Hibiscus tiliaceus</i>	3	2
Lau fou tagata, fau vau	pipturus	<i>Pipturus argenteus</i>	3	2
Lau Milo	Thespian's tree	<i>Thespesia populnea</i>	3	3

8.31 Fish poison (poisini a ika)

Only one plant, the fish-poison tree, **futu** (*Barringtonia asiatica*), was said to be used as a fish poison or stupeficient. This was mentioned by all 19 informants, who all said that it was rare on Funafuti, mainly due to land clearance. Unlike other areas in the Pacific the use of fish poisons is uncommon in Tuvalu.

8.32 Plants used for magic and casting spells (fai a vailakau fakataulaitu)

About 10 species were used traditionally for magic or casting spells (**fai a vailakau fakataulaitu**), most of which are native plants (Table 63). Some of these are still reportedly used, or believed to be used, by some people in this way. Those that are clearly in short supply are **puka** (*Pisonia grandis*), **nonu** (*Morinda citrifolia*) and **sagale** (*Lumnitzera littorea*).

Table 63. Results of the 3 most important plants traditionally used in magic or for casting spells (**fai a vailakau fakataulaitu**) and 1 of these plants that is considered to be rare or increasingly hard to find, based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total	Total
Pukavai	bird-catcher tree	<i>Pisonia grandis</i>	11	10
Nonu	Indian mulberry	<i>Morinda citrifolia</i>	8	6
Sagale	red-flowered black mangrove	<i>Lumnitzera littorea</i>	6	5
Futu	fish-poison tree	<i>Barringtonia asiatica</i>	5	2
Lautagitagi	hedge panax	<i>Polyscias spp.</i>	4	1
Olesi	papaya	<i>Carica papaya</i>	3	3
Lakau Ta Namu	blue vitex	<i>Vitex trifolia</i>	3	1
Valovalo	false elderberry	<i>Premna serratifolia</i>	2	1
Inato	beach privet	<i>Clerodendrum inerme</i>	2	0
Ogoogo	acalypha	<i>Acalypha spp.</i>	2	0

8.33 Birds

Watling's 1998 survey reported 21 native birds as being present within the Funafuti Marine Conservation Area, 16 of which were observed during the survey, of which 4 species were found to be breeding. The survey showed that Tefala and Fuafatu Islets were the most important breeding sites for **lakia** (black noddy), **akiaki** (fairy tern) and **gogo** (brown noddy) (Watling 1998).

Eighteen (18) birds were reported present in 2016 on Funafuti by respondents (Table 64). These included a wide range of seabirds and migrant birds, all considered native to Tuvalu. A number of these birds were reported to be rare or in short supply, most notably **akiaki** (*Sternula nereis*), **gogo** (*Anous stolidus*), **lupe** (*Ducula pacifica*) and **kaka** (*Limosa lapponica*). The main reasons for their threatened status were hunting and overconsumption, because these birds and their eggs are considered a traditional delicacy. The most commonly hunted birds include black noddy (**lakia**), red-footed booby (**kanapu**), brown noddy (**gogo**) and frigatebirds (**katafa**). The birds are mainly hunted in coconut trees, other large coastal trees and there is a need to increasing awareness of the problem, enforceable national and local laws and conservation areas dedicated to the protection of these birds (Table 65). As stressed by Thaman and Neemia (1992) in the Tuvalu National Report to the 1992 Rio Summit, the loss of seabirds was considered, at the time, to be one of the most serious environmental and cultural problems because seabirds are of critical importance in guiding fishermen to school of different tuna and other species.

Table 64. Results of the 9 most important land and sea birds found in Funafuti plants and 4 of these plants that are considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total x/19	Total Rare
Akiaki/matapula	Fairy tern	<i>Sternula nereis</i>	15	9
Gogo	Brown noddy	<i>Anous stolidus</i>	14	10
Lupe	Pacific pigeon	<i>Ducula pacifica</i>	10	2
Kolili	Ruddy turnstone	<i>Arenaria interpres</i>	9	2
Lakia	Black noddy	<i>Anous minutus</i>	9	2
Suvi/kaleva	long-tailed cuckoo	<i>Urodynamis taitensis</i>	9	2
Kōtā	brown booby	<i>Sula leucogaster</i>	8	0
Moa	chicken	<i>Gallus domesticus</i>	8	2
Tuli	Pacific golden plover	<i>Pluvialis fulva</i>	8	1
Kaka	bar-tailed godwit	<i>Limosa lapponica</i>	7	5
Kanapu	Red-footed booby	<i>Sula</i>	7	0
Tavakelau	White-tailed tropicbird	<i>Phaethon lepturus</i>	7	0
Katafa	Frigate birds	<i>Fregata spp.</i>	5	0
Matuku	reef heron	<i>Egretta sacra</i>	5	1
Pesini	domestic pigeon	<i>Columba livia domestica</i>	5	1
Taki	Domestic duck	<i>Anas platyrhynchos domesticus</i>	4	1
Talaaliki	Sooty tern	<i>Onychoprion fuscatus</i>	4	0
Toloo	Gray duck/Pacific black duck	<i>Anas superciliosa</i>	3	0

Table 65. Results of the 3 most important sea birds that are commonly eaten on Funafuti plants based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total x/19
Lakia	black noddy	<i>Anous minutus</i>	14
Kanapu	red-footed booby	<i>Sula</i>	11
Gogo	brown noddy	<i>Anous stolidus</i>	6
Katafa	frigate birds	<i>Fregata spp.</i>	4

8.34 Seabird nesting trees

Six trees were listing among the most important seabird nesting trees, the most important of which were the **puka** or **puka vai** (*Pisonia grandis*), a well-known seabird nesting tree throughout much of the Indo-Pacific, followed by **fetau** (*Calophyllum inophyllum*) and the coconut palm (**niu**), with all three being considered to be rare or in short-supply and in need of protection or replanting.

Table 66. Results of the 5 most important trees that sea birds nest on in Funafuti plants and 2 of these trees that are considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total x/19	Total Scarce
Puka, puka vai	bird-catcher tree	<i>Pisonia grandis</i>	13	10
Fetau	Alexandrian laurel	<i>Calophyllum inophyllum</i>	10	6
Niu	coconut palm	<i>Cocos nucifera</i>	9	7
Mei	breadfruit	<i>Artocarpus altilis</i>	7	3
Kanava	beach cordia	<i>Cordia subcordata</i>	4	1
Fala	pandanus	<i>Pandanus tectorius</i>	3	1

8.35 Domestic animals

Six domestic animals are considered to be important on Funafuti. These include ducks (**taki**), cats (**puusi**), dogs (**kuli**), pigs (**puaka**) and chickens (**moa**). The latter two are important foods, normally reserved for special occasions and feasts. Due to the shortage of land, lack of fodder and water and the harsh climate there are no cattle, sheep, goats or horses in Tuvalu. Imported frozen chicken, beef, lamb, various sausages and tinned corned beef and other tinned meats, including tinned fish, are increasingly important sources of protein on Funafuti. Cats play an important role in rat control and dogs are often used to guard residences.

Ducks. Although valued, are rare or in short supply due to over use or because the environment too dry and unsuitable. Dogs are also considered to be in short supply, although it is unclear why, although overuse was stated as a main reason and that there have been recent attempts to capture the increasing number of stray dogs that threaten chickens, pigs and people on Fogafale Islet.

Table 72. Results of the 3 most important domestic animals (**manu fagai**) on Funafuti and 2 of these that are considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total	Total
Taki	domestic duck	Anas platyrhynchos domesticus	19	17
Puaka	pig	Sus scrofa domesticus	16	0
Puusi	cat	Felis catus	14	1
Kuli	dog	Canis lupus familiaris	13	11
moa	chicken	Gallus domesticus	10	0

8.36 Lizards (moko and pili)

The lizards in Tuvalu are all geckos and skinks, five of which were mentioned by respondent groups (Table 73). The names **moko** and **pili** are probably the original Proto-Polynesian names of the more nocturnal geckos and the more diurnal skinks, although **moko** seems to be the general name for lizards in the northern atolls and **pili** in the south. The identification of these species, in terms of what Tuvaluan names they correspond to are tentative. At least 4 of these are either indigenous or, more probably, long-established introduced species that featured on a 1986 Tuvalu commemorative stamp issue (Figure S). Two that are probably human-assisted colonisations are the moth skink (*Lipinia noctuid*) and the house gecko (*Hemidactylus frenatus*). A new reportedly endemic gecko, **tepukapili** (*Lepidodactylus tepukapili*), with a highly pigmented oral cavity like the Rotuman species, *L. gardineri*) was identified from Tepuka Islet in 1998 (Zug et al. 2003). Three species are considered rare or threatened due mainly to land degradation and destruction of their habitat, mainly coastal forest and trees (with many geckos living under the bark of larger trees), and possibly predation by rats, birds and other animals. Additional skinks reported from Funafuti are *Nactus pelagicus* and *Lygosoma adenosperum* which have been reported present near mangroves (Buckley 1985).

Interestingly, the preliminary Funafuti survey, respondents, mentioned **pili mafolefole and kalisi** on most questionnaires (9/15) and also mentioned **tepuka pili** and a **pili matakafi**.

Table 73. Results of the 5 most important lizards (moko mot e pili) and 2 of these lizards that are considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total	Total
Moko lefulefu	mourning gecko	<i>Lepidodactylus lugubris</i>	13	7
Moko lefulefu?	Pelagic gecko	<i>Noctus (Gynaodactylus) pelagicus</i>	?	?
Moko	oceanic gecko	<i>Gehrya oceanica</i>	11	8
Pili lefulefu	moth skink?	<i>Lipinia noctua</i>	11	8
Pili kena	Asian house gecko?	<i>Hemidactylis frenatus</i>	9	1
Pili Uli	copper-tailed skink	<i>Emoia cyanura</i>	7	1

8.37 Coconut crabs

Although there is only one species of coconut crab (known as **uu**), respondent groups clearly recognise three different names that may represent different growth stages, size classes, sexes or different colour forms, with **fakapuna** reportedly representing larger blue coconut crabs that are found in their burrows and dug up with sticks (Table 74). All are considered to be rare or threatened. Like hermit crabs, juvenile coconut crabs also require empty gastropod shells to protect their tender abdomens until, as adults, they develop a tough protective exoskeleton and stop carrying shells. Like hermit crabs, young coconut crabs must replace their shells with larger shells as they grow to maturity (Reese and Kinsey 1968; Fletcher 1993; Greenaway 2003).

Table 74. Results of the 3 most important coconut crabs (**uu**) and 2 of these trees that are considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total	Total
Uu Kula (red)	coconut crab	Birgus latro	14	10
Uu Green	coconut crab	Birgus latro	9	6
Fakapuna	?	?	4	2

8.38 Insects and arthropods

Table 75 shows insects and other arthropods that respondent groups mentioned, which include and range of unidentified ants (**lō**) and other insects such as ladybirds, scorpions (**akalava**) and centipedes (**molokau**); and the pupae or chrysalis of butterflies (**mōmōlupe**). Strangely, no butterflies or moths (both known as **lupe**), mosquitoes (**namu**), flies (**lago** and **nono**), bees and wasps (**lagofufu** or **pī**), grasshoppers (**sē**), crickets (**ligoligo**), termites or white ants), dragonflies (**samū** or **samumu**) and spiders (**naleau**) were mentioned, although most of these, including **sikusikulauniu** (possibly a coconut stick insect or type of grasshopper) and **lō fai pakau** were mentioned during the preliminary September BIORAP. This is despite the fact that these are well known to most Tuvaluans; many are were collected on Funafuti by Hedley in the late 1890s and described by Rainbow in 1897; and Tuvalu has issued numerous commemorative stamp issues featuring insects, including: butterflies in 1981, 1985, 2000, 2001, 2003 and 2009; butterflies and moths and their caterpillars, rhinoceros beetle (**manukainiu**) and the honey bee in in 2001; "Insects of the Pacific", including the housefly, in 2005; and beetles in 2012. To stress the diversity of insects Rainbow (1897) quotes Hedley's observation about insects specimens brought back from the Royal Society of London's expedition to Funafuti in 1896 that: "The collection brought back does scanty justice to the entomological fauna of Funafuti, whose claims were, I fear, unduly subordinated to the demands of the Marine Invertebrata, the spiders being the only group whose proportions are at all fairly represented."

Table 75. Results of the 9 most important insects (e.g., ants, **mōmōlupe**, etc.) and 2 of these trees that are considered to be rare or increasingly hard to find based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total	Total
Loo Makape	ant	?	14	3
Mogamoga	Asian cockroach	<i>Blatella asahinai</i>	13	2
Loo Uli	black ant	?	12	6
Loo Ote Suka	sugar ant	?	10	4
Ladybird	ladybirds	Coccinellidae	9	1
Looata	large black ant	?	7	2
Mōmōlupe, ligoligo?	cricket	<i>Acheta domestica?</i>	6	3
Loo Uu	biting red ant	?	5	3
Akalava	scorpion	Order Scorpiones	4	2
Molokau	centipede	<i>Scolopendra subspinipes</i>	3	2

8.39 Invasive species

The most serious weeds on Funafuti are probably **mohuku solo**, which can refer to both wedelia or trailing daisy (*Sphagneticola trilobata*) or dayflower (*Commelina diffusa*); and **mouku matiotio**, sensitive plant; and **kateketeke**, bur grass, both of which have sharp thorns or burs, the latter of which gets stuck in clothing or in the fur of cats and dogs; **saketa**, beach pea; and **muta**, nutsedge, which are both serious garden weeds that reportedly overrun gardens; and trees such as papaya, coconut and breadfruit, the roots of which damage water cisterns and spoil gardens (Table 76). As discussed below under threats, *Sphagneticola trilobata* is considered one of the world's 100 worst invasive species.

Table 76. Results of the 3 most serious weed species (lakau fakamataku/fakamasei), why are they so bad, what plants, areas or animals do they affect, what can be done to control or eliminate them, based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total	Impacts
Mouku solo	Wedelia or trailing daisy or dayflower	<i>Sphagneticola trilobata</i> , <i>Commelina diffusa</i>	16	Spoil Garden
Mouku matiotio	sensitive plant, weedy grasses (gen.)	<i>Mimosa pudica</i>	16	Spoil Garden, sharp spines
Kateketeke	bur grass, sand bur	<i>Cenchrus echinatus</i>	14	Sharp spines, get in cloths, fur or cats and dogs
Saketa	beach bean, sea pea	<i>Canavalia cathartica</i> , <i>Vigna marine</i>	9	Spoil Gardens
Olesi	papaya	<i>Carica papaya</i>	8	Damage water cistern
muta	nutsedge, nutgrass	<i>Cyperus rotundus</i>	5	Spoils gardens
niu	coconut palm	<i>Cocos nucifera</i>	3	Damage water cisterns, spoils gardens
Mei	breadfruit	<i>Artocarpus altilis</i>	1	Damage water cisterns, spoils gardens

The most serious animals pests on Funafuti are clearly black rats (**kimoa**, the general name for rats); yellow crazy ants (**lō kula** or **lō makalokalo**) and a number of caterpillars or insect larvae (**anufe**) (Table 77). Black rats (*Rattus rattus*), which can climb trees, are considered serious garden pests that eat sweet potato (**pateta**), coconuts (**niu**), papaya (**olesi**), pandanus fruits (**fuifala**), which are one of the main foods of the threatened coconut crab, **uuga**), breadfruit (**mei**) and crinum lilies (**talotalo**); and gnaw and destroy human belongings such as clothing and plastic articles. They are also considered a serious threat to nesting seabirds. In 2006, black rats were the focus of a 2006 UN control programme using poison baits funded at \$US200,000 (RNZ 2006).

Yellow crazy ants, which were first reported to be a serious problem in 2014 (RNZ 2014), cause great human discomfort and infest food stuffs, kill coconut crabs, hermit crabs and other land crabs and infest pandanus and crinum lily plants, eating the fruits and using these plants as nests.

The caterpillars or larvae, which could include a range of moth or butterfly (**pepe**) larvae and the larvae of the **manukainiu**, rhinoceros beetle (*Oryctes rhinoceros*), cause serious damage to food and ornamental gardens, and affect sweet potato, coconut palms, taro and a range of garden vegetables, such as cabbages. In the past a virus was introduced, unsuccessfully, into Nanumaga to control the rhinoceros beetle.

Unfortunately the only means for controlling these pests known to the respondents were insecticides or in the case of rats, rat poison, the effects on human health and the environment of which are not well-understood in Tuvalu.



Table 77. Results of the 3 most serious animal pests (*lakau fakamataku/fakamasei*), why they so bad, what plants, areas or animals do they affect, and what can be done to control or eliminate them, based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

TUVALUAN NAME	COMMON NAMES	SCIENTIFIC NAMES	Total
Kimoa	black rats	<i>Rattus rattus</i>	11
Loo Kula. Loo makalo-kalo	yellow crazy ant	<i>Anoplolepis gracilipes</i>	9
Anufe	Caterpillars, larvae		7

9

MAJOR TRENDS OR CHANGES IN THE STATUS OF BIODIVERSITY AND ECOSYSTEM SERVICES

The main trends or changes in the status of biodiversity and ecosystem services (BES) in Tuvalu are an increasing loss of species diversity and the extirpation or seriously declining populations of important species within most terrestrial and marine ecosystems, including the resultant degradation of ecosystems and loss BES.

9.1 Threatened Ecosystems

The main threatened ecosystems are: 1) coastal forest and vegetation; 2) mangroves; 3) agricultural ecosystems, particularly intensive excavated swamp taro gardens and traditional food crop cultivars; 3) coral reefs, beaches and nearshore lagoon and ocean side marine ecosystems.

9.1.1 Coastal Forest and Vegetation: The main inhabited islets and some uninhabited offshore islets (**motu**), which are the main turtle nesting areas, seabird rookeries, are under serious threat. These areas are the main refugia for threatened land crabs, seabirds and coastal plants. Their loss is due to reclamation, land clearance, overexploitation, invasive species, free-ranging pigs and indiscriminate burning. Important species under at various levels include important multi-purpose coastal species, such as **kanava** (*Cordia subcordata*), **milo** (*Thespesia populnea*), **fetau** (*Calophyllum inophyllum*), **puka vaka** (*Hernandia nymphaeifolia*), **puka vai** (*Pisonia grandis*), **tausunu** (*Tournefortia argentea*), **futu** (*Barringtonia asiatica*) and **gie** (*Pemphis acidula*) all of which are ecologically and culturally important species.

9.1.2 Mangroves: Mangroves, which are limited in extent, have historically been under threat due to reclamation and overuse, including the loss of much or the largest mangrove on Fogafale Islet due to the construction of the airstrip prior to World War II. Species of particular concern include **sagale** (*Lumnitzera littorea*), **togo** (*Rhizophora stylosa*) and mangrove associated species surrounding mangroves, such as **milo** (*Thespesia populnea*), **fou fafie** (*Hibiscus tiliaceus*), **milo** (*Thespesia populnea*) **gie** (*Pemphis acidula*), many of which are also found in coastal forest and scrub. Although threatened are land crabs, including hermit crabs (**uga**), birds, lizards (**pili**) and **moko**, moths (**pepe**) and other organisms that live in and around mangroves.

9.1.3 Agricultural ecosystems: Agricultural ecosystems, particularly excavated swamp taro gardens (**pela**) and traditional taro cultivars, coconut- dominant agroforests and village gardens are under threat, with the reported loss of coconut, breadfruit, pandanus, banana and taro cultivars. Also of concern is the loss of agroforestry trees, such as **pua** (*Guettarda speciosa*) and **tausunu** (*Tournefortia argentea*) (Thaman and Whistler 1996).

9.1.4 Coral Reefs, Beaches and Nearshore Lagoon and Oceanside Marine Ecosystems: Coral reefs, beaches and nearshore lagoon and oceanside marine ecosystems are particularly threatened on Funafuti, where overfishing, coastal erosion and extreme weather and tidal events, exacerbated by climate change, are the main drivers of the loss of BES.

9.2 Threatened Species and Genetic Diversity

As shown in Tables 6–77 a wide range of important plants and animals within all of these ecosystems are seriously threatened, the most important of which are listed in Table 78 and the estimated numbers of each type that are threatened are shown in both Table 6 (above) and Appendix II, with almost two-thirds (668) of 1065 named species or groups of species considered to be extirpated (locally extinct), rare or threatened and in need of conservation by survey respondent groups on Funafuti (Table 6 and Appendix II). This loss represents a serious loss of BES that are the fundamental to for food, health, energy, livelihood and environmental security in Tuvalu.

Table 78. The most culturally important and most highly threatened named species or groups of species based on Community-based T2R BIORAP surveys on Funafuti, November 2015).

1.	a wide range of small and large finfishes, including eels, sharks, rays
2.	dolphins
3.	turtles
4.	small and large shellfish
5.	octopus and squid
6.	marine crabs and hermit crabs
7.	sea cucumbers,
8.	hard and soft corals,
9.	a range of other marine organisms,
10.	a wide range of native coastal, mangrove and inland trees, shrubs, vines, ferns and other herbaceous species, almost all of which are culturally-important multipurpose plants,
11.	cultivated food, ornamental and multipurpose plants,
12.	cultivars of important food crops,
13.	land and seabirds,
14.	domestic animals
15.	reptiles
16.	coconut crabs and land crabs and hermit crabs
17.	insects and arthropods

10

MAJOR THREATS TO BIODIVERSITY AND ECOSYSTEM SERVICES

The Funafuti BIORAP results showed that the main direct drivers of the loss of BES include:

1. climate change and sea-level rise;
2. impacts of extreme weather and tidal events, particularly tropical cyclones, storm waves, king tides and prolonged droughts;
3. coastal deforestation and beach erosion;
4. overexploitation of terrestrial plants and animals;
5. overfishing, including the use of destructive fishing practices
6. invasive alien species and diseases (IAS) and feral animals;
7. urban and village expansion, land clearance and land reclamation;
8. solid waste pollution of land, beaches and intertidal areas, including old derelict ships and unexploded WWII bombs (munitions) in lagoon;
9. water pollution, including pollution of the freshwater lens or water table and the lagoon by sewage and nutrient pollution from land, including waste from pigsties, other waste and oil pollution; and
10. damage to coral from boat anchors.

Indirect drivers include:

1. loss of knowledge, particularly indigenous knowledge, including the loss of knowledge or declining use and/or failure to replant important food plants and other multicultural food plants;
2. lack of awareness of , particularly among the younger generation, of environmental issues related to the importance and loss of biodiversity;
3. lack of local scientific and technical capacity required to build synergies between ILK and MSK to address the loss of BES; and inadequate governance and legislation.

Appendix II, based on the results of the 2016 Funafuti R2R BIORAP, shows how different threats are linked to different groups of plants or animal, ecosystems and ecosystems services (e.g., to food, construction or medicinal plants) and what are believed to be the interventions necessary to address the loss of BES. These direct and indirect drivers are discussed in some detail below.

10.1 Climate Change, Sea-level Rise and Extreme Weather and Tidal events

Climate change, sea-level rise and the increasingly negative impacts of extreme weather and tidal events are of utmost concern. Those extreme events that seem to be more frequent or more intense due to climate change and sea-level rise include prolonged droughts; tropical cyclones and associated strong winds, storm surges and salt spray; and king tides (extremely high spring tides that may coincide with extreme weather events, such as low pressure cells and ENSO/ El Niño Southern Oscillation events); and salt-water incursion. All of these have more serious impacts on the biodiversity and livelihoods on low-lying atolls than on larger more elevated islands and have caused serious coastal erosion and the loss of small islets and biodiversity in Tuvalu.

Severe tropical cyclones that have affected Tuvalu include Tropical Cyclone Bebe in 1972, Tropical Cyclone Meli in 1979, Tropical Cyclones Val and Ofa in 1990 and Tropical Cyclones Nina and Kina



in 1993, the latter of which caused flooding of over 0.6 m and loss of trees, damage to crops, housing and infrastructure on Nanumea, Nanumaga, Niutao, Nui and Vaitupu (Xue 2005). Most recently, during Tropical Cyclone Pam in March 2015, strong winds and storm surge coincided with a high king tide, Nui and Nukufetau were inundated causing serious damage to agriculture and forcing more than 300 people to evacuate their homes (Malakai and North 2015). Again in December 2015 gale force winds and rain during Tropical Cyclone Ula destroyed homes and uprooted trees on Funafuti (Pacific Beat 2015).

Associated with strong salt-laden winds, storm surge and king tides is increasing salt-water incursion into the freshwater lens and salt spray damage to crops and property. These incursions have polluted limited freshwater resources on most atolls and damaged or killed local crops and trees which have lower resistance to salinity than native coastal plants. Funafuti, Nanumea, Nanumaga, Niutao, Nui, and Nukulaelae have all been highly affected by salt water intrusion and increasing salt spray, which seriously burns leafy crops such as sweet potato, which is an increasingly important supplementary staple crop and pig food..

El Niño-related severe droughts also periodically affect Tuvalu, especially the northern atolls, and constitute a major limiting factor on the long-term survival of plants, particularly introduced non-coastal plants. The drought of 2011 was particularly serious, during which a state of emergency was declared in September due water shortage on Funafuti (Vula 2011). Most recently in early and late 2016 .Tuvalu was again experiencing serious drought conditions that when compounded with increasing sea spray (**pisitai**) makes the cultivation of many plants difficult.

10.2 Coastal Deforestation and Coastal and Beach Erosion

Dramatically accelerating coastal and beach erosion has led to the retreat of coastlines and loss of beaches, coastal trees and vegetation and seabird and turtle nesting sites. Coastal trees have also been cleared for urban and village expansion and for use in construction, woodcarving and other purposes, which has increased the vulnerability of coastal areas to erosion. In 1990 Tropical Cyclone Val caused parts of the Vaitupu shoreline to recede by 5–6 m (Xue 2005). This is particularly serious on uninhabited reef islets that are often free of predators and the main refuges and nesting sites for turtles, seabirds and land crabs. For example, in 1993 tropical Cyclone Kina led to the disappearance of Pukasavilivili Islet off Tepuka Islet in Funafuti; and during Tropical Cyclone Pam in March 2015, Vasafua Islet in the middle of the Funafuti Conservation area was lost to erosion.

10.3 Overexploitation of Terrestrial Plants and Animals

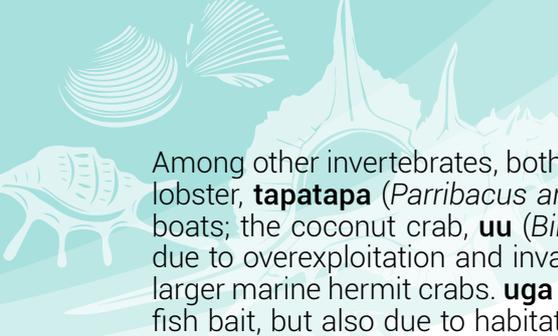
As shown in Appendix II, overexploitation or neglect of a wide range of culturally and ecologically important terrestrial plants and animals is of increasing concern. The failure to replant important cultural plants is of increasing concern as are coastal deforestation and the felling of trees such as **fetau** (*Calophyllum inophyllum*), **puka vai** (*Pisonia grandis*), **puka vaka** (*Hernandia nymphaeifolia*) and pandanus, **fala** (*Pandanus tectorius*) for timber, construction and other uses. Of increasing concern is the loss of and scarcity of culturally useful animals (particularly seabirds and land crabs) and plants used for medicine, construction, mulching, pig feed and other purposes), due to tropical cyclones, land clearance, over use and failure to replant (Appendix II). The use of guns on Funafuti and Nanumea was blamed for the overexploitation of edible seabirds, which atoll communities hunt as a protein food when they tire of fish or for important occasions. Seabirds are very important to fishermen for guiding them to schools of tuna and other schooling fish and to particular fishing grounds. With declining seabird populations, fishermen find it hard to locate schooling species which leads to increasing fuel consumption, higher costs and lower catches.

10.4 Overfishing

Overfishing and seriously declining populations, catches and sizes of a wide range of important finfish, eels, sharks, rays, shellfish, octopus and lobster species is of increasing concern and driven by both increasing population, improved fishing technology and the commercialization and local sale of some products, particularly on Funafuti. Of particular concern is overfishing inside lagoons and in nearshore ocean side waters of most atolls, particularly on Funafuti where more than 60% of the population live. The use of gillnets, night spearfishing, faster and more far-ranging boats and almost daily reef gleaning on reef flats for fish and shells are important drivers of overfishing. Poaching in marine conservation areas (CAs), which have been established on eight of Tuvalu's nine atolls, also contributes to overfishing. Poachers sneak into these areas when the CA keepers have returned home or when they are out of the keeper's sight. Until recently it had been worse within the Funafuti Conservation Area (FCA) which was established in 1999 by an Order under the Conservation Area Act. Poaching, although also happening, is less of a problem in CAs in the outer atolls that were established by local communities and managed by traditional systems. These CAs are located further away from villages so that they are less disturbed by the local communities.

Overfished species of particular concern that could be used as priority indicator species of the success of the conservation of BES, based on stated cultural importance in R2R, threatened status, consultations with local community experts and previous used as indicator species are humpback snapper, **tāea** (*Lutjanus gibbus*) and blue-stripe snapper, **savane** (*L. kasmira*), both target species of line fishers and increasingly caught in lower numbers and smaller sizes; orangespine unicornfish, **manini lakau** (*N. literatus*) and common unicornfish, **ume** (*Naso unicornis*), both heavily targeted by night spearfishermen inside the lagoon, sometimes using gillnets; sleek unicornfish, **ume** (*Naso hexacanthus*), which is targeted by night spear fishermen in aggregations in reef passes or off reef slopes; lined surgeonfish, **pone lolo** (*Acanthurus lineatus*) and convict surgeonfish, **manini** (*Acanthurus triostegus*), both targeted by net fishermen and night spearfishermen; **maiava** (*Siganus argenteus*), a favoured target species that has been reduced drastically in numbers with seemingly insufficient breeding stock to generate the massive aggregations of small post-juvenile fish known as **ō** that used to be common and targeted as a delicacy in the past (Thaman 2016); and two species that are on the IUCN Redlist as endangered and vulnerable, respectively, the giant humphead wrasse, **tagafa** (*Cheilinus undulatus*) and bumphead parrotfish, **taona** (*Bulbometopon muricatum*), both of which are seriously overfished by night fishermen, the latter having disappeared from some areas. Deepwater species that have reportedly shown signs of overfishing are the black trevally, **tafauli** (*Caranx lugubris*), which is now rarely seen, and the deepwater snappers, ruby and longtail snappers, **palu fagamea** and **palu malau** (*Etelis carbunculus* and *E. coruscans*), which used to be airfreighted to Fiji in the early 2000s, under an incentive programme to promote offshore fishing to take pressure off inshore areas (Alefaio 2016). Heavily overfished invertebrates include a range of shellfishes, lobsters, crabs, and bêche-de-mer. Giant clams (*Tridacna maxima* and *T. squamosa*) are heavily overfished on all atolls (Sauni 2000), with the true giant clam, **fasua taka** (*Tridacna gigas*) apparently having gone locally extinct on Nanumea at some time in the past as evidenced by empty shells of the species that the current generation has never seen alive. Also concerning is that of 1000 non-indigenous southern giant clams (*Tridacna derasa*) introduced into Tuvalu from Palau in 1988, there has been a steady decrease in numbers with only 8 individuals found in 2011 (mainly in the FCA), the main reason of this decrease is again overexploitation, mainly for local consumption (Sauni *et al.* 2008; Job and Ceccarelli 2012).

Other species reportedly overfished include black-lipped pearl oyster, **tifa** (*Pinctada margaritifera*), giant spider conch, **kalea** (*Lambis truncata*), bloodmouth conch, **paneā** (*Strombus luhuanus*) and trochus (*Trochus niloticus*). Seriously overfished and now extremely rare are the triton trumpet shell (*Charonia tritonis*) and the giant helmet shell (*Cassis cornuta*), both of which were used as a traditional trumpets to signal important events (**pu**) (Koch 1983). Overfished on Funafuti were thorny oyster, **hopu nifo** (*Spondylus* sp.). Also increasingly scarce, especially of the main island of Fogafale, are the range of small cowries, **pule kena** and **pule** (*Monetaria moneta* and *Monetaria annulus*) and **pule uli** (*Monetaria caputserpentis*), which are so important in the local shell handicraft trade. As a result shell gatherers have to venture further afield to our reefs by boat to collect them and some Falekaupule have placed bans on collection. Also reported to be increasingly scarce due to overexploitation are the nearshore land snails **misa** (*Melampus lutea* and *M. fasciatus*), the favoured shells for the common garlands, **tui** or **ula misa**, a major source of income (Resture and Resture 2005). Octopus, **feke** (*Octopus cyanea*), are also overfished and now almost impossible to find on the reef off the main settlement on Fogafale Islet.



Among other invertebrates, both spiny lobster, **ula** (*Panulirus penicillatus*) and sculptured mitten lobster, **tapatapa** (*Parribacus antarcticus*), are overfished due to night diving and longer range boats; the coconut crab, **uu** (*Birgus latro*) is almost extinct or increasingly rare on most islets due to overexploitation and invasive species, and land hermit crabs, **uga** (*Coenobita* spp.), and larger marine hermit crabs, **uga** (*Dardanus* spp.) are also heavily overexploited, mainly for use as fish bait, but also due to habitat clearance and invasive species; and bêche-de-mer, studies in Funafuti, Nanumea and Nukulaelae in 2006 showed that bêche-de-mer were heavily overfished with the only species present in numbers being lolifish (*Holothuria atra*), with a few specimens of leopardfish (*Bohadschia argus*), amberfish (*Thelenota anax*) and curryfish (*Stichopus herrmanni*) found present (Job and Ceccarelli 2012).

There is a consequent need to develop effective management framework to regulate all types of fishing inside lagoons, build capacity of Fale Kaupule members, encourage more fishermen to participate on policy development and to encourage more fishing in deeper waters outside the lagoon or target pelagic species to balance fishing effort (Alefaio 2016).

10.5 Invasive Alien Species and Diseases (IAS)

Invasive alien species (IAS) are an increasing concern and include: 1) agricultural pests and diseases, 2) invasive plants, such as *Sphagnetocola trilobata*, 3) the devastation of the **kanava** (*Cordia subcordata*) trees by an invasive moth caterpillar, the kou leafworm (*Ethmia nigroapicella*); 4) rats that threaten birds and other indigenous species and transmit human disease; 5) infestations of invasive ants that threaten both land crabs and seabird hatchlings; and 6) the spread of an invasive brown seaweed in Funafuti Lagoon.

10.5.1 Agricultural pests and diseases: There are a number of agricultural pests that have spread between islands and have remained problems since the 1990s, the most important of which is coconut scale insect (*Aspidiotus destructor*), which has severely infested coconut palms as well as other crops, including breadfruit, papaya, bananas, pandanus, and slightly affects taros, **pulaka** (*Cyrtosperma chamissonis*) and **talo** (*Colocasia esculenta*) and other cultural trees, such as frangipani and *Premna serratifolia*. Chemical control, through spraying of soap, kerosene and Malathion and the cutting and burning of infested plants, has been unsuccessful.

Of recent concern is the threat posed by fruit flies of the genus *Bactrocera* that have cost millions of dollars in lost fruit, export income and control costs in the Pacific. Most *Bactrocera* fruit flies have a high number of host or target species, with some species attacking more than 200 species of edible and wild fruits and vegetables. Some of host target species, which vary depending on a particular *Bactrocera* species, include breadfruit, papayas, bananas, citrus trees, figs, **felo** (*Ficus* spp.), pumpkins, eggplant, tomato, capsicums, and wild trees such as **talie** and **kunikuni** (*Terminalia* spp.), **fao** (*Neisosperma oppositifolium*), **futu** (*Barringtonia asiatica*) and **nonu** (*Morinda citrifolia*), all species of ecological and cultural importance in Tuvalu (Le Blanc and Putoa 2000; Vueti 2000).

Although a light coloured form of the Fijian fruit fly (*B. passiflorae*) has been reported present in Tuvalu and not considered to be of economic significance, there are economically damaging *Bactrocera* species found in Tuvalu's neighbouring islands that if introduced pose serious threats to fruit and vegetables and other plants in Tuvalu. These include the more common darker form of the Fijian fruit fly (*Bactrocera passiflorae*) (present in Fiji, Wallis and Futuna, Niue and the Niua islands of Tonga); the Pacific fruit fly (*B. xanthodes*) (present in Fiji, Rotuma, Tonga, Samoa, Cook Islands, Niue, Nauru, Wallis and Futuna and American Samoa); and *B. kirki* (not present in Fiji, but found in American Samoa, Samoa, Niue, Tonga, French Polynesia, Futuna and Rotuma (Vueti 2000). Also a serious threat are the Queensland fruit fly (*B. dorsalis*) (present in Queensland, Papua New Guinea, New Caledonia, French Polynesia and New Zealand), a very serious agricultural pest, which attacks over 113 species of edible and wild fruits; and the Oriental fruit fly (*B. dorsalis*), one of the five most damaging and aggressive fruit flies in the world (present in Northern Mariana Islands, Palau, Guam, Nauru, Hawaii and Tahiti) (Le Blanc and Putoa 2000), and which in 2013 was first detected on Rarotonga and Aitutaki in the Cooks islands, where the costs of control efforts (particularly to save the papaya export industry) were reportedly over a million dollars. Similarly, the introduction of *B. kirki* from Rotuma to Fiji is considered such a serious threat to Fiji's fruit and vegetable exports to New Zealand that Biosecurity Authority of Fiji has placed a biosecurity ban on shipment of all fruits to and from Rotuma and prohibits anyone from bringing

fruits from Rotuma into Fiji. This is something that Tuvalu must worry about given the initiative started in 2010 and reportedly reinvigorated in 2015 in to ship produce directly from Rotuma to Tuvalu (Moresio 2015).

10.5.2 Weeds: The most serious invasive plant in Tuvalu is, wedelia or trailing daisy (*Sphagneticola trilobata*), a plant native to the Caribbean that has spread throughout villages, along roadsides, into open lots and has colonised outer beach vegetation where it outcompetes important medicinal plants and other native species of cultural importance. It is considered one of the world's 100 worst invasive species. Once established it is almost impossible to eradicate and is slowly replacing many of Tuvalu's most important low-growing herbaceous species along beaches and roadsides and inhibits the growth of seedlings of threatened trees and other plant (Thaman 2009, 2011).

10.5.3: Rats: Rats (*Rattus* spp.) are common on all Tuvalu's atolls, including many uninhabited offshore reef islets and are a major threat to bird species, particularly ground nesting seabird colonies, poultry and other important terrestrial species, such as geckos and insects. Rats are also reportedly responsible for damaging agricultural crops, such as coconuts and sweet potato, causing livelihood difficulties and are vectors diseases such as leptospirosis that poses a threat people who depend on rooftop water catchments for drinking water. Rats have also reportedly eaten and destroy seeds of important plants preventing them from germinating.

10.5.4 Kou leaf-worm: Of particular concern was an epidemic outbreak of kou leaf-worm, the caterpillar of an introduced moth (*Ethmia nigroapicella*) in mid-2010 on the northern atoll of Nanumea, which by mid-2011 had defoliated and killed most of the trees along the lagoon coast in the main settlement. This constituted a national disaster because **kanava** provide coastal protection, shade and habitat for sea birds and other smaller organisms; is the most valued wood for canoes, wood carving and many other uses; and is considered the "tree of Nanumea." An infestation of the same larva had historically destroyed historic sacred chiefly groves of the trees in Hawai'i in the late 1800s (Thaman and O'Brien 2011). The spread of the kou leafworm to all the neighbouring islands and also to the far southern atolls has been alarmingly quicker than expected.

10.5.5 Yellow crazy ant: Alien ants are considered one of the greatest threats to biodiversity (Wetter 1997) and the yellow crazy ant (*Anoplolepis gracilipes*)(YCA), which was probably introduced with infested timber or sea cargo, was reported present in the early 2000s and is now causing serious problems in Tuvalu (Lester and Tavite 2004; Nagel 2014). The YCA, which forms dense multi-queen supercolonies and releases an acid that burns on contact, preys on a wide range of plants and invertebrate and vertebrate animals including birds, crabs, and insects and has wiped out crabs in infested areas and affected birds, geckos, plants and organism on many islands, such as Christmas Island in the Indian Ocean (Abbott 2005; TSSC 2010). On Funafuti the YCA, has destroyed crops, attacked animals such as chickens, land crabs, hermit crabs and coconut crabs and threatens seabird populations. Most recently, the YCA has spread to Nanumea, Nui and to Nukulaelae, where it has caused the decline coconut crab populations. As a result, the Kaupule on the island has banned harvesting of coconut crabs to fight against extinction of the species. The Secretariat of the Pacific Community (SPC) in the Pacific Invasive Initiative Project had expressed its disappointment on the spread of the yellow ant to Tuvalu as it shows that there has been a lapse in bio-security. Negative impacts are likely to also include indirect damage to plants caused by the ants' tendency to protect various scale insects, loss or decreased abundance of native ant species, and predation of a wide range of invertebrates and small vertebrates, resulting in a general decline in biodiversity (Csurhes and Hankhamer. 2012).

10.5.6 Invasive seaweeds: The rapid spread of a non-native brown seaweed (*Sargassum polycystum*) in Fogafale lagoon beginning in 2011 is a major concern with its dense coverage reducing sunlight and outcompeting corals and making fishing difficult. It is suspected that the seaweed was brought via international shipping (through ballast waters, hulls or anchors), possibly from Wallis and Futuna where it is present. It seems to have become established following the prolonged drought of 2011 when much of the Fogafale population used the lagoon for washing, cleaning and defecating during which time the inner reef areas were also subject to a blue-green algae outbreak (*Lyngbya* spp.). There was a correlation noticed between the density of human population on the shore and algal biomass, with the highest biomass figures opposite a school and a hotel. Water quality tests also showed nutrient levels almost twice as high in front of populated areas than in unpopulated areas of the island (N'Yeurt and Iese 2013, 2015).



10.5.7 Crown-of-Thorns Starfish: An outbreak of crown-of-thorns starfish (COTS) has also been reported from the Funafuti Conservation Area where, like in other areas of the Pacific, it has destroyed some corals. Causes may be linked increasing ocean temperature or pollution (N'Yeurt and Iese 2013).

10.5.8 Feral Animals: The presence of free-ranging or escaped pigs has also contributed to the loss of some plants, such as the **laukatafa** (bird's-nest fern), one of Tuvalu's only green vegetables, which is now found mainly on uninhabited reef islets (**motu**) where there are no pigs. This is mainly a problem on Nanumea where pigs are allowed to roam free, whereas on Funafuti most pigs are confined to the communal pig rearing area to the northeast of the main airstrip on Fogafale Islet.

10.5.8 Constraints to managing IAS in Tuvalu

As stressed in the 4th NBSAP Report constraints to managing IAS include: 1) lack of awareness or understanding of major threats posed by pests; 2) lack of information on the basic biology of invasive species; 3) accidental introductions; 4) lack of monitoring of high-risk areas; 5) competition between conservation and other interests; 6) absence of, or inadequate legislation and enforcement; 7) lack of personnel and biosecurity infrastructure; 8) inadequacy or the absence of regional protocols, such as those to warn of threats, predict invasiveness of new species at the border, maintain quarantine procedures and set priorities; and 8) inadequate funding

10.6 Urban and Village Expansion and Land Clearance

Urban and village expansion, land clearance and associated deforestation and vegetation clearance leading to the loss of habitat and important plants and animals is a growing concern. This is a particularly serious on Fogafale where increasing populations, urbanization, including expansion of urban land clearance and the expansions of villages and settlements and urban infrastructure, with the latter two also of concern on Nanumea. A main concern is unsustainable coastal infrastructure development with increasing numbers of seawalls and pig pens built too close to the shorelines. There is also concern over the continued dredging of lagoon sediments used for the reclamation of the borrow pits and other land reclamation projects which is killing the corals and other invertebrates in the lagoon.

10.7 Solid and Liquid Waste Management and Pollution:

Waste management and pollution is of increasing concern and includes the management and disposal of solid and liquid waste and oil pollution and their impact on the land, limited freshwater resources and the marine environment. Increasing consumption of imported, processed and packaged goods have led to a significant increase in the solid waste stream, particularly on Fogafale Islet, which puts increasing pressure on very limited land resources. This has been partially alleviated by the establishment of a new rubbish dump on reclaimed land on North Fogafale Islet, Funafuti and the systematic collection and transport of waste to the rubbish dump by the Kaupule.

Waste water pollution of ground water and lagoons are serious concerns with flush toilets and septic systems releasing heavily polluted water, which pollutes groundwater, discharges into Fogafale lagoon and has contributed to the degradation of the near-shore reef systems which are a major sources of livelihood and of considerable of conservation value (SOPAC 2007; Duncan 2012; Kaly 2015). Sewage leakages from septic tanks are a major factor in the contamination of the freshwater lens and very limited ground water resources, thus making them unsafe for human consumption. This is due largely to the poor design of septic tank systems, where at the end of the septic system, the waste water drains out into surrounding areas. On the outer atolls, because of the limited nature of groundwater resources, people are largely dependent on rainwater for drinking because wells are often contaminated due to pollution and increasing salinity (SOPAS 2007).Waste leakage from the increasing number of pig pens is also a serious concern with the nutrient-rich pig wastes seeping down into the ground water or running off into the sea when it rains (Kaly 2015). From the latest report, around 71% and 90% of households on Funafuti and the outer atolls own pigs. A UNEP report (Duncan 2012) on water resources says that islets, such as Fogafale that have had most of their vegetation cleared, have very limited capacity to absorb wastewater generated from urban areas to prevent pollution of groundwater

lenses; and the same report indicates that a significant percentage of mortality of children less than five years old due to diarrhoeal disease is due to contaminated and unsanitised drinking water (Duncan 2012).

Nutrient-rich waste water from septic tanks and pig pens has also linked to outbreaks of the invasive brown seaweed (*Sargassum polycystum*) and the formation other slime algae or cyanobacteria blooms that pose threats to coral reefs and to the health of sand- and sediment-forming organisms, such as foraminiferans and calcareous algae, that are so important to the maintenance of healthy beaches, lagoon bottoms and the marine ecosystem (N'Yeurt and Iese 2013, 2015)

Oil spills within Funafuti lagoon are an increasing concern. In June 2012, there was a major spill from the main wharf caused by a bunkering accident involving a local vessel. Still under investigation is a recent oil spill inside the lagoon in April 2016. A problem in relation to oil spills is that it is unclear as to which government agency is responsible for enforcement and what investigation procedures should be followed.

10.8 Loss of knowledge and Lack of awareness

Loss of knowledge about the importance, declining use or threatened status of biodiversity is a major concern because without this knowledge the conservation and sustainable use of biodiversity will be problematic. Lack of knowledge and declining use of resources such as traditional plant and marine emergency foods, medicinal plants and other cultural important organisms has also contributed to ignorance of their importance and the failure to value, protect or restore (e.g., replant) them. Related to this is the loss of local knowledge about plant and animal names and the lack of access to corresponding modern taxonomic knowledge required to build synergies between local knowledge and modern taxonomic and conservation science. For example, most names of plants, birds, fishes, crabs, shellfish, etc. are not well-known to the current generation and are either not listed or do not have the scientific names associated with them in the Tuvaluan dictionary (Jackson 2001). As was suggested during the launch of the Year of Biodiversity in Paris 2010, we need to "Name it or Lose It" and must begin teaching about and recording the names, uses and status of biodiversity and giving local people access to databases and other sources on their biodiversity so that we know about what we are trying to save (Thaman 2010, 2013).

Also serious and related to loss of knowledge is the lack of public and official government awareness of conservation issues and the threatened state of atoll and marine ecosystems and plants and animals. There are too many plans and policies without the level of awareness of conservation issues needed to implement biodiversity conservation initiatives and the need to make politicians, leaders and decision makers more aware of the threats to biodiversity and the impacts of development decisions.

10.9 Lack of Scientific and Technical Capacity

Lack of the scientific and technical capacity required to build synergies between ILK and MSK is a major constraint to the long-term sustainability of BES conservation. As a result, Tuvalu continues to depend heavily on foreign consultants to carry out surveys, write and implement plans, regulations and legislation; monitor the effectiveness of initiatives; keep records and write reports that are required to sustain the funding of most BES conservation initiatives. There is also lack of capacity to engage with local communities, promote awareness, and enforce legislation to achieve desired outcomes. Because of limited capacity the most qualified persons are often tasked with the leadership of many initiatives at the same time, often having to attend meetings or capacity building workshops which takes them away from on-the-ground leadership and implementation. This lack of capacity is also reflected in the limited English and technical writing ability on the part of Tuvaluans and the inability of foreign consultants to communicate in the Tuvaluan language, both of which limit the effectiveness of building synergies between ILK and MSK for conservation effectiveness.



10.10 Inadequate Governance and Legislation

The lack of, or failure to enforce, appropriate legislation or regulations to address the threats to biodiversity, such as oil spills, illegal fishing and the introduction and spread of invasive species and diseases is a widespread concern. For example the UNEP report on water resources (Duncan 2012) reported that there was no inter-sectoral water coordination board and no existing national water resources policy, legislation or water efficiency use plan, and Tuvalu is yet to operationalise the Tuvalu Invasive Species Committee that was formally established in 2015 and does not have the capacity to implement a national biosecurity plan. This also includes weak use of customary laws/governance by local councils, Fale Kaupule.

11

ACTIONS TO ADDRESS LOSS OF BES

As stressed above and as central principle of the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES), the implementation of effective actions to address BES loss will require building synergies between the best indigenous and local knowledge (ILK) and the best modern scientific knowledge (MSK). This could be done through a combination of: 1) actions within existing sectoral responsibilities; and/or 2) taking an island or ecosystem approach to BES conservation focusing attention on key actions within threatened ecosystems, in both cases by incorporating actions and options arising out of the BIORAP and associated community consultations. These options are discussed briefly below, all of which need to be supported by backed up by appropriate capacity building, education and awareness raising and improved governance.

11.1 Sectoral Opportunities for Building ILK-MSK Synergies

Table 79 lists “development sectors” that seem to offer the best opportunities within each “sector” for building such synergies for BES conservation at the household, community, island and national levels in Tuvalu.

Table 79. Sectoral opportunities for building synergies between indigenous and local knowledge (ILK) and modern scientific knowledge (MSK) as a basis for RtR conservation, restoration and enrichment of biodiversity and ecosystem (BES) in Tuvalu.

1. **FORESTS AND ARBOREAL RESOURCES:** Conservation, enrichment and sustainable use of inland, coastal, agricultural and village forest and tree resources
2. **MARINE RESOURCES:** Conservation and sustainable use of nearshore and offshore marine resources
3. **CLIMATE CHANGE AND EXTREME EVENTS:** Improvement of early warning, preparedness and adaptation to climate and environmental change and extreme weather and tidal events.
4. **WATER:** Watershed, water table water and water catchment and storage management
5. **SOIL AND FIRE:** Soil conservation, fertility maintenance, fallow and mulching systems and fire management
6. **AGRICULTURAL AND FOOD SYSTEMS:** Conservation, enrichment and promotion of traditional polycultural semi-subsistence food and agricultural systems based on nutritious atoll and marine foods.
7. **MEDICINE AND HEALTH:** Medicinal plant conservation and medicinal and health practices and the promotion of healthy lifestyles
8. **HANDICRAFTS AND CONSTRUCTION:** Traditional handicraft, arts, and construction (e.g., house and boat building, woodcarving, fencing, production of garlands, shell necklaces, perfumes and scented oils, etc.)
9. **INVASIVE SPECIES AND DISEASES:** Invasive alien organism (IAS) and disease management and strengthening of international and national biosecurity and awareness of IAS
10. **ENERGY AND WASTE:** Energy and waste management and environmental restoration
11. **TOURISM, RECREATION, AND SPORTS:** Development of limited ecotourism, diving tourism, dancing, sport and exercise
12. **EDUCATION AND SOCIAL AND CULTURAL SUSTAINABILITY:** Cultural sustainability, spirituality, social cohesion, education and governance.

11.2 Land-use categories for atoll terrestrial (motu) BES conservation

Table 80 is a list of threatened ecosystems or land use categories within which specific conservation actions could be directed.

Table 80. Land-use categories for atoll terrestrial (motu) biodiversity conservation, restoration and enrichment with suggested components that should be conserved and/or interventions that could be implemented within each category (Notes: 1) the first and easiest option within all ecosystems should always be: a) the conservation of existing biodiversity (e.g., native, vines and plants or banana, taro and breadfruit varieties, which can then then followed by b) restoration or replanting/re-introducing pre-existing plants or animals, etc. or elimination of weeds, and invasive species, and then by c) enrichment by adding new useful plants or animal or technologies that improve the sustainability of the land use system (e.g., planting new food tree varieties, reinforcing excavated taro gardens with cement, use of improved mulching or water catchment, management and irrigation systems; 2) some categories such as windbreaks and hedges and pig rearing areas are kept as both separate categories and as criteria within other categories because of their importance in climate and food security; and 3) although the "water management system" is not technically a "land use", freshwater is the main controlling factor on the health of all atoll terrestrial biodiversity, including human, is a very scarce resource, and is here considered and "ecosystem" which is part of atoll biodiversity.

<p>1. Atoll forest and/or atoll islet reserve (togaa vao io me se motu tapu)</p> <ul style="list-style-type: none"> a. Sustainable use of plant resources b. Prohibition on cutting trees and land clearance c. Prohibition on harvesting of seabirds, land crabs and turtles d. Prevention, eradication or control on invasive species e. Use for ecotourism, education or scientific purposes
<p>2. Coastal Forest and Vegetation (lakai mo te mouku i te tafātai mo te matāfaga)</p> <ul style="list-style-type: none"> a. Coastal trees and shrubs b. Coastal small plants and vines
<p>3. Mangrove (Togo)</p> <ul style="list-style-type: none"> a. True mangroves b. Mangrove associated plants
<p>4. Agroforestry Land (Fātoaga Niu, lakau kaina mo te lakau aoga)</p> <ul style="list-style-type: none"> a. Coconut plantations with or without residences with other planted or protected food and non-food plants b. Diversity of food and multipurpose trees c. Cultivar diversity of major food plants (e.g., coconuts, bananas, breadfruit, edible pandanus, etc.) d. Diversity of perennial food plants (e.g., pele, panikeni) e. Diversity of plants used for pig feed, mulching/fertilizer and medicines f. Development of appropriate windbreaks or hedges/living fencing g. Livestock husbandry (pig pens, and chickens)
<p>5. Excavated Taro Pit Garden (Pela mo te lakau aogo)</p> <ul style="list-style-type: none"> a. Diversity of named taro cultivars b. diversity of other useful plants c. diversity of mulching/fertilizer plants

<p>6. Village Houseyard Garden (Fātoaga Fale Nofo)</p> <ul style="list-style-type: none"> a. Diversity of Food and multipurpose trees b. Cultivar diversity of major food plants (e.g., coconuts, bananas, breadfruit, edible pandanus, etc.) c. Diversity of perennial food plants (e.g., pele, panikeni. etc.) d. Short-term vegetable garden (fenced and mulched) e. Diversity of plants used for pig feed, mulching/fertilizer and medicines f. Diversity or fragrant and ornamental plants (lakau fai manogi) g. Windbreaks or hedges/living fencing h. Possible development of key hole gardens like Tokelau
<p>7. Hedge/living fencing and Windbreak (Puipui mātagi)</p> <ul style="list-style-type: none"> a. Most effective protection from wind, cold, saltspray b. Most useful hedge (e.g., for use for animal food, fou, medicines, etc.)
<p>8. Piggery Rearing Area</p> <ul style="list-style-type: none"> a. Health and sanitary conditions b. Effective and safe use of kitchen waste and nearby presence of sources of pig feed, edible fencing or leaves, etc. c. Safe waste disposal (not polluting the lagoon or water table) d. Secure fencing and/or tethering
<p>9. Water Management System</p> <ul style="list-style-type: none"> a. Effective and clean rainwater catchment and storage system b. Efficient and effective (non-wasteful) use of water for human consumption, health and cleanliness, gardens and animals c. Efficient and effective (non-wasteful) use of water for gardens and domestic animals d. Protection of wells and groundwater from pollution e. Safe and conservative disposal and reuse of wastewater

11.3 BES Conservation Interventions Favoured by Funafuti Communities

BES conservation interventions favoured by Funafuti communities during the BIORAP and associated consultations that could fall into one or more of these sectoral categories are listed in Table 81.

Table 81. Conservation interventions favoured by Funafuti communities during the BIORAP and associated consultations.

<ol style="list-style-type: none"> 1. Enforceable conservation legislation, including stronger local island by-laws to control unsustainable practices and to protect threatened marine and terrestrial species and ecosystems; 2. Establishment or strengthening of a system of marine managed areas, including no-take MPAs and species or gear restrictions; 3. Designation of selected uninhabited, preferably pest-free, reef islets (motu) or forest remnants as reserves for threatened plants and animals; 4. restrictions on exploitation of threatened species until numbers recover; 5. establishment of agricultural conservation and enrichment areas, including improved excavated taro pit gardens, coconut dominant agroforestry plots and village gardens; 6. systematic propagation and replanting of trees and other environmentally and culturally important plants, especially coastal protection plants;
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7. planting of improved windbreaks, hedges, living fencing and seawalls for protection against wind, salt spray, dust and air pollution;
8. beach protection, restoration and enrichment programmes;
9. soil enrichment and revegetation programmes for the reclaimed barrow pit and lagoon lands;
10. improved pig and chicken husbandry systems, including improved fodder resources;
11. improved marine pollution control and waste management, including the installation of sealed septic tanks for all residences and buildings and the use of biogas digesters;
12. strengthened international and national biosecurity and IAS prevention, eradication and management programmes;
13. Listing of major outbreaks of weeds and invasive species and diseases that need to be eradicated or controlled.
14. national awareness and education programmes on the value of and threats to BES, targeting the general public, students and leaders from the public, business, NGO and religious sectors;
15. Expand and strengthen formal and non-formal education opportunities, including postgraduate studies, in BES relevant areas to increase local scientific and technical capacity at all levels;
16. promotion of nature and cultural tourism sites and "living laboratories" for Tuvaluans and ecotourists, to learn about Tuvalu's biodiversity and ecosystem services;
17. recording and teaching traditional knowledge about BES;
18. Establish a Register of "Living Treasures" to recognize people with in-depth knowledge or skills in particular BES-related areas, such as fishing, housebuilding, woodcarving, boatbuilding and navigation, traditional medicine, agriculture, plant propagation, shell craft,, lei and perfume making, etc.
19. Establish a register of "Tuvalu Heritage Trees" or heritage tree groves that should be protected and also be used for teaching, ecotourism, etc.; these would be placed on the R2R GIS;
20. Establishment of a list or lists of national trees, plants, birds, fishes, shellfishes, medicinal plants, lakau manogi, etc. which could also include favored plants or animals from each atoll to promote biodiversity and culture

11.4 Sustainable Income Opportunities

In terms of what Funafuti's communities community would like promoted to cash income by using their BES in a sustainable manner, the only activities favoured by respondents were: 1) development of a market for handicrafts; 2) development of tourism facilities, particularly those focusing on or showcasing atoll biodiversity including the development of tourism sites related to diving and snorkeling and wildlife tourism on uninhabited atoll islets; and 3) production, marketing and encouraging the consumption of nutritious local foods (Table 82).

Table 82. Results of two (2) new activities that you think your community would like to promote to gain money or income by using your environment and plants and animals in a sustainable manner based on questionnaire surveys of 19 male and female informant groups on Funafuti Atoll, Tuvalu conducted in November 2016.

Activity/Action	Total
Develop Handicraft Market	19
Development of Ecotourism facilities, sites and activities	19
Production, promotion and increased sale of nutritious foods	4

12

INDICATOR SPECIES OF CONSERVATION EFFECTIVENESS

The BIORAP identified a wide range of well-known, often distinctive, named marine and terrestrial species that could be used by local communities and partners as priority indicator species of the success of marine and terrestrial conservation and restoration initiatives. Many of these were said to be extirpated, rare or have clearly declined in abundance so that their harvest or production is no longer sustainable. Others, although not threatened in a conservation sense, would be good indicator species of the restoration of some ecosystem services, such as hedging, medicines, food, fertilizers or mulching, coastal protection, shade that contribute to food, health and livelihood security. Table 83 lists marine indicator species (fish, shellfish, crabs, etc.) and Table 84 lists suggested terrestrial indicator species, including wild plants, food crops and other useful planted species, seabirds, crabs, etc. all of which are well-known to Tuvaluans on Funafuti. These tables could be used as checklists or inventory sheet to monitor changes in abundance of the individual species from a community perspective.

Because many of these species have different habitat requirements, or take longer to grow or recover (e.g., large carnivorous fishes, large non-pioneer tree species, food trees, etc.), it is suggested that a large number of indicator species be identified to assess the short- and long-term success of conservation interventions, such as the establishment of MPAs, forest or agricultural reserves, village garden enrichment and food security programmes, invasive species and disease control initiatives, etc. Within the tables, the species have been grouped based on either their life forms (e.g., whether they are fish, shellfish, turtles, trees, herbs or vines) or by the ecosystem goods and services they provide if they are in sufficient numbers (e.g., plants that provide coastal protection, wind and salts spray protection, food, medicines, animal food, fertilizer or mulch, etc.).

As can be seen from the table 83, whereas there is a wide range of well-known small and large finfish are suggested as indicator species, most of these are coral reef or nearshore species that have been overfished, because most deepwater species, such as tunas, mahimahi are caught beyond the limits of the impact of management regimes under the Tuvalu R2R. With plants some of them have been double listed because they are included in multiple categories, such as coastal and mangrove species as well as in medicinal plants, food plants, etc. In the case of trees and other plants that are the main sources of wood for construction, woodcarving, toolmaking, toys and firewood they have been listed together to minimise repetition.

As suggested in the captions for Tables 83 and 84, the tables can be used by local communities as inventory sheets of the conservation status of specified indicator organisms before, during or after BES conservation initiatives have been implemented. It was suggested that local communities assess abundance on a relative basis using the following levels of "abundance" : V = very abundant (**uke kii**), A = abundant (**uke**), C = common (**malie**), O = Occasional (**naikoga**), U = uncommon (**seasea**) , R = rare (**fano seai**), E = absent or extinct/extirpated (**seai**). In terms of post-conservation status, the same classes could be used with R = returned (**foki**) or some other abundance category being used if the organism had been previously extirpated or lost; and I = increasing abundance and/or size (**faka uke**), which could be used along the current abundance category.

Local communities would, of course, have to be introduced to and trained in the classification system with the original and post-conservation assessments being conducted with appropriate R2R staff.

Table 83. Selected species or groups of named marine species that could serve a priority indicator species of the success of the BES conservation interventions within R2R ecosystems in Tuvalu, based on stated cultural importance, threatened status, consultations with local community experts and previous survey findings (Sauni et al 20008; Job et al. 2009 and 2013)(Notes: 1) In terms of current status for a given location, V = very abundant (**uke kii**), A = abundant (**uke**), C = common (**malie**), O = Occasional (**naikoga**), U = uncommon (seasea), R = rare (fano sea), E = absent or extinct/extirpated (seai); 2) in terms of post-conservation status, the same classes can be used or R = returned (**foki**) if previously lost and I = increasing abundance and/or size (**faka uke**).

Tuvaluan Name	Common Name (s)	Scientific name (s)	Current Status	Change/Comments
SMALL FINFISH				
maiava	rabbitfish	<i>Siganus spp.</i>		
Kalo, vete, kai vete	Schooling goatfish	<i>Mulloidichthys spp.</i>		
salala	mackerel scad	<i>Selar crumenophthalmus</i>		
Maono, api	White-spotted surgeonfish	<i>Acanthurus guttatus</i>		
ponelolo	Striped surgeonfish	<i>Acanthurus lineatus</i>		
Manini lakau, umalei	Orangespine unicornfish	<i>Naso literatus</i>		
kanase	Fringelip mullet	<i>Crenimugil crenilabis</i>		
savane	Common bluestripe snapper	<i>Lutjanus kasmira</i>		
taiva	Dory snapper, one-spot snapper	<i>Lutjanus fulviflamma</i> , <i>L. monostigma</i>		
Tā malau	Sabre squirrelfish	<i>Sargocentron spiniferum</i>		
LARGE FINFISH				
Kamutu, laea	Large male blue parrotfishes	<i>Chlorurus and Scarus spp.</i>		
Ulaŋi	longnose parrotfish, other parrotfishes	<i>Hipposcarus longiceps</i>		
Ume, kosotu, tāŋivi and pokapoka	Unicorn fishes	<i>Naso spp.</i>		
nanue	drummers	<i>Khyphosus spp.</i>		
Gatala, Munua	Malabar grouper	<i>Epinephelus malabaricus</i>		
Fapuku, Feata, Palati	Brown marbled grouper	<i>Epinephelus fuscoguttatus</i>		
Tagafa, Malatea	Humphead wrasse, Napoleon wrasse	<i>Cheilinus undulatus</i>		
Aseu, ulua	Bluefin trevally	<i>Caranx melampygus</i>		
Ulua, tino ulua	giant trevally, large trevallys	<i>Caranx ignobilis</i>		
DEEPWATER FINFISH				
Valu,	Dogtooth tuna	<i>Gymnosarda unicolor</i>		
isave	flyingfishes	<i>Cypselurus, Cheilopogon, Exocoetus spp.</i>		
EELS				
Pusi Kena, puhitea	Peppered moray eel	<i>Gymnothorax pictus</i>		
Pusi Ulaula, puhigatala	Giant moray eel	<i>Gymnothorax javanicus</i>		
Puleva	Snowflake or starry moray	<i>Echidna nebulosa</i>		

tuna	Black-edged conger eel	<i>Conger cinereus</i>		
SHARKS				
malu	Whitetip reef shark	<i>Triaenodon obesus</i>		
kili	Blacktip reef shark	<i>Carcharhinus melanopterus</i>		
Māgō, lālāila	Grey reef shark	<i>Carcharhinus amblyrhynchos</i>		
moemoeao	Tawny nurse shark	<i>Nebrius ferrugineus</i>		
alava	sicklefin lemon shark	<i>Negaprion acutidens</i>		
RAYS				
Faimanu	Spotted eagle ray	<i>Aetobatus narinari</i>		
Faifalua	Manta ray	<i>Manta birostris</i>		
DOLPHINS				
tafolā	Spinner dolphin	<i>Stenella longirostris</i>		
tafolā	Bottlenose dolphin	<i>Tursiops aduncus</i>		
TURTLES				
Fonu una	Hawksbill turtle	<i>Eretmochelys imbricata</i>		
Fonu, fonu ma-sani?	Green turtle	<i>Chelonia mydas</i>		
OCTOPUS AND SQUIDS				
Feke	Day octopus	<i>Octopus cyaneus</i>		
gufeke	Bigfin reef squid	<i>Sepioteuthis lessoniana</i>		
SMALL SHELLFISH				
Pule kena, pule uli, pule uli lasi	cowries	<i>Cypraea annulus, C. caputserpentis, C. moneta, C. mauritiana</i>		
Kasi, kahi	Asaphis clams	<i>Asaphis violacens</i>		
panea	bloodmouth conch	<i>Strombus luhuanus</i>		
Alili, pōhina	Turban snails	<i>Turbo setosus</i>		
Tio, ugakoa	Great worm snail	<i>Dendropoma maximum</i>		
kivikivi	Rockshells and vase shells	<i>Thais and Vasum spp.</i>		
Sipō	Nerite snails	<i>Nerita spp.</i>		
Fasua	Giant clams	<i>Tridacna maxima, T. squamosa</i>		
Lī, asule, ahule	Striate beach clam	<i>Atactodea striata</i>		
Sōpu nifo	Thorny oyster	<i>Spondylus sp.</i>		
sōpu	Jewelbox shell	<i>Chama sp.</i>		
muliuga	Mitre and Auger shells	<i>Mitra and Terebra spp.</i>		
Fakamili, mili	Cone shells	<i>Conus spp.</i>		
tugage	Ark clams	<i>Anadara sp.</i>		
LARGE SHELLFISH				
Kalea	Giant Spider conch	<i>Lambis truncata</i>		
pū	Triton trumpet snail	<i>Charonia tritonis</i>		
pū	Helmut shell	<i>Cassis cornuta</i>		
tifa	Blacklip pearl oyster	<i>Pinctada maculifera</i>		

fasua taka	Giant clams	<i>Tridacna maxima</i> , <i>T. squamosa</i>		
mulikao	Trochus and top shells.	<i>Trochus spp.</i> , <i>Tectis pyramis</i> .		
Fakamili	Cone shells (large)	<i>Conus spp.</i>		
ECHINODERMS				
funafuna	Black teatfish	<i>Holothuria fuscogilva</i> , <i>H. nobilis</i> , <i>H. whitmaei</i> , <i>H.</i> , <i>Bohadschia argus</i>		
Vana uli	Blue-black urchin	<i>Echinothrix diadema</i>		
CRABS				
Uu, ū	Coconut crab	<i>Birgus latro</i>		
Uga	Land hermit crabs	<i>Coenobita spp.</i>		
Uga o te tai	Large marine hermit crabs	<i>Dardanus spp.</i>		
tupa	Land crab	<i>Cardisoma carniflex</i>		
kaviki	Ghost crab	<i>Ocypode cerophthalma</i>		
Kaipea, paikea	Mouthless land crab	<i>Cardisoma crassum</i>		
matamea	Smooth red-eyed crab	<i>Eriphia sebana</i>		
Paka, paka pulepule	Reef crabs	<i>Carpilius convexus</i> , <i>C. maculatus</i>		
LOBSTERS AND SHRIMPS				
Ula	spiny or rock lobsters	<i>Panulirus spp.</i>		
Tapatapa, tuatu-aula	Slipper lobsters	<i>Parribacus spp.</i>		
valo	Banded mantis shrimp	<i>Lysiosquilla maculata</i>		

Table 84. Selected species or groups of terrestrial (land) species that could serve a priority indicator species of the success of the conservation of BES R2R ecosystems in Tuvalu, based on stated cultural importance in RfR, threatened status, consultations with local community experts and previous survey findings (Thaman et al. 2012; Thaman 2016))(Notes: 1) In terms of current status for a given location, V = very abundant (**uke kii**), A = abundant (**uke**), C = common (**malie**), O = Occasional (**naikoga**), U = uncommon (**seasea**), R = rare (**fano seai**), E = absent or extinct/extirpated (**seai**); 2) in terms of post-conservation status, the same classes can be used or R = returned (**foki**) if previously lost and I = increasing abundance and/or size (**faka uke**).

Tuvaluan Name	Scientific name (s)	Current Status	New Status
MANGROVE TREES AND SHRUBS			
Togo	<i>Rhizophora stylosa</i>		
sagale	<i>Lumnitzera littorea</i>		
Gie	<i>Pemphis acidula</i>		
Futu	<i>Barringtonia asiatica</i>		
Milo	<i>Thespesia populnea</i>		
Fala	<i>Pandanus tectorius</i>		
COASTAL AND INLAND WILD TREES AND SHRUBS (LAGOON AND OCEANSIDE)			
fetau	<i>Calophyllum inophyllum</i>		
kanava	<i>Cordia subcordata</i>		
tausunu	<i>Tournefortia argentea</i>		
Futu kafutu	<i>Barringtonia asiatica</i>		

fao	<i>Ochrosia oppositifolia</i>		
Pua	<i>Guettarda speciosa</i>		
Milo	<i>Thespesia populnea</i>		
Felo	<i>Ficus tinctoria</i>		
Fala	<i>Pandanus tectorius</i>		
Talie	<i>Terminalia samoensis</i>		
kunikuni	<i>Terminalia catappa</i>		
Laku Kilisimasi	<i>Casuarina equisetifolia</i>		
Puka vaka	<i>Hernandia nymphaeifolia</i>		
pukavai	<i>Pisonia grandis</i>		
valovalo	<i>Premna serratifolia</i>		
ogoogo	<i>Acalypha grandis</i>		
COASTAL AND INLAND WILD HERBS AND VINES			
Tolotolo	<i>Triumfetta procumbens</i>		
fetai	<i>Cassytha filiformis</i>		
Fue kena	<i>Ipomoea macrantha</i>		
Fue	<i>Ipomoea macrantha</i>		
Katuli	<i>Portulaca</i> spp.		
luna	<i>Laportia ruderalis</i>		
maile	<i>Microsorium grossum</i>		
Laukatafa, laulū	<i>Asplenium nidus</i>		
FOOD AND MULTIPURPOSE TREES			
niu	<i>Cocos nucifera</i>		
mei	<i>Artocarpus</i> spp.		
Futi, pata, kefu	<i>Musa</i> cultivars		
Falakai, falagau	<i>Pandanus</i> cultivars		
olesi	<i>Carica papaya</i>		
felo	<i>Ficus carica</i>		
moli	<i>Citrus</i> cultivars		
NON-TREE FOOD PLANTS			
pulaka	<i>Cyrtosperma chamissonis</i>		
talo	<i>Colocasia esculenta</i>		
Talo tana	<i>Xanthosoma</i> spp.		
Pateta, kumala	<i>Ipomoea batatas</i>		
tāmu	<i>Alocasia macrorrhizos</i>		
vatia	<i>Tacca leontopetaloides</i>		
tivoli	<i>Dioscorea nummularia</i>		
panikeni	<i>Cucurbita</i> cultivars		
laupele	<i>Abelmoschus manihot</i>		
Kapisi Saina	<i>Brassica chinensis</i> hybrids		
Laukatafa, laulau	<i>Asplenium nidus</i>		
kukama	<i>Cucumis sativus</i>		
pepa	<i>Capsicum annum</i>		

polofeū	<i>Capsicum frutescens, Capsicum annuum</i> vars.		
ANIMAL FOODS			
coconut	<i>Cocos nucifera</i>		
futi	<i>Musa</i> cultivars		
mei	<i>Artocarpus altilis</i>		
Pateta, kumala	<i>Ipomoea batatas</i>		
felo	<i>Ficus tinctoria</i>		
Puka vai	<i>Pisonia grandis</i>		
Fue kena	<i>Ipomoea macrantha</i>		
katuli	<i>Portulaca</i> spp.		
Ogoogo, ka-lakalāpuhi	<i>Acalypha grandis</i>		
Fou tagata, fau tu	<i>Hibiscus tiliaceus</i>		
Fou fafine, fau vau	<i>Pipturus argenteus</i>		
kanava	<i>Cordia subcordata</i>		
lautagitagi	<i>Polyscias</i> spp.		
togo	<i>Rhizophora stylosa</i>		
FRAGRANT AND ORNAMENTAL PLANTS			
'aute	<i>Hibiscus rosa-sinensis</i>		
Mili	<i>Ocimum tenuiflorum</i>		
nikalailai	<i>Tecoma stans</i>		
Piitasi	<i>Jasminum sambac</i>		
Tiale	<i>Gardenia taitensis</i>		
Pua	<i>Guettarda speciosa</i>		
Tapua, talotalo	<i>Crinum asiaticum</i>		
valvovalo	<i>Premna serratifolia</i>		
kaipuaka	<i>Lantana camara</i>		
Pua Fiti, melia	<i>Plumeria rubra</i> vars.		
naleau	<i>Gloriosa superba</i>		
HEDGE/WINDBREAK PLANTS			
lautagitagi	<i>Polyscias</i> spp.		
Gasu	<i>Scaevola taccada</i>		
Inato	<i>Clerodendrum inerme</i>		
ti	<i>Cordyline fruticosa</i>		
Lakau ta namu	<i>Vitex trifolia</i>		
'aute	<i>Hibiscus rosa-sinensis</i>		
Ogoogo kula, ka-lakalāpuhi	<i>Acalypha wilkesiana</i>		
Talotalo, tupua	<i>Crinum asiaticum</i>		
Lakau pula kena	<i>Pseuderanthemum carruthersii</i>		
Talasina launiu, talasina kena	<i>Dracaena angustifolia, D. sanderiana</i>		
tiale	<i>Gardenia taitensis</i>		

Laku Kilisimasi	<i>Casuarina equisetifolia</i>		
kanava	<i>Cordia subcordata</i>		
Fetau	<i>Calophyllum inophyllum</i>		
Fala	<i>Pandanus cultivars</i>		
MEDICINAL PLANTS AND MAGIC PLANTS			
tolotolo	<i>Triumfetta procumbens</i>		
Valovalo, aloalo	<i>Premna serratifolia</i>		
tausunu	<i>Tournefortia argentea</i>		
Talie	<i>Terminalia samoensis</i>		
Inato	<i>Clerodendrum inerme</i>		
kanava	<i>Cordia subcordata</i>		
Fetau	<i>Calophyllum inophyllum</i>		
Futu, kafutu	<i>Barringtonia asiatica</i>		
Fala	<i>Pandanus cultivars</i>		
Nonu	<i>Morinda citrifolia</i>		
Fetai	<i>Cassytha filiformis</i>		
Puka vai	<i>Pisonia grandis</i>		
Gasu	<i>Scaevola taccada</i>		
sagale	<i>Lumnitzera littorea</i>		
Talotalo, tapua	<i>Crinum asiaticum</i>		
Felo	<i>Ficus tinctoria</i>		
Ogoogo, ka-lakalāpuhi	<i>Acalypha grandis</i>		
lautagitagi	<i>Polyscias spp.</i>		
Lakau ta namu	<i>Vitex trifolia</i>		
Mohuku solo	<i>Commelina diffusa</i>		
CONSTRUCTION. TOOLMAKING, WOODCARVING, BOATBUILDING, FIREWOOD, ETC. PLANTS			
kanava	<i>Cordia subcordata</i>		
Milo	<i>Thespesia populnea</i>		
Fala	<i>Pandanus cultivars</i>		
Fetau	<i>Calophyllum inophyllum</i>		
Puka vaka	<i>Hernandia nymphaeifolia</i>		
pukavai	<i>Pisonia grandis</i>		
Futu, kafutu	<i>Barringtonia asiatica</i>		
togo	<i>Rhizophora stylosa</i>		
Sagale	<i>Lumnitzera littorea</i>		
Tiale	<i>Gardenia taitensis</i>		
Gie	<i>Pemphis acidula</i>		
valovalo	<i>Premna serratifolia</i>		
Pua	<i>Guettarda speciosa</i>		
fao	<i>Ochrosia oppositifolia</i>		
mei	<i>Artocarpus spp.</i>		



Nonu	<i>Morinda citrifolia</i>		
SEABIRDS AND MIGRATORY BIRDS			
Akiaki/matapula	<i>Sternula nereis</i>		
Gogo	<i>Anous stolidus</i>		
Lupe	<i>Ducula pacifica</i>		
Kolili	<i>Arenaria interpres</i>		
Lakia	<i>Anous minutus</i>		
Suvi, kaleva	<i>Urodynamis taitensis</i>		
Kōtā	<i>Sula leucogaster</i>		
Kaka	<i>Limosa lapponica</i>		
Kanapu	<i>Sula sula</i>		
Tavakelau	<i>Phaethon lepturus</i>		
Katafa	<i>Fregata spp.</i>		
Matuku	<i>Egretta sacra</i>		
Talaaliki	<i>Onychoprion fuscatus</i>		
Toloa	<i>Anas superciliosa</i>		
LAND SNAILS AND SHELL USED FOR NECKLACES AND JEWELLERY			
Misa kena	<i>Melampus faciatus</i>		
Misa uli	<i>Melampus luteus</i>		

13

PRIORITY SPECIES FOR FURTHER IN-DEPTH BIODIVERSITY SURVEYS

Based on the results of the 2016 Funafuti R2R BIORAP and comparison with findings of past marine and terrestrial biodiversity surveys conducted in Tuvalu, a number of priority groups of organisms or organisms important for the delivery of specified ecosystem services were identified as priorities for further in-depth biological and community-based assessments (Table 85). These groups or species (most of which are included above in Tables 82 and 83 as priority indicators species) include 1) invasive alien species and diseases (IAS), 2) sea birds, 3) crabs, 4) molluscs, 5) reptiles, 6) schooling and aggregating fish, 7) coastal trees and plants, 8) soil enrichment and mulching plants, 9) food plant cultivars and 10) medicinal plants (Table 82). Some of the specifics of these are listed in Table 84.

Table 85. Priority areas for further in-depth biodiversity surveys or re-surveys based on the results of the Funafuti R2R BIORAP after comparison with findings of past studies of marine and terrestrial biodiversity.

1. IAS: Invasive alien species: with possible priority species including rats, ants, noxious weeds, food crop diseases, coastal plant diseases and marine algae and cyanobacteria.
2. Sea Birds: Sea bird populations on uninhabited atolls that have only been inventoried in detail in the 1994 in the Funafuti conservation area, but which constitute an important food source, navigation and fish-finding guides for Tuvaluan fishermen, provide important links and ecological services in the RTR marine-atoll link and critical niche ecotourism activities. Associated with this survey would be a component to assess the threat posed by rats, ants and other IAS, drought and habitat loss on existing bird populations.
3. Crabs: Particularly threatened are a number of crabs, including the coconut crab (uu), a number of overexploited land and shore crabs (kaipea, kaviki), hermit crabs (uga) and selected reef crabs.
4. Molluscs: Land snails (misa) and other target marine molluscs (pule, pu, kalea, alili, fasua, etc) that are of central importance to Tuvalu's main export and local handicraft trade, the sustainability of which is critical.
5. Reptiles: Possibly reptiles, e.g., geckos and skinks that may be negatively affected by ants and other invasive species, and which may be good indicators of the overall health of atoll islands
6. Schooling and Aggregating fish: Some schooling and small school fish, the massive spawning aggregations of which seen to have historically declined dramatically. These could include maiava (*Siganus argenteus*), manini (*Acanthurus triostegus*) and fapuku (*Epinephelus polyphekadion*).
7. Coastal Trees and Plants: Important coastal trees, including mangroves, and other indigenous coastal plants that are in need of protection, propagation and replanting, with the assistance of a mass propagation scheme to allow for coastal rehabilitation and reinforcement.
8. Soil enrichment and mulching plants: Protection and restoration, including propagation of plants vital to the maintenance and improve soil fertility and for making mulch (kaiao) in the extremely poor soils of the atolls.
9. Food plant cultivars: Important food plant cultivars that are central to food security in Tuvalu and that need to be enriched and planted. There is a need to assess the need for and ways to propagate key food species.
10. Medicinal Plants: Many medicinal plants, which are critical to health and cultural security are now reportedly threatened or in short supply.

TWELVE (12) COMMANDMENTS FOR THE CONSERVATION OF ATOLL AND OCEAN BES IN TUVALU

“Twelve (12) Commandments for the Conservation of Atoll and Ocean Biodiversity and Ecosystem Services (BES) in Tuvalu” are presented here (Table 86) as a “living” updatable guideline and commitment to action necessary to conserve the BES (**mea ola mo te vaega mea aoga kia tatou mo fenua mo tai**) that Almighty God has given to the people of Tuvalu. They are based on the results of 2015 Funafuti R2R BIORAP. The “12 Commandments” can serve as working guidelines for the conservation, restoration, enrichment, sustainable use and equitable sharing of BES as basis for adaptation to climate change, sea-level rise and the increasingly negative impacts of extreme weather and tidal events and for food, health, energy and environmental security in Tuvalu. They highlight areas of opportunity for building synergies between indigenous and local knowledge (ILK) and modern scientific knowledge (MSK). They can also serve as a foundation for social, cultural, economic and environmental sustainability, spirituality, social cohesion, education and governance and should be collectively used by the people of Tuvalu (local communities, traditional leaders and knowledge holders, teachers, scientists, government, NGOs, sports and cultural bodies and faith-based organisations) to successfully develop and implement a Tuvalu R2R Biodiversity Conservation Action Plan (BCAP). The 12 Commandments will also insure that Tuvalu’s BES will be part of our education system; our leaders and policy makers will understand the importance of Tuvalu’s BES; and that our BES-based ecocultural tourism will continue to provide some income.

Many of the 12 commandments are interrelated and reinforce each other, e.g., a good diet, adequate clean freshwater, good health care service and good nutrition, which all depends on the protection of our BES, can have multiple positive effects on the lives of Tuvaluans. Appendix VII contain the “12 Commandments” along with more detailed information of the importance and ways of implementing each of the commandments. It is envisioned that the “12 Commandments” could be made into posters that could be placed in schools, maneapa, Sunday schools, hotels and other accommodation, offices and other appropriate places which would be supported by the rationale, supporting materials and possible actions that can be promoted under each commandment are included in Appendix III.

Table 86. "TWELVE COMMANDMENTS" for the Conservation of Atoll and Ocean Biodiversity and Ecosystem Services (BES) in Tuvalu (Appendix VII lists the 12 Commandments along with the rationale, supporting materials and possible actions that can be promoted under each commandment).

PROTECT TREES, FORESTS AND COASTAL VEGETATION (Tree and Forest Management)

- 1. USE MARINE RESOURCES WISELY** (Fisheries Management)
- 2. CONSERVE AND DEVELOP FRESHWATER RESOURCES** (Water Management and Conservation)
- 3. CONSERVE AND ENRICH SOIL AND SAND RESOURCES** (Soil, Sand and Fire Management)
- 4. PROTECT AND IMPROVE AGRICULTURAL, FOOD AND HEALTH SYSTEMS** (Agricultural, Food and Health Security)
- 5. PROMOTE AND IMPROVE TRADITIONAL ARTS, CRAFTS AND CONSTRUCTION** (Conservation and Innovation of Material Culture)
- 6. PREVENT AND CONTROL INVASIVE ALIEN SPECIES AND DISEASES** (Biosecurity and Invasive Species Management)
- 7. PREVENT AND REDUCE POLLUTION AND WASTE** (Energy, Waste and Pollution Management)
- 8. PREPARE FOR CLIMATE CHANGE AND NATURAL DISASTERS** (Disaster Risk Management and Planning)
- 9. ESTABLISH A SYSTEM OF PROTECTED AREAS AND SPECIES** (Conservation Area Development)
- 10. TEACH AND IMPROVE AWARENESS ABOUT BIODIVERSITY** (Environmental Education and Awareness)
- 11. SUPPORT GOOD GOVERNANCE AND PLAN FOR THE FUTURE** (Environmental Governance and Planning)



APPENDIX

Estimated total named plant or animal species or groups of species recorded as important in different R2R ecosystems or habitats and/or for the delivery of specified ecosystem goods and services on Funafuti Atoll, Tuvalu; the numbers of these that are said to be threatened, rare or in depleted numbers*; and the major drivers of and solution/interventions to address BES loss (listed in order of importance or seriousness) based on surveys of 19 respondent groups on Funafuti Atoll in November 2016 (Notes: * many of these species or groups of specie, e.g., shellfish, such as cone shells and cowries and finfish, such as soldierfishes or parrotfishes represent multiple species so the number of actual species, including those that are threatened is far greater than these numbers represent; number extracted from Table 1 above)

Types/Taxa	Total Species* (No. rare or threatened)	No. Threatened, rare or extirpated	Drivers of Loss	Solutions/Interventions
Small nearshore fishes	40	19	Overuse/overfishing, land reclamation, pollution, climate change	Conservation (MPA), regulation/enforcement, awareness, pollution control,
Large inshore fishes	30	12	Overfishing, unknown	Conservation (MPA), regulation/enforcement, awareness
Deepwater fishes	17	13	Overfishing, longline fishing, climate change, naturally rare, fish migration, unknown,	Regulation/enforcement, conservation, awareness, ban near-shore longlining
eels	7	6	Overfishing, use for bait, unknown, pollutions	Conservation
sharks	13	10	Overfishing, longline fishing, pollution, climate change	Conservation, regulation, ban nearshore longline fishing
rays	7	5	Overfishing, naturally rare, climate change	Conservation, regulation, enforcement
Dolphins or whales	5?	4	Overfishing, longline fishing, climate change	Conservation, regulation, enforcement
turtles	2	2	Overfishing, ceremonial consumption	Conservation, regulation, enforcement
Small shellfish	16	10	Overuse, overfishing, reclamation, habitat degradation, pollution	Conservation, regulation, enforcement, awareness, waste management,
Large shellfish	11	8	Overuse, overfishing, reclamation, pollution	Conservation, regulation, enforcement, awareness, waste management,
Octopus and squid	7	6	Overfishing, use for bait, pollution, naturally rare, unknown, climate change	Conservation, regulation, enforcement, awareness, control marine pollution
Crabs and hermit crabs	19	12	Overfishing, use for bait, unknown, pollutions, reef degradation, climate change	Conservation, regulation, enforcement, awareness,
Lobsters and shrimps	12	9	Overfishing, naturally rare, unknown, reef degradation, climate change	Conservation, regulation, enforcement, awareness,

Sea cucumbers, bêche-de-mer	19	12	Overfishing, use for animal feed, commercial fishing,	Conservation, regulation, enforcement, awareness,
Sea urchins, starfish	13	11?	Overfishing, pollution, degradation, land reclamation, climate change, unknown	Conservation, regulation, enforcement, awareness, control marine pollution
Sea worms	8	5	Overuse, degradation, use for bait, wave damage/erosion, land reclamation, climate change, unknown	Conservation, regulation, enforcement, awareness
Hard and soft coral	25	16	Climate change, pollution, reef degradation, boat anchor damage	Control pollution, enforceable legislation against coral degradation
jellyfishes	15	10	Climate change, pollution, unknown, reef degradation, use as animal feed, naturally rare	Conservation, regulation, enforcement, awareness
seaweeds	14	12	Climate change, degradation, pollution, land reclamation, consumption by herbivores, unknown, naturally rare	Pollution control, Conservation, regulation, enforcement, awareness
Organisms eating/controlling algae	32	18	Overfishing,	Conservation, regulation, enforcement, awareness
Fishing bait	24	11	Overuse, habitat degradation, naturally rare, use for animals food	Conservation, regulation, enforcement, awareness
Shells used in making necklaces and handicrafts	25	13	Overuse, climate change, wave erosion, drought	Conservation, regulation, enforcement, awareness
Mangrove trees and other associated plants	20	16	Overuse, land clearance and reclamation, use for livestock feed, use for fertilizer, climate change, storm waves	Conservation, regulation, enforcement, awareness, replanting
Lagoonside trees and large plants	20	16	Coastal erosion, land clearance, overuse, coastal erosion, climate change	Conservation, regulation, enforcement, awareness, replanting
Lagoonside small plants and vines	21	10	Habitat degradation, land clearance, overuse, climate change, free ranging animals, burning	Conservation, regulation, enforcement, awareness, replanting, building seawalls
Oceanside trees and large plants	17	13	Land clearance, overexploitation, coastal erosion, drought, climate change, no replanting	Conservation, regulation, enforcement, coastal reforestation, awareness, replanting, nursery development, building seawalls
Oceanside small plants/vines	21	15	Overuse, climate change, coastal erosion	Conservation, regulation, enforcement, awareness, building seawalls
Inland trees/large plants	24	8	Overuse, land clearance, climate change,	Conservation, regulation, enforcement, awareness, propagation and replanting, nursery establishment

Inland Small plants/vines	28	12	Overuse, land clearance, climate change, drought, naturally rare, burning, roaming pigs	Conservation, regulation, enforcement, awareness, propagation and replanting
ferns	7	5	Overuse, land clearance, free ranging pigs, indiscriminate burning	Conservation, regulation, enforcement, awareness
Cultivated food plants	24	20	overexploitation, land clearance, land shortage, soil infertility, prolonged drought, saltwater incursion and salt spray, climate change, failure to replant, shortage of planting materials, loss of knowledge, declining use due to replacement imported foods	Development of nurseries/plant propagation capacity, education and awareness, promotion of local foods
Coconut palm cultivars	19	13	As above	As above
Pandanus cultivars	19	12	As above	As above
Breadfruit cultivars	12	11	As above	As above
Banana or plantain cultivars	10	9	As above	As above
Giant swamp taro cultivars	19	10	As above	As above
Taro cultivars	15	11	As above	As above
Animal food/fodder	19	12	Overuse, feeding pigs, land clearance and drought, failure to plant	Increase planting, establish fodder reserves, plant edible hedges/fences
Garland and body ornamentation	28	17	Land clearance, overuse, failure to replant, naturally rare, non-use, coastal erosion	Conservation, regulation and enforcement, awareness, replanting, propagation
Ornamental plants	29	19	Land clearance, failure to replant, overuse, naturally rare, climate change, declining use	replanting, propagation, protection
Fence/hedge plants	23	16	Clearance, failure to plant, pests and disease, lack of planting material	Replanting and propagation, protection
Medicinal plants	39	26	Overuse, land clearance, climate change	Conservation, regulation, awareness, and enforcement, replanting, propagation
Animal Medicines	11	8	Overuse, land clearance	Conservation, regulation
Construction/housebuilding	16	11	Land clearance, climate change, overuse, not planting	Regulation, conservation, awareness, replanting,
Woodcarving/toolmaking	14	10	Land clearance, climate change, overuse, not planting	Regulation, conservation, awareness, replanting, afforestation
Canoe or boat-building	10	7	Land clearance, climate change, overuse, not planting, firewood, coastal erosion	Regulation, awareness, conservation

firewood	13	7	Land clearance, climate change, coastal erosion	Regulation, awareness, enforcement, conservation
Weaving and handicrafts	12	8	Land clearance, climate change, overuse, coastal erosion	Regulation, awareness, enforcement, conservation
Cordage, string, rope	4	3	Not planting, overuse, climate change	awareness, planting, conservation
Fishing equipment	13	8	Land clearance, climate change, overuse, coastal erosion	Regulation, awareness, conservation
Necklaces and beads	9	8	Land clearance, climate change	Regulation, awareness, conservation, replanting, afforestation
Toys and games	8	6	Land clearance, climate change, coastal erosion	Regulation, awareness, conservation
Wrapping/parceling	15	13	Land clearance, climate change	Regulation, conservation, awareness, replanting,
Perfumes/scenting coconut oil	23	15	Land clearance, climate change, not planting	conservation, awareness, replanting,
Dye or paint	2	2	Climate change, land clearance	replanting
Fertilizer/mulching plants	12	10	Climate change, land clearance, overuse	Conservation, awareness, regulation,
Magic/black magic plants	10	8	Climate change, land clearance	Conservation, awareness
Land and sea-birds	18	12	Overuse/hunting birds and eggs, climate change, unknown	Regulation, enforcement, conservation, awareness
Migratory/non-resident birds	19	17	Overuse (Eating birds and eggs), climate change (drought)	Conservations, regulation, , awareness
Edible sea birds	4	4	Overuse (Eating birds and eggs),	Conservations, regulation, , awareness
Seabird nesting trees	6	6	Land clearance, overuse,	Conservations, regulation, , awareness
Domestic animals	5	3	Overuse	awareness, planning
lizards	7	4	Land clearance, habitat degradation	Conservations, regulation, , awareness
Coconut crabs	1	1	Overuse, , habitat degradation	Conservations, regulation, , awareness
Insects and arthropods	10	?	Land clearance, habitat degradation	Conservations, , awareness
TOTAL	1065	668		