TUVALU NATIONAL BIODIVERSITY STRATEGY AND ACTION PLAN: FIFTH NATIONAL REPORT TO THE CONVENTION ON BIOLOGICAL DIVERSITY

Ministry of Foreign Affairs, Trade, Tourism, Environment and Labour
Government of Tuvalu
2016

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Compiled by Randy Thaman[1] with assistance from Faoliu Teakau[2], Moe Saitala[3], Epu Falega[4], Feagaiga Penivao[5], Mataio Tekenene[6] and Semese Alefaio[7]

for the

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Cover photo: Aerial view looking west across south Fogafale Islet, Funafuti Atoll, Tuvalu (Source: Thaman 2016).

[1] Emeritus Professor of Pacific Islands Biogeography, The University of the South Pacific, Suva, Fiji. [Thaman_r@usp.ac.fj]
[2] Biodiversity Strategy and Action Plan Coordinator, Department of Environment, Ministry of Foreign Affairs, Tourism, Trade, Environment and Labour (MFATTEL), Government of Tuvalu, Vaiaku, Funafuti, Tuvalu. [fteakau@gmail.com]
[3] Acting Director of Environment, Ministry of Foreign Affairs, Trade, Tourism, Environment and Labour Government of Tuvalu, Vaiaku, Funafuti, Tuvalu [mtsaitala@gov.tv]
[4] Former Biodiversity Strategy and Action Plan coordinator Department of Environment,
Vaiaku, Funafuti, Tuvalu
[5] LMMA Officer, Tuvalu Ridge to Reef Project (R2R), Department of Environment Ministry of Foreign Affairs, Trade, Tourism, Environment and Labour Government of Tuvalu, Vaiaku, Funafuti, Tuvalu.
[6] Former Director of Environment and current Coordinator of the Tuvalu Ridge to Reef Project (R2R), Department of Environment Ministry of Foreign Affairs, Trade, Tourism, Environment and Labour Government of Tuvalu, Vaiaku, Funafuti, Tuvalu.
[7] Marine Scientist, Master Fisherman (Tautai), Fisheries Expert and Acting Inshore Fisheries Officer, Tuvalu Fisheries Department [semesea@tuvalufisheries.tv]

DEDICATION

To past and current generations of Tuvaluan men and women who have, since the first settlement of Tuvalu, been the custodians responsible for preserving, enriching and passing on to future generations their unique indigenous knowledge of their atoll and ocean environment and biodiversity as their most important, but seriously threatened, foundation for sustainable atoll development and the first line of defense against climate, environmental and global change.

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ACRONYMS AND ABBREVIATIONS

ATs	Aichi Targets
AusAID	Australia Agency for International Development
BES	Biodiversity and Ecosystem Services
BIORAP	Rapid Biodiversity Assessment
CA	Conservation Area
CANCC	Coalition of Low Lying Atoll Nations on Climate Change
CBD	Convention on Biological Diversity
CC & ND	Climate Change and Natural Disasters
DoE	Department of Environment
EEZ	Exclusive Economic Zone
ENSO	El Niño Southern Oscillation
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FCA	Funafuti Conservation Area
FFA	Forum Fisheries Agency
GCCA	Global Climate Change Alliance
GEF	Global Environment Facility
GoT	Government of Tuvalu
IPBES	Intergovernmental Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
IUCN	World Conservation Union or International Union for the Conservation of Nature
JICA	Japanese International Cooperation Agency
LMMAs	Locally Managed Marine Areas
MFATTEL	Ministry of Foreign Affairs, Tourism, Trade, Environment and Labour
GCCA PSIS	Global Climate Change Alliance Pacific Small Islands States Alliance
ILK	Indigenous and Local Knowledge (ILK)
MET	Meteorological Department
MSK	Modern Scientific Knowledge
NAPA	National Adaptation Plan of Action (Phases 1 and 2)
NBSAP	National Biodiversity Strategy and Action Plan
NCDs	Non-Communicable Diseases
NZAID	New Zealand Overseas Development Assistance
PII	Pacific Invasives Initiative
PSIS	Pacific Small Islands States
R2R	Tuvalu Ridge to Reef Project
SDGs	Sustainable Development Goals
SIMS	Small Island Micro-States
SOPAC	Applied Geoscience and Technology Division, SPC
SPC	Secretariat of the Pacific Community
SPREP	Secretariat of the Pacific Regional Environment Programme
SWAT	Solid Waste Agency of Tuvalu
TC Pam	Tropical Cyclone Pam
UNDP	United Nations Development Programme
USP	The University of the South Pacific
WHO	World Health Organization
YCA	yellow crazy ant (*Anoplolepis gracilis*)

EXECUTIVE SUMMARY

1 INTRODUCTION

The isolated, small, low-lying resource-poor atolls of Tuvalu are clearly on the frontline against climate change, the escalating impacts natural disasters and declining food, health and energy security. Because of very limited potential for modern development, Tuvalu's first line of defence is the conservation and sustainable use of very limited and highly threatened biodiversity and the rich indigenous knowledge of these living resources. This Fifth Tuvalu National Report (5th Report) to the Convention on Biological Diversity (CBD) summarises the nature, cultural importance, conservation status and threats changes to Tuvalu's Biodiversity and actions taken or that need to be taken to promote the conservation and sustainable use of biodiversity since the submission of the fourth national report in 2010.

2 TUVALU AND ITS BIODIVERSITY

2.1 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 km^2 spread over an ocean area of about 1.3 million km^2 between 5º and 10.5º S latitude and 176º and 179.5º E longitude (Carter 1984). Tuvalu's Exclusive Economic Zone (EEZ) covers an oceanic area of approximately 900,000 km^2.

Funafuti, the most highly populated atoll and capital, has 33 islets encircling a lagoon with a land area of about 275 km^2. One-third of the total area of Fogafale 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. 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 km^2 for Tuvalu and over 2000 per km^2 for Funafuti, where over half of the population now lives, almost all on increasingly urbanised Fogafale Islet. The people are almost all indigenous Polynesians. About 95% of the land in Tuvalu is indigenous customary land owned by individuals

2.2 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.

2.3 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. 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). 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 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.

2.4 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^{o} C and a daily minimum of 25^{o} 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. 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. 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.

2.5 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.

2.6 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. 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.

2.7 Flora and Vegetation

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

2.8 Terrestrial Ecosystems and Vegetation

Despite severe habitat degradation, selective removal and over harvesting of important 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. These are found mainly on the uninhabited reef islets. The main vegetation or land cover types that constitute the main terrestrial ecosystems found in Tuvalu, of which there are many combinations and shared species, include inland broadleaf forest and woodland, coastal littoral forest and scrub, mangroves and wetlands, coconut woodland and agroforest, excavated taro gardens, village houseyard and urban gardens, intensive vegetable and food gardens, constantly disturbed ruderal vegetation, beaches,

coral rubble and coastal beach rock and unvegetated recently reclaimed areas infilled with lagoon sediment

2.9 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.

2.10 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.

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. 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. All of these zones are important fisheries with the intertidal flats being among the most important, over exploited, and increasingly vulnerable traditional fisheries.

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. 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 IMPORTANCE OF BIODIVERSITY AND ECOSYSTEM (BES)

For Tuvalu, food, health, livelihood, environmental and cultural security ultimately depend on the conservation of biodiversity and ecosystem services (BES)—the benefits people obtain

from ecosystems, which are broken down into four categories: provisioning, regulating, cultural and supporting services.

3.1 Provisioning Services (products necessary for food, health and livelihood security) include: 1**) foods**, such as staple and supplementary ground and tree crops, domesticated animals and their food, and wild terrestrial plants and animals and a wide range of marine foods, including seabirds, turtles, finfish, shellfish, crustaceans and other marine invertebrates; 2) **raw materials** including wood for construction, woodcarving, boatbuilding, toolmaking and other purposes, fibre, cordage, seeds, flowers and other plant materials used for making handicrafts, body ornamentation and other purposes and organic mulching and fertilizers that are so vital in dry, infertile soils; 3) **fresh water**, which is essential for the health and survival of all life, is extremely limited, with local freshwater resources consisting of only limited groundwater, water and drinks from coconuts and water-rich fruits and vegetables; 4) **energy** in the form of fuelwood and other plant biomass for cooking, food preservation and other purposes; 5) traditional medicines, almost exclusively from plant resources; and 6) **ornamental and fragrant materials**, including flowers, leaves, seeds and other plants parts and marine products, particularly shells, for the productions of garlands, jewellery, scented coconut oil and perfume and important exchange items.

3.2 Regulating Services (benefits obtained from the regulation of ecosystem processes) include: 1) **climate regulation**, including carbon sequestration, temperature and moisture regulation, and shade and protection from ultraviolet light; 2) **water regulation**, especially the regulation of water flow between the open ocean and lagoons and the flushing and renewal of water in lagoons needed to purify and oxygenate lagoon water and facilitate the flow of nutrients, planktonic larvae and the movement of migratory and schooling species; 3) **erosion control and protection** from strong winds and salt spray provided by healthy coastal vegetation, beaches, coral reefs and algal beds; 4) **waste management, decomposition and purification** including detoxification performed by insects, fungi and detrivores, bioremediation by land and marine plants, and purification/detoxification of water, soil and air by trees, plants and filter-feeding organisms; and 5) **pest and disease control** of weeds, insects, invasive algae and diseases by natural or introduced predators, including control of invasive marine algae and algal blooms by marine organisms.

3.3 Cultural services (non-material benefits from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences) include: 1) **aesthetic values** such as colour, fragrance, appearance, humour, architecture, gardening, folklore, motifs and patterns or designs in arts and crafts, symbols, emblems, plants or animals; 2) **spiritual and historical values**, such as chiefly foods, ceremonial and burial valuables, place names, lyrics of songs; 3) **recreation and sports**, e.g., skilled fishers, navigators, dancers, singers, etc. which depend on BES.; 4) **tourism and travel**, both international and internal, are dependent on healthy BES; 5) **science and education**, based on study of BES, with some of the first studies of Pacific shells, insects and the formation of atolls being conducted in the late 1880s in Tuvalu.

3.4 Supporting services (services necessary for the production of all other ecosystem services) include: 1) **primary production** to support all natural and cultural food chains, production systems and to produce healthy soils and beaches.; 2) **soil, sediment, sand, rubble and substrate provision**
so crucial for atolls; 3) nutrient recycling by terrestrial and marine plants (e.g., fallow vegetation), animals and micro-organisms; 4) habitat provision for both terrestrial and marine organisms is provided by healthy BES, particularly important of which are intact coastal littoral forest and; 5) pollination, which is essential for the fruiting, production and reproduction of flowering plants and the optimum functioning of both natural communities and agricultural systems and is performed by a range of bees, flies, butterflies, moths and other insects, birds and geckos and skinks; 6) dispersal and migration pathways, connectivity and spawning aggregations for the spread, reproduction, re-establishment and survival of populations of most organisms.

4 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 mainly an increasing loss of species diversity and declining population levels of some important species within many of the main ecosystems discussed above, including the resultant degradation of ecosystems and loss BES. This loss includes the loss of agricultural diversity within Tuvalu's traditional agricultural ecosystems. The main ecosystems that are under threat 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 near-shore lagoon and Oceanside marine ecosystems.

Within all of these ecosystems there is a wide range of threatened plants and animals, with over half of over 1000 named species or groups of species, considered extirpated, rare or threatened and in need of conservation by local communities. Among the most threatened species are: 1) a wide range of small and large finfishes, including eels, sharks, rays, dolphins and turtles; 2) small and large shellfish; 3) octopus and squid; 4) marine and land crabs; 5) sea cucumbers; 6) hard and soft corals; 7) 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; 8) ultivated food, ornamental and multipurpose plants; 9) cultivars of important food crops; 10) land and seabirds; 11) reptiles; and 12) insects and arthropods

5 MAJOR THREATS TO BIODIVERSITY AND ECOSYSTEM SERVICES

The mains drivers of this loss of BES which have remained essentially the same since the 4th Report to the CBD. Direct drivers include: 1) climate change and sea-level rise; 2) impacts of extreme weather and tidal events, particularly tropical cyclones, storm waves and prolonged droughts; 3) coastal deforestation and beach erosion; 3) overexploitation of terrestrial plants and animals; 4) overfishing; 5) invasive alien species and diseases (IAS) and feral animals; 6) urban and village expansion, land clearance and land reclamation; 7) solid and liquid waste

management and water pollution; and 9) feral animals; and indirect drivers include 10) loss of knowledge, particularly indigenous knowledge, and lack of awareness lack of awareness, particularly among the younger generation; and 11) inadequate governance and legislation.

6 ACTIONS TO ADDRESS LOSSES OF BIODIVERSITY AND ECOSYSTEM SERVICES

Interventions favored by communities include: 1) enforceable conservation legislation, including stronger local by-laws; 2) establishment or strengthening of a system of marine managed areas, including no-take MPAs; 3) designation of selected uninhabited, preferably pest-free, reef islets or forest remnants as reserves for threatened plants and animals; 4) restrictions on exploitation of threatened species until numbers recover; 5) replanting of coastal protection species; 6) beach protection, restoration and enrichment programmes; 7) establishment of agricultural conservation and enrichment areas, including improved excavated taro pit gardens, coconut dominant agroforestry plots and village gardens; 8) improved windbreaks, hedges and seawalls; 9) development of re-vegetation soil enrichment programmes for reclaimed barrow pit and lagoon land; 10) nursery and propagation capacity development;11) improved pig and chicken husbandry systems, including improved fodder resources; 12) improved marine pollution control and waste management; 13) strengthened international and national biosecurity and IAS eradication and management programmes; 14) national awareness and education programmes, including the recording and teaching traditional knowledge; and 15) promotion of nature and cultural tourism sites and "living laboratories" for Tuvaluans, to learn about Tuvalu's biodiversity and ecosystem services.

7 TUVALU NBSAP, THE AICHI TARGETS AND SUSTAINBLE DEVELOPMENT GOALS

Tuvalu has tried to achieve most of the goals of the NBSAP; and although most of the Aichi Biodiversity Targets (ATs) and Sustainable Development Goals (SDGs) are relevant to Tuvalu, some are of higher priority and others may be less attainable or less relevant for the isolated, fragmented, low-lying, resource- and biodiversity-poor and culturally homogenous Polynesian atolls of Tuvalu.

8.1 NBSAP Activities and the Aichi Biodiversity Targets (ATs)

Priority NBSAP activities related to the respective Aichi Biodiversity Targets (ATs) include:

- AT 6 - Raising awareness of the importance of biodiversity, the most important of which have been initiatives by the Agricultural, Fisheries, Environment and Education Departments, the main partners in BES conservation.
- AT 5 – Efforts to arrest degradation on uninhabited atoll islets and to establish CAs and LMMAs in the nearshore marine areas.

- AT 6 – Establishment a system of LMMAs and party to The Nauru Agreement, an eight-country agreement to cooperatively manage the control the western and central Pacific tuna stocks.
- AT 7 – Programmes to restore and enrich traditional taro pit gardens (**pela**) and coconut-dominant agroforestry systems with "climate-ready crops and to increase production and diversity of short-term home vegetable gardens.
- AT 8 – Efforts control sewage seepage into Funafuti lagoon and the freshwater table, conversion of waste into compost, and source control and more efficient and re-use of wastewater.
- AT 9 – Tuvalu Invasive Species Committee coordinated by DOE stablished in 2015; biosecurity staff received training in 2012, but management the most serious IAS (rats, yellow crazy ants, weeds, crop diseases and kou leafworm remain problematic and probably requires assistance from international partners
- AT 10 – Tuvalu has remains committed and involved in most international initiatives addressing climate change and anthropogenic impacts on BES including the recently established Coalition of Low Lying Atoll Nations on Climate Change (CANCC).
- AT 11 – Funafuti Conservation Area (FCA) (Kongatapu) established which clearly protects a significant percentage of Tuvalu's ecologically important ecosystems; and similar protected areas are being protected under local by-laws on the outer atolls.
- AT 12 – Because Tuvalu has virtually no endemic plants and animals, the emphasis of biodiversity conservation in Tuvalu has focused on the conservation, restoration and enrichment of a wide range of threatened culturally and ecologically important plants, animals and fish that are central to sustainability in Tuvalu. Indicator species are also being identified to assess the effectiveness of conservation efforts. There have been effective protection regimes and associated awareness campaigns to protect turtles, giant clams and some threatened sea birds of global conservation interest.
- AT 13 – There has been some support for the protection, propagation and increased planting of cultivars of Tuvalu's staple food crops under the GCCA Agroforestry Project and Department of Agriculture initiatives.
- AT 14 – Effort has been placed on increasing the capacity and efficiency of rainwater catchment and storage systems, which for Tuvalu, are seen as a "critical" part of the "freshwater ecosystem" and central to the health of atoll plants, animals, crops and people.
- AT 15 – Given its small forest area there is limited scope for Tuvalu to play a major role in mitigation to enhance carbon stocks, apart from the protection of the photosynthetic capacity of their reefs and algal beds, although there is very limited scope for replanting coastal forest and mangrove species to make a symbolic contribution, the main contribution of which would be coastal and wildlife habitat protection.
- AT 17 – Participatory community and government consultations were held in 2016 to update the Tuvalu NBSAP.
- AT 18 - As a small island state inhabited and governed by indigenous Polynesian people, Tuvalu has been very active in the recording and application of ILK to the conservation and sustainable use of biodiversity, with the full and effective participation of indigenous and local communities.
- AT 19 – Efforts have been made to improve, share and apply the knowledge, science and technologies relating to biodiversity as a central theme in projects of the Agroforestry, Locally Managed Marine Areas, Disaster Risk Management, NAPA, R2R and other programs.

- AT 2O – Has mobilized financial resources to achieve as many of the ATs in accordance with the process in the Strategy for Resource Mobilization.

ATs that have been less well addressed are:

- AT 2 - integration of biodiversity values into national and local development and poverty reduction strategies, planning processes and accounting and reporting systems.
- AT 3 - elimination or phasing out of incentives and subsidies harmful to biodiversity and introduction of positive incentives for the conservation and sustainable use of biodiversity.
- AT 4 – Implementing plans for sustainable production and consumption to keep the impacts of use of natural resources well within safe ecological limits.
- AT 16 – Little action in relation to Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization, again due to limited potential for bioprospecting and the exploitation of terrestrial plants animals and micro-organisms that are unique to Tuvalu.

8.2 NBSAP Activities and the Sustainable Development Goals (SDGs)

The SDGs of most concern in Tuvalu (numbers in parentheses) are **food security** (2), **good health and wellbeing** (3), **quality education** (4), **clean water and sanitation** (6), **affordable clean energy** (7), **responsible consumption and production** (12) and (although there are no cities in Tuvalu) **sustainable cities and communities** (11), in terms of making Tuvalu's human settlements inclusive, safe, resilient and sustainable. All these SDGs have been addressed in some way in NBSAP activities, because all are dependent on the conservation and enrichment of our very limited and highly threatened atoll BES and on building synergies between ILK and modern scientific knowledge (MSK) as a basis for finding the right combinations of "soft" and "hard" interventions needed to promote sustainable atoll development.

Other priority SDGs include **climate action** (13), which although combatting climate change by regulating emissions has limited relevance for Tuvalu given its small population and low overall emissions, developments in renewable energy, particularly solar energy, are very important. Of central importance and a focus of many NBSAP activities are **life below water** (14), the conservation and sustainable use of nearshore and offshore marine resources, and **life on land** (15), the conservation, restoration and sustainable use of limited atoll terrestrial BES. And **peace, justice and strong institutions** (16) and **partnerships for the goals** (17) are also important, especially in the context of developing strong legislation and enforcement and developing appropriate partnerships to increase the capacity of Tuvalu to manage BES, especially in the promotion of new hybrid solutions to managing BES as a basis for sustainable development.

Of the remaining SDGs, **ending poverty** (1), **gender equality** (5) and **reduced inequalities** (10), although of relevance, are not considered serious problems in Tuvalu; **decent work and economic growth** (8) are important but problematic due to small size, limited land area, extremely narrow resources base, geographic isolation, and small local market size; and **industry, innovation and infrastructure** (9), although playing critical roles in facilitating

improved livelihoods, health and sustainable use of limited biodiversity, prospects for "industrialization" are virtually non-existent in Tuvalu.

With respect to SDGs 1, 2, 14 and 15, although there is no stark poverty and hunger as found in some countries, there are serious issues related to food security and food dependency, sustainable agriculture and fishing, and the increasingly serious levels of malnutrition and nutrition-related non-communicable diseases that are strongly linked to a shift from diets based on nutritious local foods to a dominance by nutritionally inferior imported foods and drinks.

Finally, unlike the Aichi Targets, there is very up-front in the SDGs about the importance of indigenous knowledge and culture; and if SDGs like quality education, sustainable communities and life below water, life on land, strong institutions, etc. are not linked to Tuvaluan culture's central role in BES conservation, achieving these goals will be problematic. Similarly, although international partnerships are critical to both the ATs and the SDGs, perhaps more important in Tuvalu is strengthening of local partnerships between national-level institutions and local communities, which, along with local leadership, will ultimately implement, monitor and determine the success or failure of conservation initiatives in Tuvalu.

Part I: Introduction and Overview of Tuvalu and its Biodiversity

1. INTRODUCTION

The isolated, small, low-lying resource-poor atolls of Tuvalu are clearly on the frontline against climate change, sea-level rise, the increasingly devastating impacts of extreme events and natural disasters and declining food, health and energy security. Because of very limited potential for modern urban and commercial development, Tuvalu's first line of defence against these negative changes is the conservation and sustainable use of its very limited and fragile terrestrial, freshwater and marine biodiversity and our rich indigenous knowledge of these living resources – both of which are under threat. This Fifth Tuvalu National Report (5th Report) to the Convention on Biological Diversity (CBD) summarises the nature, cultural importance, conservation status and threats changes to Tuvalu's Biodiversity and actions taken or that need to be taken to promote the conservation and sustainable use of biodiversity since the submission of the fourth national report in 2010. The report was formulated following the guidelines[8] set out by the CBD parties. It includes:

> Part I. An overview of Tuvalu's geography and biodiversity, including up-to-date information on location, island types, demography, economy, geomorphology and topography, climate, hydrology and freshwater resources. Soils and substrates, flora, terrestrial ecosystems and vegetation, terrestrial fauna, marine biodiversity, including finfish and non-finfish resources.
>
> Part II. An update on the status of biodiversity, trends, and threats and implications for human well-being, including: the importance of biodiversity and ecosystem services (BES) (provisioning, regulating, cultural and supporting services) for Tuvalu; major trends and status of BES in Tuvalu; and major threats to BES.
>
> Part III. A Review of the activities and progress made in relation to the themes and objectives of the Tuvalu NBSAP, the Aichi Biodiversity Targets and the Sustainable Development Goals

2. TUVALU AND ITS BIODIVERSITY

2.1 Geography and Demography

Tuvalu (formerly known as the Ellice Islands when it was part of the British Gilbert and Ellice Islands colony) 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 km^2 spread over an ocean area of about 1.3 million km^2 between 5º and 10.5º S latitude and 176º and 179.5º E longitude (Carter 1984). The nearest island groups are Kiribati (Gilbert Islands), Samoa, Wallis and Futuna, Fiji and the isolated island of Rotuma which is part of Fiji (Fig.

[8] Guidelines for the Fifth national report

1). As a result of the spread of islands over a vast expanse of sea, Tuvalu's Exclusive Economic Zone (EEZ) covers an oceanic area of approximately 900,000 km^2.

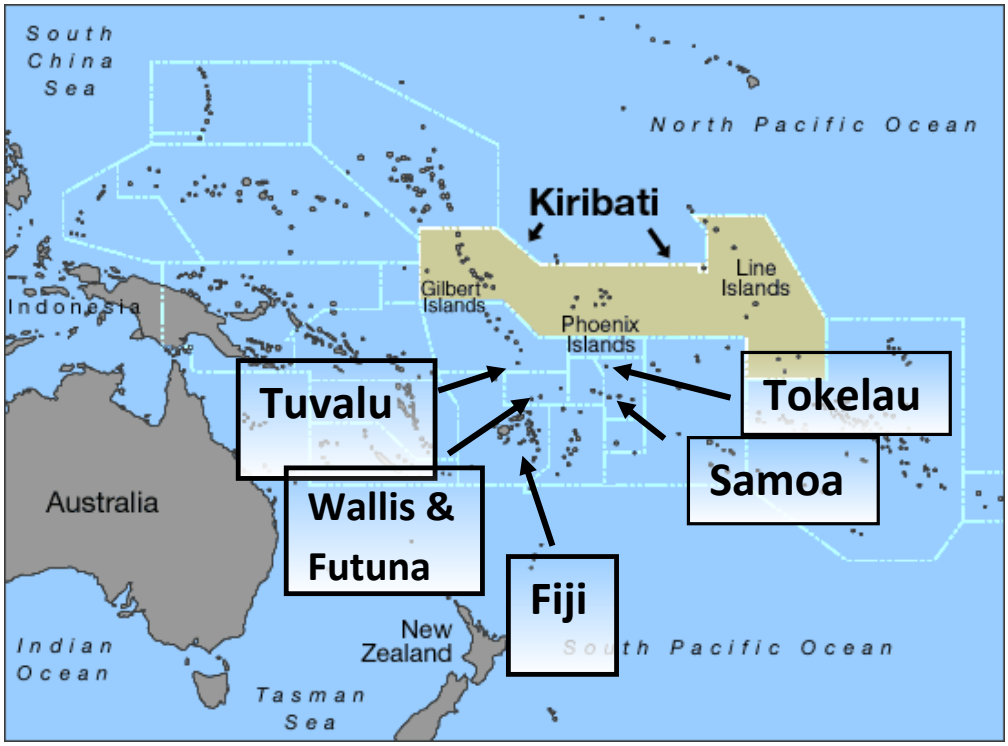

Figure 1: Map of the Pacific Islands showing the locations of the Tuvalu

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 3); 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 km^2 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). .

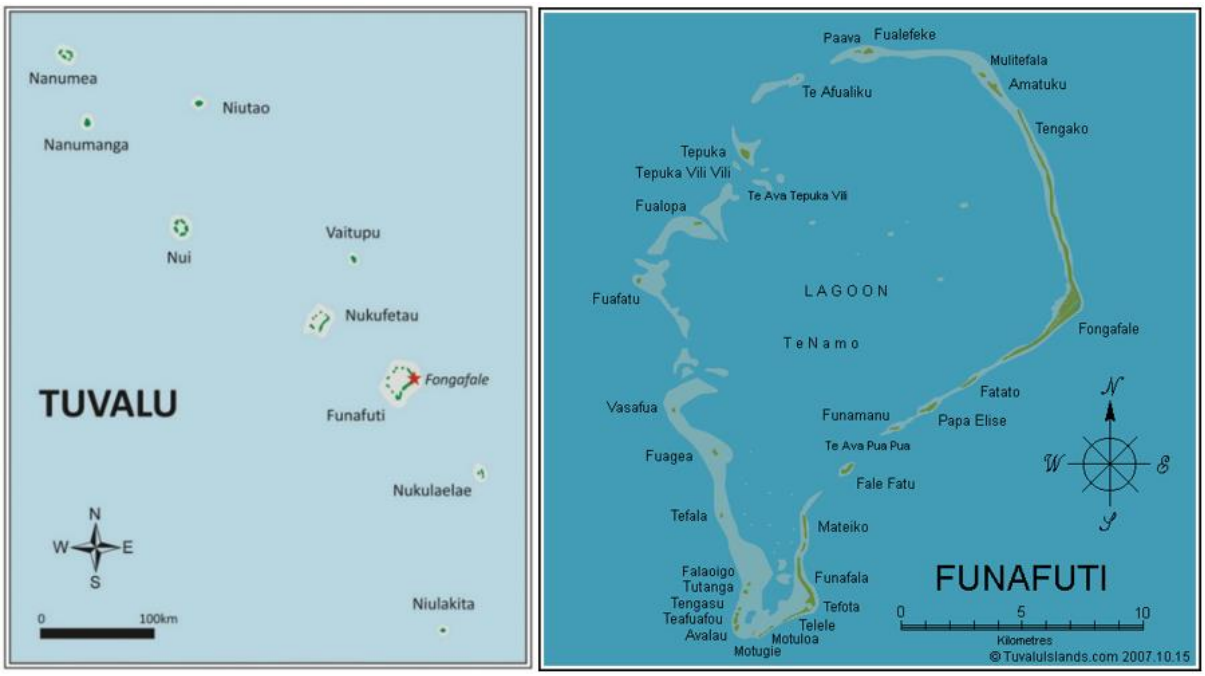

Figure 2: a) Map of Tuvalu showing the locations of the nine atolls from Nanumea in the northwest to Niulakita in the southeast (left) (Source: www.nowshoptime.com); and b) map of Funafuti Atoll showing the central lagoon and the individual reef islets (motu), including Fogafale Islet, The largest and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

Figure 3: Aerial photos of Fogafale 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 of Tuvalu, has 33 islets encircling a lagoon about 23 km long and 18 km wide with a surface area of about 275 km^2, by far the largest lagoon in Tuvalu (Fig. 2b). The total land area of Funafuti is 2.8 km^2 and Fogafale, the largest and easternmost individual islet, which is about 500 m wide at its widest point, is the seat of the Tuvalu government, although the entire atoll of Funafuti is officially the capital. One-third of the total area of Fogafale 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 currently most prominent structures and developments on the atoll include the Taiwan government-funded Tuvalu Government Building completed in 2004; the Vaiaku Lagi Hotel; the air terminal and runway; the new Tuvalu Sports Complex, which was developed with imported soil and plants (including weeds) from Fiji; the Church of Tuvalu in Vaiaku; and the port and Princess Margaret Hospital to the north of the main settlement. There are also new settlements in South and North Fogafale that accommodate communities from the other atolls.

The estimated population of Tuvalu in March 2016 was 10,157 down from an estimated 10,782 in 2014 due to emigration overseas. Population densities are about 425 per km^2 for Tuvalu and probably over 2000 per km^2 for Funafuti, where over half of the population now lives, almost all of whom are on the increasingly urbanised Fogafale Islet (Index Mundi 2014; Country Meters 2014). The people are predominantly Polynesians, although the people of Nui Atoll are culturally and linguistically Micronesians of I Kiribati descent and, because of the long relationship with Kiribati under the Gilbert and Ellice Islands Colony, there has been considerable intermarriage between Tuvaluans and I Kiribati and a strong Kiribati influence on Tuvaluan culture, including the use of plants.

About 95% of the land in Tuvalu is customary land owned by individuals, with some communal lands and crown land on a few of the islands. The land tenure system is based on inheritance from father or mother to sons and daughters and sub-division of land between the landowners themselves. This has led to the fragmentation of land by continual division, multiple ownership and disputes over land boundaries which is sometimes a hindrance to conservation and restoration initiatives.

2.2 Economy

Economically, most Tuvaluans practice subsistence fishing, farming and the harvest of a range of wild, mainly plant, products. Only about one-quarter of the population participates in the formal wage economy. 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, such as the bird's nest fern (**laukatafa**) as their main locally produced foods. The limited number of indigenous wild plants and other plants and a limited range of marine products are also the main traditional sources of medicines, fuel, construction and boatbuilding materials, handicrafts, garlands and perfumes and a wide range of other products (Thaman *et al*. 2012),

Until independence, the main source of cash income and foreign exchange was coconut oil and copra made from the dried flesh of coconuts. The sale of Tuvalu's stamps (many of which feature biodiversity) has historically been a significant source of government revenue. Wage employment is almost exclusively within the public (government) sector, with a limited number of people working in a small private sector. The main sources of government revenue and foreign exchange are currently licensing fees and royalties from foreign vessels fishing in Tuvalu's EEZ, remittances from Tuvaluan merchant seamen, fishermen and others working or living overseas, official development aid and income from the Tuvalu Trust Fund that was established at the time of independence. Substantial income has also come from the lease of Tuvalu's Internet domain name ".tv". 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).

2.3 Geomorphology and Topography

From the ocean to the lagoon side of a typical atoll islet there is normally distinction zonation of substrates and associated vegetation. In the case of Funafuti, there is usually an uplifted fringing limestone reef in the wave zone on the ocean side, which may be covered by sandy beach or beach rock (Fig. 4). The beach then becomes a raised rampart or ridge 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). This is the case along the east coast of Funafuti, where there is a substantial coral rubble or shingle rampart that has been thrown up by major tropical cyclones, the most recent of which was Tropical Cyclone Bebe in 1971 (Fitchett 1987) (Fig. 5a). Inland from the rampart and extending toward the lagoon are areas of windblown sand and a thin layer of soil. In the case of Fogafale Islet, Funafuti, just inland from the rampart is a limited area with a "back-beach" basin bordered with mangroves (Fig. 5b), an area, which, based on a geological map in 1896, formerly covered much of the interior part of Fogafale Islet before the airstrip was built in 1942 (Kayanne *c*. 2007; Thaman *et al*. 2012). Toward the lagoon shore, increasingly fine deposits are of lagoonal origin. Limestone outcrops or pavements with little or no soil and low-lying swampy areas or areas that are periodically inundated are also common (Fosberg 1949; Thaman 2008).

With an average elevation of only one metre above mean sea level (MSL) and the highest areas being less than 5 metres MSL, Tuvalu's atolls are all highly vulnerable to cyclones, tsunamis, king tides and other extreme tidal or weather events, making Tuvalu one of the most vulnerable countries in the world to climate change and rising sea levels. 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. Tuvalu, its people and its limited biodiversity inheritance are clearly on the frontline in the battle against climate change and sea-level rise.

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 th

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

2.4 Climate

Climatically, 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 31º C and a daily minimum of 25º C. Two seasons are recognized, a cooler season, between April and October, when the Southeast Tradewinds are strongest, and a warmer rainier season from November to March, when the winds are more westerly or northerly. Annual rainfall ranges from about 2000 mm in the drier northern islands of Nanumaga and Niutao, to 3500 mm in the wetter southern atolls, such as Funafuti, with most rain coming during the warm season (Rodgers 1991). Tropical cyclones were traditionally uncommon, with major tropical cyclones affecting Tuvalu in 1883, 1972 (Tropical Cyclone Bebe), and in 1990 (Tropical Cyclones Val and Ofa). Most recently, during Tropical Cyclone Pam in March 2015, strong winds and storm surge that coincided with a high spring ('king") tide inundated most atolls of Nui and Nukufetau causing serious damage to agriculture 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).

Heavy waves, spring tides and exceptionally high spring tides that are coupled with heavy winds, and low pressure systems (known as "king tides") affect both the ocean and lagoon coasts and often flood the interior areas of atolls. 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. El Niño events and predicted increases in sea level due to global warming also contribute to the increased frequency and severity of such events (Thaman *et al*. 2013).

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. The drought of 2011 was particularly serious, during which a state of emergency was declared in September 2011 due to water shortage on Funafuti and Nukulaelae with uncertain reserves on some of the other atolls (Vula 2011; Duncan 2012)), during which water had to be imported from overseas (Duncan 2012). Most recently in early 2016 Tuvalu again experienced prolonged drought conditions that seriously impacted human health, agriculture and the health of plants and animals.

2.5 Hydrology and Freshwater Resources

There are no surface freshwater resources in Tuvalu and the only permanent freshwater resource is groundwater in the form of a lens of often slightly brackish freshwater, hydrostatically floating on higher density saltwater beneath it. The height of the freshwater lens above sea level and the level of salinity vary in relation to the elevation, geology, texture, shape and width of islets, the amount of salt water incursion and the amount of water use and rainfall. Replenishment or recharge of the lens is dependent on rainfall. During excessively wet periods, especially during high spring tides and king tides, pools are sometimes found in areas where the lens is close to the surface, although these same tides are responsible for saltwater incursion and pollution of the freshwater lens. The location and degree of development of the groundwater resource influences the health of the vegetation and associated wildlife, such as seabird colonies, as well as the location of village wells and

excavated taro pits. On Funafuti the freshwater lens is most extensive and highly developed on the largest islet, Fogafale, thus providing the most favourable conditions on the atoll for both native and introduced plants and for the excavation of traditional taro pits (**pela**) to the level of the freshwater lens (SOPAC 2007). A more recent report indicates that the freshwater resources of Fogafale are extremely limited in relation to the population size (Duncan 2012). As a result, much of Fogafale is dependent on household and community rainwater catchment systems supplemented by very limited desalination plants, with periodic droughts limiting the ability to replenish rainwater catchments (Duncan 2012; Thaman 2013).

2.6 Substrates and Soils

The substrates and soils of Tuvalu are among the poorest in the world. They include exposed limestone rock, beach rock 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 carbonatic mineralogy and high pH values of up to 8.2 to 8.9. They are usually deficient in most of the important nutrients needed for plant growth (e.g., nitrogen, potassium and micronutrients such as iron, manganese, copper and zinc)(Morrison 1987; SOPAC 2007).

Most recently 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. The dredged material consists of mainly biogenic sand of foraminiferous origin along with varying proportions of calcareous algae, coral and shells remains. The dredging was continued in 2016 to reclaim a large area extending some 100 m on the lagoon side of the Tuvalu Government Building and the Vaiaku Lagi Hotel using dredged sediments with a higher proportion of calcareous algae, mainly *Halimeda* spp. which make up a large proportion of sediments of Funafuti Lagoon (Fig. 6a)(Smith 1995). The area, which was formerly opened as Queen Elizabeth II Park in early 2016 has an estimated area of about 40,000 m^2. (Fig. 6b). A similar area has also been reclaimed on the main inhabited islet of Nukufetau.

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

2.7 Flora

The indigenous terrestrial vegetation and flora of Tuvalu are highly disturbed and the flora is now numerically dominated by introduced exotic species. This has been the result of the following periods of development:

1. long settlement of the atolls for over two thousand years by indigenous Tuvaluans and other Pacific islanders who brought with them a range of culturally useful plants and possibly some associated weeds;
2. a long post-European-contact and British colonial heritage, including over a century of planting monocultural coconut plantations for the export production of coconut oil and copra on most available productive land, including most uninhabited atoll islets or **motu**;
3. extensive excavation and habitat destruction and conversion of much of the best cultivable land on Funafuti and a large area on Nanumea and Nukulaelae from "borrow pits" to access material to build airstrips during World War II;
4. since independence in 1979, rapid population growth, including the migration from outer atolls to, and the expansion of, the main settlement and government centre on Fogafale Islet, Funafuti. During this period and continuing to this day there has been an increase in shipping and air services and agricultural development projects that have increased the frequency and ability of people to introduce new plants.
5. Finally, the highly degraded and excavated former "borrow pits" and an extensive area along the lagoon in central Fogafale have just been reclaimed and infilled with lagoon sediments and will require considerable rehabilitation and enrichment if vegetation is to be re-established.

Throughout all of these periods of development, there has been 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 (Thaman *et al*. 2012)

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 (about 12 or more) 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 (Fosberg 1946; Thaman 2008; Thaman *et al*. 2013).

Table 1: Assumed origin of vascular plants reported present on Funafuti Atoll

Class	**Indigenous**	**Aboriginal**	**Recent**	**Total**
Ferns and Fern Allies	6	-	3	9
Gymnosperms	-	-	2	2
Monocotyledons	11	8	84	103
Dicotyledons	42	6	200	248
Total	**59**	**14**	**289**	**362**

Of the 59 possibly indigenous species, 6 are widespread pantropical or paleotropical ferns or fern allies (pteridophytes), and 53 are angiosperms or flowering plants, of which 19 are monocotyledons and 48 are dicotyledons (Appendix II). There are no indigenous gymnosperms.

Of the 303 non-indigenous or exotic species, 14 could be aboriginal introductions that were brought to Tuvalu before European-contact times by either Tuvaluans or other Pacific Islanders, such as I Kiribati, Tokelauans, Samoans or Tongans who have historical links with Tuvalu. The remaining 290 species have probably been introduced since the time of first European contact by Mendaña in the latter half of the 1500s, most of which have probably been introduced since the introduction of Christianity in the 1860s and subsequently after the incorporation of Tuvalu into the British Empire and the British Gilbert and Ellice Islands Colony (GEIC) beginning in the late 1800s, the establishment of American bases in Tuvalu 1942 during World War II, and, most recently after Tuvaluan independence in 1978 and the establishment of regular air links with Fiji and other Pacific Island sources of introduced plant materials. Most of these recently introduced species are weeds, ornamental plants and food plants. A relatively high number of these have either remained in very low numbers or are no longer present.

As stressed by Fosberg in his paper "Atoll Vegetation and Salinity" (1949):

> . . . though numerous species have been tried out, both by the plant-loving natives and by residents of foreign origin, relatively few of them have survived. Still fewer can be considered successful even under the protection and cultivation of man. Those that survive, but are not especially successful, show, without exception, signs of a severe localized chlorosis (yellow coloring) of the type usually associated with excessive sodium, with resultant deficiency of assimilated potassium and a more general chlorosis possibly associated with deficiencies of other ions due, perhaps, to high pH. *Lantana camara*, ordinarily a most aggressive weed, is yellow and sterile where planted in the Marshall Islands. Even some of the species, such as the papaya, which survive and reproduce themselves, are often chlorotic. Also these species are much more successful toward the center of an islet where the salinity is naturally lower. Very few of the

introduced plants, excepting those which are themselves strand plants with a tolerance toward high salinity, or those which are shallow-rooted, thus living in the upper layers where the salt is to some extent leached out by rains, have succeeded in becoming naturalized.

2.8 Terrestrial Ecosystems and Vegetation

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)

Table 2 shows the main vegetation or land cover types that constitute the main terrestrial ecosystems found in Tuvalu. The main vegetation types, of which there are many combinations and shared species, have been discussed in detail by Woodroofe in his "Vegetation of Tuvalu" (1991). Table 3 shows the estimated land use or land cover types as presented in the 4th 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 under marine ecosystems in Table 5) are an important cover type on the interface between the land and sea that protect Tuvalu's atolls from coastal erosion and saltwater incursion.

Table 2: Main vegetation and land cover types found on Funafuti and other

1	Inland Broadleaf Forest and Woodland
2	Coastal Littoral Forest and Scrub
3	Mangroves and Wetlands
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
10	Unvegetated recently reclaimed areas infilled with lagoon sediment

Table 3: Estimated areas of different land use/land cover types present in Tuvalu

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

2.8.1 Inland Broadleaf Forest and Woodland: Relatively undisturbed areas of inland broadleaf atoll 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.

2.8.2 Coastal Littoral forest and Scrub: The least disturbed areas of coastal littoral forest and scrub (those plants than 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.

2.8.3 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

2.8.4 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.

2.8.5 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.

Figure 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)

2.8.6 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.

2.8.7 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. These initiatives include a series of houseyard food garden initiatives, such as the UNICEF Home Garden Development Program; the Technical Mission of Taiwan's International Cooperation and Development Fund's (ICDF) vegetable production project which has recently expanded from Funafuti to Vaitupu; and the Pacific Regional Agricultural Project (PRAP) Atoll Farming Systems Program in the late 1990s and early 2000s. 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.

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).

2.8.8 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).

2.9 Terrestrial Fauna

The indigenous terrestrial vertebrate fauna of Tuvalu includes no indigenous land mammals, amphibians or freshwater fishes. There are a number 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 (Watling 1998). Sea birds are of particular importance for guiding fishermen to schools of skipjack tuna and other target schooling species (Thaman and Neemia 1992). Birds are also a very important traditional food source and a wide range of birds have been traditionally hunted using traps, nets, snares, forked sticks, throwing stones or sticks and specialised nets on poles that are used after climbing special bird-catching trees (**tula**). Among the birds hunted are the brown noddy, **gogo (***Anus stolidus*), black or white-capped noddy, **lakia** (*Anous tenuirostris*), crested terns, **tala** (*Sterna bergii*), brown boobies, **kanapatua** (*Sula leucogaster*), frigatebirds, **katafa** (*Fregata minor*), lesser golden plover, **tuli** (*Pluvialis dominica),* wandering tattler, **tulitainamu** (*Heteroscelus incanus***),** ruddy turnstone, **kolili** (*Arenaria interpres*), *Pacific* pigeon, **lupe** (*Ducula pacifica*) and the Pacific black ducks, **toloa** (*Anous superciliosa*), which is found on the lagoons of some atolls (Koch 1983).

Notable terrestrial invertebrates are land or shore crabs, including **paikea** (*Cardisoma rotundum*), **tupa** (*Cardismoa carniflex*), **kamakama** (*Grapsus albolineatus*), a range of hermit crabs, **uga** (*Coenobita* spp) and the coconut crab, **uu** (*Birgus latro*) with Koch (reporting that seven species of crab are eaten. Most of the smaller crabs are also used as preferred fish bait, with the ghost crab, **keviki** (*Ocypode cerophthalmaa*) also serving as bait in bird traps (Koch 1983). Also important are a range of land snails, **misa** (*Melampis* spp.) that are used to make shell leis (**ula**) and handicrafts, four endemic land snails and two jumping spiders that were reported from Hedley's expedition in the late 1800s. These include the land snails *Sinployea pseudovicaria*, *Sinployea* e*llicensis*, *Vatusila vaitupuensis* and *Thaumatodon decemplicata* and two endemic jumping spiders, *Ascyltus audax* and *Ascyltus ferox* (NZTEC n.d.), most of which were reported by the Hedley expedition in the late 1800s. There is also a range of largely unassessed other invertebrates.

2.10 Marine Biodiversity

Because of very limited terrestrial biodiversity, the marine biodiversity within Tuvalu's 900,000 km^2 Exclusive Economic Zone (EEZ,) is of immense importance to food, livelihood, cultural and environmental security. It is the main local source of animal protein, products, such as shells, for handicraft production and revenue from licensing agreements with foreign fishing nations to fish 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. Tuvalu controls a large EEZ with the

total value of production estimated at about A$ 163 million in 2014, comprised mostly of the value of the tuna catch from within the EEZ (Gillett 2016). Most of this value, however, does not go to Tuvalu because there are no offshore locally-based boats and little local employment is generated, with Tuvalu's share of the value coming from the government selling licenses to foreign vessels fishing for tuna in the EEZ (Tilling and Fihaki 2009). Over the past few years, however, the revenue from licensing fees has risen due to improved negotiations with fishing nations by working through regional organizations (Gillett 2016).

Table 4: Estimated volumes and value of annual fisheries catches and aqua cultural harvest in Tuvalu in 2014

Harvest Sector	Volume (mt)	Value (A$)
Coastal Commercial	300	912,500
Coastal Subsistence	1,135	1,366,750
Offshore Locally-based	0	0
Offshore Foreign-based	96,898	160,981,136
Freshwater	2	2,000
Aquaculture	0.5	1,000
Total	**98,336**	**163,263,386**

The marine environment is comprised of five main ecosystems, habitat types or ecological zones based on depth and location in relation to the atolls, with mangroves commonly being included as both terrestrial and marine ecosystems (Table 5).

Table 5: Main marine ecological zones, ecosystems or habitat types in Tuvalu

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

Within each of these often overlapping ecosystems or ecological zones 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 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 6 shows the diversity of the types of fishing and target zones used by Tuvalu's fishers, with reef gleaning (collecting), normally during low tide, and other forms of nearshore fishing being more important than offshore ocean fishing. The most

common methods of fishing used by Tuvaluan locals include reef gleaning, hand lining, gill netting and trolling.

Table 6: Number of households engaged in specified type of fishing activities

Island	Collecting on Reef Flat	Collecting on Lagoon Flat	Collecting on Ocean Flat	Reef Fishing	Lagoon Fishing	Ocean Fishing	Total
Total	**540**	**341**	**274**	**971**	**932**	**675**	**1,761**
Nanumea	36	33	13	78	79	38	115
Nanumaga	60	1	51	61	1	66	116
Niutao	57	1	27	87	1	49	123
Nui	68	31	24	106	90	75	138
Vaitupu	101	20	32	188	159	101	226
Nukufetau	34	28	25	95	97	94	124
Funafuti	175	212	84	314	461	207	845
Nukulaelae	8	15	17	38	44	42	67
Niulakita	1	0	1	4	0	3	7

2.10.1 Finfish Resources

Particularly important are Tuvalu's finfish resources with a 2009 study of finfishes on Nanumea, Nukulaelae and Funafuti bringing the overall total of nearshore reef species recorded for Tuvalu to 607 (Job and Alefaio 2009; Job and Ceccarelli 2012). This estimate included sharks and rays, but did not list eels and many of the deepwater fishes. More recent studies by Thaman (2016) suggest that the total number of reef and inshore fish species might approach 800 species; and the figure for total finfish species could be 900 or more, if deepwater and offshore species are included. Of these totals, about 496 species are recognised by name in Tuvalu, with there being about 283 distinct Tuvaluan names for these species with about 122 modifiers that differentiate between species or growth stages or colour variations of different species (Thaman 2016). Appendix II lists the most important finfish families in order of their importance in the Tuvaluan fishery and/or the number of species and/or their ecological importance.

2.10.2 Marine Invertebrates

The marine invertebrate fauna is diverse and very important and includes many culturally, nutritionally and economically important molluscs, crustaceans, echinoderms, corals and other marine invertebrates. Most important are molluscs which are food resources and used for the manufacture of shell necklaces and other handicraft of significant cultural and economic value. The diversity of molluscs in Tuvalu is exemplified by the results of a survey of shell resources on Funafuti and Nukufetau Atolls in 1983 by Parkinson (1985) to determine the potential for establishing a small-scale shell industry. The study found present a total of 122 gastropod species from 14 families commonly sought by collectors, many of which were

first records for Tuvalu. These are shown in Appendix III. Parkinson also prepared a list of all gastropod shells collected in Tuvalu since the first surveys in the late 1800s, and stressed that many of these species were first described from shells collected in Tuvalu by the Royal Society of London's Expedition that collected in Tuvalu three times between 1896 and 1898. One of the shells which was collected then by dredging near Funafuti in depths over 100 m was named *Murex funafutiensis* (now known as *Favartia funafutiensis*), which Parkinson suggested could be used as a logo for a specimen shell business (Parkinson 1983).

Not included in Parkinson's survey are a range of important bivalve molluscs, some of which are heavily overexploited. These include giant clams, **fasua** (*Tridacna* spp.) and black-lipped pearl oysters (*Pinctada margaritifera*), thorny oysters, **sopuu** (*Spondylus* spp.), jewelbox shells, **hopu paa** (Chama sp.) and ark shells, **kohi** (*Arca* and *Barbatia* spp.). Also of considerable importance are cctopus, **feke** (*Octopus cyanea*). Koch (1983) reports that on Nukufetau the people looked for eleven different species. The smallest of which were collected in hundreds of baskets. Women and children reportedly are the main ones harvesting the smaller shells whereas men usually are responsible for harvesting giant clams (*Tridacna* spp.) and pearl oysters.

Although not a traditional food in Tuvalu, a number of bêche-de-mer species have been exported beginning in the late 1970s, especially from 1993—1995 when a Fiji-based Asian company promoted the fishery, and then sporadically since then until in 2011 when resources on most islands were reportedly depleted. The main species targeted for export were the white teatfish (*Holothuria fuscogilva*) and the black teatfish (*H. whitmaei*); other less important species were prickly redfish (*Thelenota ananas*), elephant trunkfish (*H. fuscopunctata*), blackfish (*Actinopyga miliaris*), surf redfish (*A. mauritiana*), brown sandfish (*Bohadschia marmorata*) and leopardfish (*B. argus*). 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 ((Belhadjali, 1997; Kench *et al*. 2008; Job and Ceccarelli 2012)

Part II: Update on biodiversity status, trends, and threats and implications for human well-being

3. IMPORTANCE OF BIODIVERSITY AND ECOSYSTEM SERVICES (BES) FOR TUVALU

Because there are few opportunities for modern urban commercial development in Tuvalu, future food, livelihood, energy, water, environmental and cultural security depend on the conservation, sustainable use and enrichment of very limited but fragile atoll biodiversity and the somewhat richer, but also limited and threatened marine biodiversity. As a small island atoll nation on the front line against climate change, rising sea levels, increasing impacts of

natural disasters, invasive species and increasing population pressure the conservation and sustainable use of our BES is clearly our first line of defence (UNEP 2014?).

As defined by the Millennium Ecosystem Assessment (MA) (2005) ecosystem services (ES), the benefits people obtain from ecosystems, 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,). Table 7 attempts to show the diversity of ecosystem services provided by terrestrial, freshwater and marine biodiversity. This diversity, which is discussed briefly below, is roughly broken down into natural and cultural ecological services, some of which could fall into one or more of the four above categories.

Table 7: Natural and cultural ecological services and goods provided by terrestrial, freshwater and marine biodiversity

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	Preservatives
Switch/Whips/Discipline	Hats/Sunshades	Brush/Paint Brush Baskets
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

3.1 PROVISIONING SERVICES (Products necessary for food, health and livelihood security obtained from BES, some of which are overexploited or suffer from invasive pests and diseases) include:

3.1.1 Food

This includes staple and supplementary ground and tree crops, domesticated animals and their food, and wild terrestrial plant and animals, foods, spices and sauces. Tree crops, such as coconut palms, pandanus and breadfruit, and a wide range of marine foods, including seabirds, turtles, finfish, shellfish, crustaceans and other marine invertebrates play a central role in the nutrition and food security in Tuvalu. Because of the poor soils and very limited land area relative to Tuvalu's more extensive nearshore and deep water marine area, marine foods are particularly important. There is also limited export of prepared food to Tuvaluans overseas and has, in the past, included limited export of fresh fish, such as deepwater snapper, in the past.

3.1.2 Raw materials

These include timber and wood for construction, woodcarving, boatbuilding, toolmaking and making fishing equipment, musical instruments and handcrafts; fibre and cordage from special cultivars of coconut, pandanus and other plants used for making handicrafts, exchange items and gifts; rock, coral, shells, seeds and other material for use in construction and for handicrafts, body ornamentation and other items; and organic mulching and fertilizers that are so vital in the dry, infertile soils of Tuvalu.

3.1.3 Fresh Water

Fresh water, which is essential for the health and survival of all life on Tuvalu is extremely limited, with freshwater resources consisting of only limited groundwater which is dependent on rainfall for recharge, plus water and drinks from coconuts and the limited variety of water-rich fruits and vegetables. Also a critical part of the built ecosystem is the rainwater catchment system which is central for the continued provision of this ES.

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3.1.4 Energy

Fuel wood and other types of plant biomass, including all parts of the coconut palm, are a critical, but increasingly threatened, resource for cooking and other purposes. This could also include wave, tidal, wind and solar energy needed to power sailing craft, canoes and to dry copra and fish and other preserved foods.

3.1.5 Medicines, Poisons and Repellents

Traditional medicines, almost exclusively from plant resources, most of which are from wild native and long established plants, are extremely important given the isolation of the outer atolls and the very limited availability and high cost of modern medicines to treat most diseases, injuries and health problems. Some plants and marine resources are also used as fish poisons, insect repellents and for other chemical purposes.

3.1.6 Ornamental and Fragrant Resources

Flowers, leaves, seeds, roots and other plants parts and some marine products, particularly shells, are central to the Tuvaluan culture and economy for the productions of garlands (**fou**), leis or necklaces (**ula**), jewellery and other body ornamentation (**lapelape**), wreaths, scented coconut oils (**sinu**), dyes and handicrafts as traditional exchange items or for sale to tourist, travellers or for export. Studies show that a high proportion of household incomes in Tuvalu is derived from income from the production of shell leis and handicrafts by Tuvaluan women (Tiraa-Passfield 1996).

3.1.7 Genetic Resources

The maintenance or enrichment of genetic resources is essential to ensure dietary diversity, breeding material for plants, pets and other culturally or aesthetically valued products; and to provide insurance against pest and disease outbreaks, climate change, increasing salinity and extreme events.

3.2 REGULATING SERVICES (benefits obtained from the regulation of ecosystem processes) that are particularly important in Tuvalu in both the terrestrial and marine environment) include:

3.2.1 Climate Regulation

Climate regulation, including carbon sequestration, temperature and moisture regulation, and shade and protection from ultraviolet light, are all critically important to Tuvalu given its extreme susceptibility of land, freshwater and marine environments of atolls to increasing ultraviolet radiation, climate change and extreme events.

3.2.2 Water Regulation

Water regulation is particularly important on atolls, especially the regulation of water flow between the open ocean and lagoons and the flushing and renewal of water in lagoons which normally occurs via tidal currents through reef passes. This movement is needed to purify and oxygenate lagoon water and facilitate the flow of nutrients, plankton and the planktonic larval phases of marine organisms and the movement of migratory and schooling species (Leis *et al*. 2003). The maintenance of healthy beaches, mangroves and other coastal vegetation is also important to protect the limited groundwater resources from saltwater incursion or over wash during extreme tidal events.

3.2.3 Erosion control and Protection from Strong Winds and Salt Spray

Natural windbreaks, protection from strong winds, waves and tidal erosion and salt spray are provided by coastal and mangrove vegetation and coral reefs and algal beds. Protection is also provided by well-designed, deliberate plantings of trees, windbreaks, hedges and other vegetation and the protection of coral reefs and algal beds.

3.2.4 Waste management, Purification and Detoxification

The consumption and decomposition of detritus and waste by insects, fungi and detrivores such as hermit crabs and bioremediation by land and marine plants are important for waste management. Nutrient pollution from human and animal (pig) waste pollutes the groundwater on atolls, especially on Funafuti and is a major problem in the shallower lagoon areas. Plants through bioremediation can protect precious groundwater resources and reduce nutrient pollution in lagoons, and the pollution can be diluted and flushed if water currents are maintained though open passes between atolls islets and if microbial and other waste consuming organisms such as beneficial algae and marine invertebrate communities remain healthy.

Purification/detoxification of water, soil and air by trees, plants and by filter-feeding organisms, such as bivalve molluscs, sea cucumbers (holothurians) and by healthy algal beds is also important.

3.2.5 Pest and Disease Control

Control of pests, such as weeds, insects, invasive algae and diseases by natural predators in both the terrestrial and marine environment, including bioremediation and control of invasive marine algae and algal and cyanobacteria blooms by herbivorous fish and a range of other marine organisms is an important ecosystem service for atolls. It has been shown that the maintenance of healthy natural vegetation reduces populations of pests, such as weeds, ants and other opportunistic species, most of which depend on continued human disturbance.

3.3 CULTURAL SERVICES (Nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences are central to Tuvaluan culture and human wellbeing).

3.3.1 Cultural/Aesthetic Value

Colour, fragrance, appearance, humour, architecture, gardening (including ornamental gardening), folklore, motifs and patterns or designs in arts and crafts, national or island symbols, emblems, plants or animals are all very important, but often overlooked benefits from biodiversity. For example some shells, flowers and leaves are particularly valued for leis or garlands due to their bright (often red, orange or yellow colour) or their distinctive shapes.

3.3.2 Spiritual and Historical values

Plant and animal resources have significant traditional cultural and spiritual importance in Tuvalu, much of which has been retained along with the spiritual values of the predominant modern Christian religion. For example, sea turtles (**fonu**) are still considered chiefly foods. Fishes, crabs, plants and named places also feature in the lyrics of many old songs, with many songs, such as songs of master canoe or house builders already lost (Koch 2000). Shell handicrafts and jewelry are particularly important, with excavations of ancient graves on Vaitupu and Nukufetau finding necklaces and pendants made from mother-of-pearl and cowrie shells. Shell headbands and jewelry are still worn on important ceremonial occasions and by men and women when performing traditional dances (**fatele**); and shell necklaces, headbands and jewelry are still presented to honored guests and friends and family members travelling overseas (Tiraa-Passfield 2009; Job and Cecarelli 2012). The giant helmet shell (*Cassis cornuta*) and triton trumpet shells (*Charonia tritonis*) are also reportedly used as traditional trumpets (**pu**) and slitgongs (**lali**), made from special woods, such as **fetau** (*Calophyllum inophlyllum*) were used to send signals and herald special occasions (Koch 1983)

3.3.3 Recreation and Sports

There are traditional sports in Tuvalu, the equipment of which are made out of local materials, such as pandanus or coconut leaves. Fishing and shell collecting, although done mainly for practical purposes, involves a bit of competition and recognition of those who catch the largest of most fish or find the rarer shells; and Tuvaluans acknowledge master fishermen with the title **te tautai**.

3.3.4 Tourism and Travel

Although not a major industry in Tuvalu, there is limited tourism, including the influx of international consultants and representatives of international agencies, many of whom are interested in the unique atoll environment and taking trips to uninhabited offshore islets or beaches to swim, see bird colonies and other scenery, or to better understand the Tuvaluan culture, cuisine, etc. This would also include limited ecocultural tourism, diving, snorkelling, game fishing, shell collecting, birdwatching, etc., all of which depend on the conservation of atoll biodiversity and our biocultural traditions. Tuvaluans and other Pacific Islanders are also renowned for their sailing and navigation skills and traveling or return voyaging to visit relatives on other islands, an activity that is made more satisfying by intact biodiversity and biocultural heritages.

3.3.5 Science and Education

The use of natural and cultural ecosystems, their biodiversity and indigenous knowledge has always been important for traditional education and scientific discovery in Tuvalu. As discussed above, the first ever collections of a number of shell species and the development of a better understanding of atoll formation were the result of the findings of Royal Society of London's Expedition to Funafuti in the late 1800s. The inclusion of both traditional and modern scientific knowledge about Tuvalu's biodiversity and ecosystem services is more critical today than ever because of increasing urbanisation, the loss of local knowledge among the younger generation and the need to build synergies between indigenous and local knowledge as a basis for the conservation of biodiversity in the face of global change, all important objectives of the Tuvalu NBSAP. It must be stressed that for most scientific assessments of the current state of biodiversity and how our conservation interventions are working will depend on building synergies between the best local knowledge and modern science, because it is only local people who know what local names for their biodiversity and what has changed.

3.4 SUPPORTING SERVICES (Services necessary for the production of all other ecosystem services such as food production, water and air management and purification, flood and erosion control) include)

3.4.1 Primary production

The maintenance of healthy terrestrial and marine vegetation and photosynthetic organisms as a basis for production of plant and other organic materials required to support all natural and cultural food chains and production systems and to protect soils and beaches from erosion, etc.

3.4.2 Soil, sediment, sand, rubble and substrate provision

The provision of soil, sediment, rubble and other materials required for healthy soils, beaches, coastal ridges and lagoon or marine substrates is critical in Tuvalu. These processes are particularly critical on atolls where virtually all soils, beach sands, coral rubble and boulders and lagoon bottom sediments, are of biogenic origin, with their replenishment after extreme tidal or weather events requiring the maintenance of a health sand, sediment or rubble budgets. For example, the provision of sand and sediment by organisms, such as foraminifera, calcareous and coralline algae and bio-erosion agents such as sea urchins, molluscs and parrotfishes, is critical to atolls and, if these organisms are overharvested or killed by pollution or other factors, the soil, sand and sediment budgets of atolls will be negatively affected.

3.4.3 Nutrient recycling

Nutrient recycling by terrestrial and marine plants (fallow vegetation), animals and micro-organisms is central to maintaining a healthy atoll environment. For example, plants, such as **pua** (*Guettarda speciosa*) and **pukavai** (*Pisonia grandis*) are both known as indicators and producers of good mulch and soils and detrivores (e.g., hermit crabs) and healthy soil microfauna are critical to the productivity of the nutrient-poor dry soils of atolls and in the marine environment.

3.4.4 Habitat Provision

Provision of adequate habitat for both terrestrial plants and animals is provided by healthy biodiversity and ecosystems. Particularly important, but threatened, terrestrial ecosystems are intact coastal littoral forest which is the main habitat for the diverse sea and migratory bird, land crab faunas, a limited lizard fauna, a poorly known insect and invertebrate land fauna and a diversity of coastal trees, shrubs, vines, ferns and herbs; and healthy un-eroded beaches with healthy littoral vegetation are the main nesting grounds for sea turtles, crabs and some shellfish. Critical habitats also include healthy mangroves, intertidal flats, lagoons and coral reefs, all of which house and provide nesting and nursery areas for Tuvalu's diverse marine fauna and flora.

3.4.5 Pollination

Pollination is essential for the fruiting, production and reproduction of flowering plants and the optimum functioning of both natural communities and agricultural systems. There is a range of bees, flies, butterflies, moths and other insects and birds and wind that are responsible for pollination in Tuvalu. Less well-known is the fact that lizards, such as geckos and skinks, are also important pollinators, especially on islands where there is less diversity of land birds and arthropods (Olesen and Valido 2003). Major threats to pollinators include habitat loss, pests and diseases and indiscriminate insecticide use, including the use of household and agricultural insecticides (Daily 1997).

3.4.6 Dispersal and Migration Pathways, Connectivity and Spawning Aggregations

Dispersal and migration pathways and spawning aggregation sites are critical in both the terrestrial and marine environments for the spread, reproduction, re-establishment and survival of populations of most organisms, with most of Tuvalu's indigenous plants and animals being dispersed or distributed by ocean and tidal currents, wind or birds. Many also carry out seasonal migrations (e.g. sea turtles, sea and migratory birds) which require healthy habitat, nesting grounds, transit areas, pathways or entry ways (e.g., coral passes or **ava**). This is particularly important for the health of Tuvalu's marine diversity because most marine finfishes and invertebrates (e.g., shellfish, crustaceans, corals, echinoderms, etc.) reproduce through external fertilization during spawning and have planktonic larval phases that after leaving the spawning grounds go through a pelagic oceanic phase of variable duration. This is true of most coral reef fishes that spend a mainly sedentary adult life in lagoons and onshore areas but have a very mobile open water pelagic larval phase. After the oceanic phase, the matured post-larval (pre-juvenile) phases re-enter the nearshore, lagoonal or coral reef environment and return to resettle in their preferred habitat to recruit into adults on reefs or in lagoons or other inshore habitats (Leis and McCormick 2002; Leis *et al*. 2003;). Changes in these routes or currents through the construction of causeways over reef passes or the reclamation of areas can lead to loss of connectivity and population collapses of fishes, crabs, lobsters, corals and other marine organisms. Of particular importance are fish mass spawning or aggregation sites for some species such as groupers and coral trouts, usually in reef pass channels, promontories and outer reef-slope drop-offs to which fish return every spawning season from widespread locations to form large spawning aggregations that are susceptible of overfishing which in turn has led to serious declines or the collapse of local populations of many species (Sadovy de Mitcheson *et al*. 2008; Sadovy de Mitcheson and Colin 2012).

4. 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 mainly an increasing loss of species diversity and declining population levels of some important species within many of the main ecosystems discussed above, including the resultant degradation of ecosystems and loss BES. This loss includes the loss of agricultural diversity within Tuvalu's traditional agricultural ecosystems, although there are conscious attempts through a number of aid-funded initiatives, over the last decade, to develop nurseries to enhance agricultural and agroforestry diversity, including the propagation of new climate- and salt-resilient trees and crops, as a basis for building resilience to climate change.

4.1 Threatened Ecosystems

The main ecosystems that are under threat are:

4.1.1 Coastal forest and vegetation on the main inhabited islands, including the loss of some species from uninhabited offshore islets (**motu**), which are the main turtle nesting areas, seabird rookeries. And refugia for threatened land crabs and coastal plants. This is due to reclamation, land clearance, overexploitation, invasive species and . Important species that are under various levels of threat 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*) and **tausunu** (*Tournefortia argentea*), all of which are ecologically and culturally important species.

4.1.2 Mangroves due to reclamation and overuse. Species of particular concern include **sagale** (*Lumnitzera littorea*) and mangrove associated species surrounding mangroves, such as **gie** (*Pemphis acidula*), many of which are also found in coastal forest and scrub.

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

4.1.4 Coral Reefs, Beaches and Nearshore Lagoon and Oceanside Marine Ecosystems particularly on the main Funafuti Atoll. Where overfishing, coastal erosion. Extreme weather and tidal events and climate change are the main drivers of the loss of BES.

4.2 Threatened Species and Genetic Diversity

Within all of these ecosystems there is a wide range of threatened plants and animals (Table 8). The most important of these, the estimated numbers of each type, and the numbers that are threatened, rare or extirpated are shown in Appendix IV, the results of the 2016 Funafuti R2R

BIORAP. As can be seen, over 1000 named species or groups of species, which represent a much higher number because many names, especially for organisms in the marine environment, represent multiple species. Of these, over half of which were considered extirpated, rare or threatened and in need of conservation by survey respondent groups. This loss represents a serious loss of BES that are the fundamental to for food, health, energy, livelihood and environmental security in Tuvalu.

Table 8: The most important and the 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, dolphins and turtles,
2	small and large shellfish
3	octopus and squid,
4	marine crabs and hermit crabs,
5	sea cucumbers,
6	hard and soft corals,
7	a range of other marine organisms,
8	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,
9	cultivated food, ornamental and multipurpose plants,
10	cultivars of important food crops,
11	land and seabirds,
12	domestic animal,
13	reptiles
14	land crabs and hermit crabs
15	insects and arthropods

5. MAJOR THREATS TO BIODIVERSITY AND ECOSYSTEM SERVICES

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The Tuvalu 4th Report to the CBD said that:

> Perceived threats can be summarised as arising from deleterious human actions and negative attitudes to the environment, leading to inappropriate behaviour, such as littering, over-fishing and hunting, using fishing nets and modern fishing methods, the use of guns and the introduction of pests; the use of inappropriate technologies, such as solid and liquid waste water disposal systems; uncontrolled use of resources and control of livestock; increasing consumption patterns, arising from increases in human populations, demands and changing lifestyles; institutional weaknesses; ignorance and lack of knowledge; natural factors and climate change (Tilley and Fihaki 2009).

The situation is essentially the same in 2016 with certain threats specified in more detail or intensifying. Table 9 lists main threats to BES as reported in the 2009 4th Report are summarized along with an assessment of the current status of those threats and new emerging threats. Appendix V, 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 or medicinal plants) and what are believed to be the interventions necessary to address the loss of BES.

Direct drivers of BES loss still considered serious, intensifying or emerging as new issues in Tuvalu and reinforced by the results of the Funafuti R2R BIORAP (Appendix V) include: 1) climate change and sea-level rise; 2) impacts of extreme weather and tidal events, particularly tropical cyclones, storm waves and prolonged droughts; 3) coastal and beach erosion; 3) overexploitation of terrestrial plants and animals; 4) overfishing; 5) invasive alien species and diseases (IAS); 6) urban and village expansion, land clearance and land reclamation; 7) solid and liquid waste management and water pollution; and 9) feral animals.

Table 9: Perceived major threats to biodiversity and ecosystem services (BES)

Nature of Threats	**4th Report 2009**	**5th Report 2016**	**Comments**
Climate change and sea-level rise	4	4	Remains major concern
Overharvesting/overfishing	4	4	Increased
Invasive species and diseases	4	4	Intensifying
Waste/Waste water management	4	4	Increasing
Coastal and beach erosion	3	4	Accelerating
Salt water intrusion	3	4	Worsening
Prolonged drought	3	4	Worse and more frequent

Urban/Village expansion and land clearance	3	4	Increasing signficantly
Extreme tidal events/king tides, waves	2	4	Impacts worsening
Natural disasters/tropical cyclones	2	3	Negative impacts increasing
Limited replanting	2	3	Limited land, shortage of planting material, loss of knowledge, increasing dependence on imports
Loss of knowledge and skills/disuse	2	3	Increasing, but being included in education
High consumption/import dependency	1	3	Increasing, especially on Funafuti
Increasing population density/crowding	1	2	Increasing
Gun use for hunting birds and fish	2	?	?
Uncontrolled pigs	2	2	Controlled on Funafuti
Commercialization of biodiversity	1	1	?
Declining usage	1	2	Still a problem related in import dependency
No legal protection/poor governance	1	2	Still a priority need
Habitat/vegetation loss	1	3	Increasing
Littering/solid waste	2	3	Some control with new dump
War debris	1	?	
Weak customary laws/governance	1	1	
Loss of medicinal plants	-	2	New issue 2016
Lack of awareness	-	3	New issue 2016
Marine oil spills		2	New issue 2016
Coastal deforestation		2	New issue 2016
Declining seabird populations		2	New issue 2016
Land reclamation		2	New issue 2016

Sources: Adapted from Paeniu, 2009a; Paeniu, 2009b and Saini, 2009; Tilling and Fihaki 2009; Thaman *et al*. 2013; Thaman 2016; Alefaio 2016,

Indirect drivers include 8) loss of knowledge and lack of awareness lack of awareness of the extent problem, particularly among the younger generation, of the importance and conservation status of biodiversity as Tuvalu's most important defence against negative global changes; 10) Inadequate governance and legislation. Also a problem was that some of the younger generation no longer know the names or traditional uses of many of the threatened organisms which also negatively impacts the protection of the biodiversity-dependent Tuvaluan culture. These threats are discussed in some detail below.

5.1 Climate change, sea-level rise and extreme weather and tidal events

Climate change, sea-level rise and extreme weather and tidal events are of utmost concern. From 1993, the National Tidal Facility Institute from Australia has established automatic monitoring stations around the region and in Tuvalu has monitored sea pressure, sea temperature and wind velocity. From March 1993 to September 2009 the average seal level trend has been 5.3 mm per year for Tuvalu while the global average is 1-2 mm per year.

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 in Tuvalu. Severe tropical cyclones, which were reportedly infrequent in the past, seem to be increasing in both frequency and intensity with major tropical cyclones affecting Tuvalu in 1891, 1972 (Tropical Cyclone Bebe),1979 (Tropical Cyclone Meli), 1990 (Tropical Cyclones Val and Ofa) and 1993 (Tropical Cyclones Nina and Kina), with Nana and Kina causing flooding of over 0.6 m over Nanumea, Nanumaga, Niutao, Nui and Vaitupu; loss of trees, damage to crops, housing and infrastructure (Xue 2005). Most recently, during Tropical Cyclone Pam in March 2015, when 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 many atolls and damage or killed local crops and trees which have lower resistance to salinity than native coastal plants to high salinity. Nanumea, Nanumaga, Niutao, Nui, Nukulaelae and Funafuti have all been were highly affected by salt water intrusion and increasing salt spray, which seriously burns leafy crops such as sweet potato, an increasingly important supplementary 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 2011 due water shortage on Funafuti (Vula 2011). Most recently in early and late 2016 .Tuvalu was again experiencing serious drought conditions.

5.2 Coastal Deforestation and coastal and beach erosion

Dramatically accelerating severe 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 which are often free of predators and the main refuges and nesting sites for turtles, seabirds and land crabs. For example, 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.

5.3 Overexploitation of terrestrial plants and animals

As shown in Appendix IV, 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 for construction and other uses. Of increasing concern is the loss of and scarcity of culturally useful animals and plants (particularly seabirds, land crabs and plants used for medicine, construction, mulching and pig feed), due to tropical cyclones, land clearance, over use and failure to replant (Appendix V). 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. As stressed above, 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.

5.4 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 o**verfishing 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 which 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 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 favored 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, **panea** (*Strombus luhuanus*) and trochus (*Trochus niloticus*). Seriously overfished and now extremely rare are the triton tumpet 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 spondilis, **hopu nifo** (*Spondylus* sp.). Also reportedly increasingly scarce, especially of the main island of Fogafale, are the range of cowries, **pule kena** and **pule** (*Monetaria* oblevata and *Cypraea annulus*) and **pule uli** (*Cypraea*

caputserpentis), so central ot 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** (*Melampis lutea* and *M. fasciatus*), the favoured shells for the common garlands, **tui** or **ual misa**, a major source of income (Resture and Resture 2005). Octopus, **feke** (*Octopus cyanea*) are also overfished and almost impossible to find on the reef off the main settlement on Fogafale Islet.

Among other invertebrates, both spiny lobster, **ula** (*Panulirus pencillatus*) 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 (Aleifaio 2016).

5.5 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 *Sphagneticola trilobata*, 3) the devastation of the **kanava** (*Cordia subcordata*) trees by an invasive moth caterpillar, the kou leafworm (*Ethmia nigroapicella*); 4) threats to birds and other indigenous species from rats; 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.

5.5.1 Agricultural Pests: Agricultural pests that have spread between islands and have remained problems since the 1990s include:

- coconut scale insect (*Aspidiotus destructor*), one of the most destructive pests to coconuts, which also attacks other crops and plants. On Nanumaga it severely infested coconut palms, breadfruit, papaya, bananas, pandanus and slightly affects the principal rootcrops crops, giant swamp taro, **pulaka** (*Cyrtosperma chamissonis*) and taro, **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 material have been unsuccessful. A biological

control method was tried through the introduction of ladybird (Cocinellidae) beetles. Re

- pink mealybug (*Maconellicoccus hirsutus*) is a perennial but sporadic pest of breadfruit and other crops including the exotic introduced leaf vegetable nambele.
- black mirid garden fleahoppers (*Microtechnites*/*Haiticus* spp.) are reported to affect plants on Funafuti, Vaitupu, Nukufetau, Niulakita and Nui.
- Other pests worth noting includes aphids, (*Aphis gossypii*, *Aphis craccivora* (both polyphagous) and *Pentalona nigronervosa* (on banana), and the delphacid planthopper, *Tarophagus proserpina* (on taro) all of which cause leaf deformation and yellowing as pests or may act as vectors of plant viruses.

The current status of these pests, which is based on data from the Entomology and Plant Protection Project of 1996—1998, needs to be updated.

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. Most of the economically damaging *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 **kunkun** (*Terminalia* spp.), **fao** (*Neisosprema oppositifolium*), **futu** (*Barringtonia asiatica*) and **nonu** (*Morinda citrifolia*I, 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 treats 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 reinvigoratied in 2015 in to ship produce directly from Rotuma to Tuvalu (Moresio 2015).

5.5.2 Invasive plants: The invasive alien plant in Tuvalu is, wedelia or trailing daisy (*Sphagneticolaa 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).

5.5.3 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.

5.5.4 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 has historically destroyed historic 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.

5.5.5 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).

5.5.6 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).

5.5.7 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).

Constraints to managing IAS in Tuvalu, as stressed in the 4th Report include:

- Lack of understanding of the major threats posed by pests
- Lack of information on the basic biology of many invasive species
- Accidental introductions
- Lack of monitoring of high-risk areas
- Competition between conservation and other interests
- Absence of, or inadequate legislation and enforcement
- Lack of personnel and biosecurity infrastructure
- Inadequate 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 priority
- Inadequate funding

5.5.8 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 vegetable, 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.

5.6 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 u**nsustainable 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.

5.7 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 collapse 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 unsanitized drinking water (Duncan 2012).

The disposal 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 foraminferans 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 is agency is responsible for enforcement and what investigation procedures should be followed.

5.8 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.

5.9 Inadequate Governance and Legislation

The lack of, or failure to inforce, appropriate legislation 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 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.

6. ACTIONS TO ADDRESS LOSSES OF BIODIVERSITY AND ECOSYSTEM SERVICES

The main intervention favoured by most R2R BIORAP respondents was the implementation of enforceable conservation and restoration practices, including the establishment or strengthening of a systems of marine managed areas, including some no-take MPAs (Appendix VI). Also suggested were restrictions on the catching of particularly threatened species until their numbers recovered in sufficiently to allow for exploitation to recommence. Other interventions suggested include improved marine pollution control and waste management, including improved household and institutional sewerage treatment and disposal; and enforceable legislation or by-laws against coral degradation (e.g., damage due to boat anchors). A Concerted campaign to raise awareness of the importance and conservation status of biodiversity was also considered a priority by most informants.

Much the same as marine organisms and ecosystem services, the main interventions to address these drivers of the loss of terrestrial BES were the implementation of enforceable conservation and restoration practices, national awareness and education programmes; the propagation, and replanting of coastal protection species, specifically coastal reforestation, and the establishment of nurseries, improved windbreak and hedges and seawalls. Among the suggested conservation interventions would be the designation of selected uninhabited reef islets (**motu**) as wildlife reserves for threatened native plants and animals where their exploitation could be made illegal or where sustainable harvesting practices could be encouraged. Such islets would ideally be pest-free (e.g., ant-, rat- and weed-free) or could be the focus of eradication programmes for these species. Islets like Tepuka Islet and the associated marine protected area could also serve as nature and cultural tourism sites and "living laboratories" for Tuvaluan students to learn about their biodiversity and ecosystem services.

Agricultural conservation areas could also be established, which could include:

1. An excavated taro pit garden (**pela**) conservation and enrichment initiative, in which a diversity of cultivars of both taro and other plants could be promoted, as well as the planting of important mulching or fertilizer plants around these area;
2. promotion of mixed coconut-dominant agroforestry areas;
3. the establishment of fodder and mulching plant reserves with appropriate plants used for feeding pigs and other animals, many of which are also the main plants used for

mulching and composting. This could include including living fencing and hedging that can be pruned to provide fodder or mulch;

4. village garden enrichment programmes that include increased cropping of food trees and other perennial food plants, short-terms seasonal vegetables, medicinal and other culturally valuable plants and improved hedge plants. This could also see villages designated as horticultural enrichment areas which include areas where threatened medicinal plants such as **tolotolo** (*Triumfetta procumbens*) and **akatā** (*Sida fallax*) could be planted.

Part III. A Review of the activities and progress made in relation to the themes and objectives of the Tuvalu NBSAP, the Aichi Biodiversity Targets and the Sustainable Development Goals

7. TUVALU NBSAP, THE AICHI TARGETS AND SUSTAINBLE DEVELOPMENT GOALS

Appendix VI is a log frame (logistical framework) showing the themes, objectives and implemented, completed, ongoing and planned actions under the Tuvalu National Biodiversity Strategy and Action Plan (NBSAP) 2012—2016 and their linkages with the Aichi Targets and Sustainable Development Goals. These are summarized in the following discussion.

Although the Aichi Biodiversity Targets (ATs) of the Strategic Plan for Biodiversity for 2011-2020 and the Sustainable Development Goals (SDGs) – "The Global Goals for Transforming our World: the 2030 Agenda for Sustainable Development" are very relevant to biodiversity conservation and sustainable development in Tuvalu, some ATs and SDGs are not as relevant or attainable for small island micro-states (SIMS) such as the isolated, fragmented, low-lying, resource- and biodiversity-poor, and culturally homogenous Polynesian atolls of Tuvalu.

As stressed above, Tuvalu faces many challenges that are more specific to SIMS than to larger island countries and continental countries. These include, as discussed in detail above: 1) immediate threats due to climate change and sea-level rise; 2) clearly increasing negative impacts of extreme weather and tidal events (e.g., prolonged droughts, tropical cyclones, storm surges and king tides) on biodiversity, infrastructure and human well-being; 3) extremely poor (very limited with virtually no unique endemic species) but highly threatened native flora and fauna; 4) disproportionate livelihood dependence on fragile marine biodiversity; 5) absence of surface freshwater resources and very limited and increasingly depleted and polluted groundwater resources; 6) increasing salt-water incursion and salinity due to salt-spray; 7) extremely poor, limited and increasingly saline soil resources; 8) invasive alien species and diseases (IAS); and 7) increasing food and import dependency and associated nutrition-related non-communicable diseases.

7.1 NBSAP Activities and the Aichi Biodiversity Targets (ATs)

Most Aichi Biodiversity Targets (ATs) are relevant to Tuvalu and, given its limited capacity, has been doing what it can under the NBSAP to reach the targets. The relevant activities, which are detailed in Appendix VI are summarized below:

- AT 6 - Many activities related to raising awareness of the importance of biodiversity, the most important of which have been initiatives by the Agricultural, Fisheries, Environment and Education Departments, the main partners in BES conservation. Most recently, these have included the 1st Fisheries Monitoring and Management Consultation and the R2R BIORAP, a community-based assessment, along with community consultations on the conservation status of culturally and ecologically important BES on Funafuti and threats and interventions needed to conserve and use it sustainably.

- AT 5 – Given severe land and water shortage, poor soils, high population densities and widespread land clearance on the main inhabited atoll islets to build housing and infrastructure, land degradation continues on main islets, although attempts have been made to arrest degradation on uninhabited atoll islets and to establish CAs and LMMAs in the nearshore marine areas.
.
- AT 6 – Tuvalu has established a system of LMMAs and is party to The Nauru Agreement, an eight-country agreement to cooperatively manage the control the western and central Pacific tuna stocks.

- AT 7 – There are continuing programmes to restore and enrich traditional taro pit gardens (**pela**) and coconut-dominant agroforestry systems with "climate-ready crops and to increase production and diversity of short-term home vegetable gardens. Cement-encased taro pit gardemns were installed in 2016 on Nanumaga where increased saltwater incursion had made it almost impossible to grow taro and associated food plants.

- AT 8 – Concerted attempts and plans have been made to control sewage seepage into Funafuti lagoon and into the limited freshwater table though the installation of sealed sewage systems and septic tanks, through the conversion of waste into compost, and through source control and more efficient and re-use of wastewater. A documentary video, "Funafuti Master Plan" focused on the impacts and need to control wastewater (Kaly 2015).

- AT 9 – Major IAS and disease threats to Tuvalu's BES and human health have been identified; a Tuvalu Invasive Species Committee coordinated by DOE was established in 2015 but there has been limited activity; and biosecurity staff received training in 2012. Capacity is limited to address the main IAS threats to BES which include rats, yellow crazy ants (YCA), weeds, such as wedelia or trailing daisy (*Sphagneticola trilobata*)(which provides habitat for rats), crop diseases and the kou leafworm (*Ethmia nigroapicella*) which devastated the **kanava** (*Cordia subcordata*) groves, the main

coastal protection and woodcarving tree on Nanumea. The control of all these IAS remain problematic and probably requires assistance from SPC and international partners, such as the New Zealand Based Pacific Invasive Initiative (PII) which works with agencies to strengthen the capacity of Pacific Island Countries and Territories to effectively manage IAS.

- AT 10 – Tuvalu has remains committed and involved in most international initiatives addressing climate change and anthropogenic impacts on BES including the recently established Coalition of Low Lying Atoll Nations on Climate Change (CANCC), of which Tuvalu's Prime Minister is the current Chair. Tuvalu is also making concerted efforts through its LMMA Network to reduce overfishing and to establish a system of LMMAs on all atolls.

- AT 11 – Tuvalu has established the Funafuti Conservation Area (FCA)(Kongatapu), a marine conservation area covering 33 km^2 of reef, lagoon and uninhabited reef islets (**motu**) in the far west of Funafuti Atoll which clearly protects a significant percentage of Tuvalu's ecologically important ecosystems. LMMAs and similar protected areas are being protected under local by-laws on the outer atolls.

- AT 12 – Because Tuvalu has virtually no endemic plants and animals, the emphasis of biodiversity conservation in Tuvalu has focused on the conservation, restoration and enrichment of a wide range of threatened culturally and ecologically important plants, animals and fish that are central to sustainability in Tuvalu. This has been the main thrust of the recent R2R BIORAP – to identify and document, from a local community perspective, those threatened species, drivers that threaten them and co-management options to address their loss. Indicator species are also being identified to assess the effectiveness of conservation efforts. There have, however, been effective protection regimes and associated awareness campaigns to protect turtles, giant clams and some threatened sea birds that are of global conservation interest.

- AT 13 – There has been some support for the protection, propagation and increased planting of cultivars of Tuvalu's staple food crops (giant swamp taro, common taro, coconuts, breadfruit, edible pandanus and native fig) under the GCCA Agroforestry Project and other Department of Agriculture initiatives.

- AT 14 – Limited work has been done on restoring ecosystems that provide BES related to water and contribute to health, livelihoods and well-being. Substantial work and emphasis has, however, been placed on increasing the capacity and efficiency of rainwater catchment and storage systems, which for Tuvalu, are seen as a "critical" part of the "freshwater ecosystem" of inhabited atolls and central to the health of atoll plants, animals, crops and people.

- AT 15 – Given its small forest area there is limited scope for Tuvalu to play a major role in mitigation to enhance carbon stocks, apart from the protection of the photosynthetic capacity of their reefs and algal beds, although there is very limited scope for replanting coastal forest and mangrove species to make a symbolic contribution, the main contribution of which would be coastal and wildlife habitat protection.

- AT 17 – In late 2016, participatory, community and government consultations were held to update the Tuvalu NBSAP, the draft of which will be finished by June 2017.

- AT 18 - As a small island state inhabited and governed by indigenous Polynesian people, Tuvalu has been very active in the recording and application of ILK to the conservation and sustainable use of biodiversity, with the full and effective participation of indigenous and local communities at all relevant levels.

- AT 19 – There have been concerted efforts to improve, share and apply the knowledge, science and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss. This has formed a central theme in many of the projects of the Agroforestry, Locally Managed Marine Areas, Disaster Risk Management, NAPA, R2R and other programs.

- AT 2O – Given its limited capacity Tuvalu has, through its NBSAP and other relevant initiatives, as discussed above, mobilized financial resources for trying to achieve as many of the ATs in accordance with the consolidated and agreed process in the Strategy for Resource Mobilization.

ATs that have been less well addressed are:

- AT 2 - the integration of biodiversity values into national and local development and poverty reduction strategies, planning processes and accounting and reporting systems.

- AT 3 - elimination or phasing out of incentives and subsidies harmful to biodiversity and introduction of positive incentives for the conservation and sustainable use of biodiversity are developed.

- AT 4 – Implementing plans for sustainable production and consumption to keep the impacts of use of natural resources well within safe ecological limits.

- AT 16 – There has been little action in relation to Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization, again due to limited potential for bioprospecting and the exploitation of terrestrial plants animals and micro-organisms that are unique to Tuvalu.

7.2 NBSAP Activities and the Sustainable Development Goals (SDGs)

Tuvalu has, under the NBSAP and other related development initiatives, made progress towards achieving the Sustainable Development Goals (SDGs). These related activities are shown in Appendix VI and briefly summarized below. The SDGs of most concern in Tuvalu (numbers in parentheses) are **food security** (2), **good health and wellbeing** (3), **quality education** (4), **clean water and sanitation** (6), **affordable clean energy** (7), **responsible consumption and production** (12) and (although there are no cities in Tuvalu) **sustainable cities and communities** (11), in terms of making Tuvalu's human settlements inclusive, safe,

resilient and sustainable. All these SDGs have been addressed in some way in NBSAP activities, because all are dependent on the conservation and enrichment of our very limited and highly threatened atoll BES and associated ILK and on building synergies between indigenous knowledge and modern scientific knowledge (MSK) as a basis for finding the right combinations of "soft" and "hard" interventions needed to promote sustainable atoll development.

Other priority SDGs include **climate action** (13), which although combatting climate change by regulating emissions has limited relevance for Tuvalu given its small population and low overall emissions, developments in renewable energy, particularly solar energy, are very important. Of central importance and a focus of many NBSAP activities are **life below water** (14), the conservation and sustainable use of nearshore and offshore marine resources, and **life on land** (15), the conservation, restoration and sustainable use of limited atoll terrestrial BES. And **peace, justice and strong institutions** (16) and **partnerships for the goals** (17) are also important, especially in the context of developing strong legislation and enforcement and developing appropriate partnerships to increase the capacity of Tuvalu to manage BES, especially in the promotion of new hybrid solutions to managing BES as a basis for sustainable development.

Of the remaining SDGs, **ending poverty** (1), **gender equality** (5) and **reduced inequalities** (10), although of some relevance, are not considered serious problems in Tuvalu, particularly with respect to the conservation and sustainable use of atoll biodiversity; **decent work and economic growth** (8) are important but problematic due to small size, limited land area, extremely narrow resources base, geographic isolation, and small local market size; and **industry, innovation and infrastructure** (9), although playing critical roles in facilitating improved livelihoods, health and sustainable use of limited biodiversity, prospects for "industrialization" are virtually non-existent in Tuvalu.

With respect to SDGs 1, 2, 14 and 15, although there is no stark poverty and hunger as found in some countries, there are serious issues related to food security and food dependency, sustainable agriculture and fishing, and the increasingly serious levels of malnutrition and nutrition-related non-communicable diseases that are strongly linked to a shift from diets based on nutritious local foods to a dominance by nutritionally inferior imported foods and drinks. This is particularly serious on Funafuti where recent surveys show that from 20—30% of female and male children suffer from malnutrition induced stunted growth due an over dependence on nutritionally poor imported staple foods, meats, soft drinks, etc.; and there is an almost epidemic incidence of nutrition-related non-communicable disease (e.g., diabetes, hypertension and cardiovascular disease) and early mortality (Ministry of Health 2011). There is also a need to address maternal-child mortality related diseases and cases of pollution-related diseases.

Finally, unlike the Aichi Targets, there is very little up-front in the SDGs about the importance of indigenous knowledge and culture as a foundation for effective conservation of BES and sustainable development. If SDGs like quality education, sustainable communities and life

below water, life on land, strong institutions, etc. are not linked to traditional biodiversity-dependent Tuvaluan culture's central role in BES conservation, achieving these goals will be problematic. Similarly, although international partnerships are critical to the realization of both the ATs and the SDGs, perhaps more important in the context of Tuvalu are strengthening of local partnerships between national institutions and local communities, which, along with local leadership (e.g. **Kau Pule**, the local councils that pass by-laws), will ultimately monitor and determine the success or failure of community-based BES conservation initiatives on their atolls and water, is of central importance.

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APPENDICES

Appendix I. Persons consulted during the preparation of the Tuvalu National Biodiversity Strategy and Action Plan Fifth National Report to the Convention on Biological Diversity

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Hon. Enele Sopaga
Prime Minister of Tuvalu

Ursala Kaly
Ecosystem Scientist **and Natural Resources, Environment, Social Survey and Data Adviser/Consultant**

Gary Preston
Tuvalu Fisheries Advisor
Tuvalu Fisheries Department (TFD), Ministry of Natural Resources Fisheries, **Agriculture and Lands. Funafuti**

Talavai Iona
Permanent Secretary
Ministry of Education, Sports and Culture
Funafuti

Siaosi Finiki
Master Gardener and Former Chief of Funafuti Atoll

Sione Pome'e
Agriculturalist/Agroforester
North Fogafale Islet

Akelitia Pesega
Research Officer
Department of Agriculture
Ministry of Natural Resources

Appendix II. Important finfish families or groups of finfishes, well-known Tuvaluan names, and estimated number of species found in Tuvalu starting with sharks, rays and eels and then listing families/groups in order of their importance in the Tuvaluan fishery and/or the number of species and/or their ecological importance (Source: Adapted from Thaman 2016).

Family (Families) or Groups of Finfishes	**Tuvaluan Names of well-known species (gen. indicates general names for species within the family (families)**	**No. of Species**
Sharks	magō (gen.) kili, lālāila, lokea, malu, mataitaliga, moemoe'ao), palu magō	18
Rays	Fai (gen.), fai kili, fai manu, faifālua	5
Eels	puhi (gen.), tuna	13
Tunas and Mackerels (Scombridae)	atu, atualo, pāla, salala, takua, takuo, tavatava, uli, valu	10
Billfishes (Istiophoridae) and Swordfishes (Xiphidae)	sakulā, hakulā, hakulā tuāniu, tuāniu, ululau, ūlau	6
Mahimahi (Coryphaenidae)	mahimahi	1
Oilfiishes and Snake Mackerels (Gempylidae)	palu (gen.), kuakua	4
Travellies or Jacks (Carangidae)	āheu, atule, filu, lai, tafa'uli, talitali'uli, ulua	21
Barracudas (Sphyraenidae	Ono	5
Rockcods, Groupers and Coral Trouts (Serranidae)	gatala (gen.), eve, falō, fāpuku, feata, katakata, loi, mataele, munua, palu gatala, pula, papa, tonu	44
Snappers or Seaperches (Lutjanidae)	fagamea, hāputu, sāputu, havane, savane, palu (gen. for deepwater spp.), tāea, tagau, tā'iva, takuku, utu	28
Emperors and Breams (Lethrinidae)	filoa, gutula, hāputu, sāputu, kailo, kāpatiko, liki, mū, noto, tanutanu	16
Parrotfishes (Scaridae)	alomea, homo, kamutu, kapuga, laea, lavia, somosomolaea, ufuufu, ulafi	25
Wrasses (Labridae)	gole, kiole, lautōtonu, malatea, papo, papu, tagafa, uloulo	38
Surgeonfishes (Acanthuridae/Acanthurinae)	alogo, api, kapalagi, mā, maito, manini, pone	18
Unicornfishes (Acanthuridae/Nasinae)	kosotū, manini lakau, tativi, ume, umalei	9
Triggerfishes (Balistidae)	sumu, humu, umu	15
Filefishes (Monocanthidae)	sumu, humu, sumu kāleva, humu kāleva	4
Flyingfishes (Exocoetidae)	sipa, hipa, sasave	10?
Soldierfishes and Squirrelfishes (Holocentridae)	malau, tā, talakihi, talakisi	18
Goatfishes (Mullidae)	afulu, kalo, mālili, vete	14?

Rabbitfishes (Siganidae)	maiava	4
Mullets (Mugilidae)	kafa, kafakafa, kanahe	3
Bonefishes (Albulidae)	kiokio	1
Milkfish (Chanidae)	ava	1
Biddies or mojarras (Gerridae)	matu	2?
Chubs or Drummers (Kyphosidae)	nanue	2
Needlefishes (Belonidae)	aku, galiolio	4
Halfbeaks (Hemiramphidae)	tute, ise, ihe	2
Butterflyfishes (Chaetodontidae)	tifitifi, laulaufou	30?
Angelfishes (Pomacanthidae)	laulaufao	5
Moorsih Idol (Zanclidae)	laulaufao	1
Spadefishes (Ephippidae)	laulaufou	1
Porcupine fishes (Diodontiidae)	tautū	1
Pufferfishes and Tobies (Tetraodontidae)	hue, sue, tētē	7
Boxfishes and cowfishes (Ostraciidae)	moamoa, tētē	2?
Scorpionfishes (Scornpaenidae)	nofu, hakukakulele	6
Damselfishes (Pomicentridae)	gafugafu, gagafu, mutumutu, mutu, takuku	30?
hawkfishes (Cirrhitidae)	pātuki	5
Lizardfishes (Synodontidae)	kalapa (Tv, Tk)	3?
Sandperches (Pinguipedidae)	kalapa (Tv, Tk, PP)	3?
Flounders (Bothidae)	ali (Tv, Tk)	2
Bigeyes (Priacanthidae)	matapula (Tv, Tk)	2
Fusiliers (Caesionidae)	ulihega	5
Silversides (Atherinidae) sardines and herrings (Clupeidae)	salī (Ff), halī (Nm, PP?)	6

Appendix III. Specimen shells identified during surveys from 15 November to 16 December 1983 on Funafuti and Nukufetau Atolls, Tuvalu and all records, including records from the Royal Society of London's expedition collection (1896—98), subsequent collections and records compiled in 1983 by Parkinson (1985).

Common Name (Family)	1983	All Records (1898—1983)
Mitres (Mitridae/Costellariidae	26	28
Cones (Conidae)	20	33
Cowries (Cypraeidae)(**pule**)	18	41
Augers (Terebrdae)	15	15
Ceriths (Cerithidae)	15	22
Strombs (Strombidae)(**kalea, panea**)	8	9
Tritons (Cymatidae)	6	13
Turbans (Turbinidae)(**alili**)	-	4
Drupes (Thaididae)	4	4
Helmets and Bonnets (Cassidae)	-	4
Trochus (Trochidae)	2	3
Harps (Harpidae)	1	1
Vases (Vasidae)	1	1
Olives (Olividae)	1	1
Dog Whelks (Nasssriidae)	1	1
Murex (Muricidae)	1	4
Frog shells (Bursidae)	1	1
Enginas and whelks (Buccinidae)	1	1
Star shells (Astraeinae)	1	1
Terebellum conch (Seraphsidae)	-	1
Nautiluses (Nautilidae)		1
TOTAL	122	188

Appendix IV. Estimated total named plants or animals recorded as important in: 1) different R2R ecosystems or habitats and/or for the delivery of specified ecosystem goods and services; and 2) the number that are considered threatened, rare or extirpated 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 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 (Source: Thaman et al. 2017).

Que. 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 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	Oceanisde 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/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/parceling	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	Land crabs and hermit crabs	Ū, paikea, uga	4	4	4

75	Insects and arthropods	manufoliki aofia	10	?	O
76	weeds	lakau fakamataku/fakamasei	10		
77	Animal pests	manu fakamataku	3	0	0
78	diseases	masaki fakamataku	2	?	?
	TOTAL		**1066**	**669**	**232**

Appendix V. 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 nearshore 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	Development of nurseries/plant propagation capacity, education and awareness, promotion of local foods

			planting materials, loss of knowledge, declining use due to replacement imported 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, prootion
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 boatbuilding	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/parcelling	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 seabirds	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	**1063**	**666**		

Appendix VI. Log frame (logistical framework) showing the themes, objectives and implemented, completed, ongoing and planned actions under the Tuvalu National Biodiversity Strategy and Action Plan (NBSAP) 2012—2016 and their linkages with the Aichi Targets and Sustainable Development Goals.

Themes &Objectives	**Actions**	**Completed, Ongoing and Planned Action**	**Aichi Targets and Sustainable Development Goals Addressed**
Theme 1: Climate Change and Disaster Risk Management			
Objective 1: Improve knowledge on the impact of climate change and natural disasters on biodiversity	1. Conduct assessment of impacts of climate change and natural disasters (CC&ND) on biodiversity	Rapid Assessment team visited all islands to assess impacts of Tropical Cyclone Pam. Main impacts loss of crops and home gardens (AU$958,000), livestock (AU$1,408,000) and fisheries (AU$490,000). R2R assessed Impacts of CC & ND on BES.	Aichi Target 1, SDGs 2 & 13 Aichi Targets 1 & 19, SDG 13
	2. Raise awareness of meteorologists and climatologists on the linkages between climate information and biodiversity conservation	Completed- Meteorology (MET) staff received training	Aichi Targets 5 and 19, SDGs 2, 13 and 15
	3. Assess and establish effective coordination arrangements to facilitate the mainstreaming of biodiversity conservation into climate change and disaster risk management policies and programmes by 2011	A central theme in NAPA and other projects. Completed during NAPA 1 project, coastal plants were planted along the coast on 9 atolls as soft protection measures. Unfortunately most of them were washed away during TC PAM Cement encased pulaka pits (**pela**) were installed on Nanumaga as an adaptation measure for sea water intrusion under the NAPA 1 project. The Nanumaga kaupule further installed additional cement pulaka pits under their SDE (Special Development Expenditure)	Aichi Targets 1 and 19, SDG 13
	4. Document and disseminate key information on the		

	impact of climate change and natural disasters on biodiversity 5. Develop and conduct awareness and understanding programmes on the inter-connections between biodiversity, climate change (CC) and natural disasters targeting all levels: national, islands, community groups and non-government organizations	Completed and ongoing - Data archived in MET database and ready to share in Excel. *Tuvalu Climate Bulletin* issued monthly Awareness programmes done by all current, completed and pipeline projects that related to CC, Biodiversity and DRM.	
Objective 2: Ensure meteorology and climate change information systems are relevant to biodiversity protection and conservation	1. Work closely with the MET office to develop information systems that are relevant to biodiversity 2. Build capacity to understand MET and early warning information systems and their relevance to biodiversity 3. Identify potential donors for implementation of above actions and prepare relevant project proposals	MET has developed "OUTLOOK", a 3-month prediction of rainfall which is the main limiting factor on the health and conservation status of BES. Planned activity - NAPA II project will procure and conduct awareness activities to all islands on "improving early warning system" in Tuvalu NAPA II Project will work collaboratively with MET, TVBC, TTC to improve communication	Aichi Target 14 and SDG 6
Objective 3: Develop contingency plans to ensure biodiversity, culture and	1. Contribute to dialogue and planning for adaptation and mitigation purposes should Tuvalu be relocated due to impacts of climate	Not applicable - the current government policy is migration as a last resort so this is no longer applicable. However, migration policy is in drafting stage	

traditions of Tuvalu are preserved and protected in time of extreme events of climate change and natural disasters	change and natural disasters 2. Identify options for ecosystem based adaptation 3. Identify ex-situ conservation options for conservation of Tuvalu biodiversity 4. Collect, research, documents, record and store traditional knowledge on impacts of climate change and natural disasters on biodiversity	A major focus of the R2R BIORAP community-based survey in the 1st phase survey on Funafuti was the identification by local communities of ecosystem-based responses to the loss of BES Some emphasis on the planting of threatened plants and food crop cultivars in village home gardens National Cultural Policy has been drafted in 2015 identifying this as an action. This was also one of the emphases of the R2R BIORAP	SDG 2 Aichi Targets 1, 18 and 19
Theme 2: Traditional Knowledge, Cultural Practices, Indigenous Property Rights			
Objective 1: Foster and promote the use of traditional knowledge and cultural practices in the conservation and management of biodiversity in Tuvalu	1. Integrate traditional knowledge and cultural practices into the education curriculum for all levels of education in Tuvalu 2. Conduct research and document all traditional knowledge (TK) and cultural practices pertinent to biodiversity	Endorsed the Early Learning and Development Standard for 3-6 yrs. Training of teachers on Biodiversity carried out by the IIB project. emphasized the importance of TK and to use this as an activity in the Tuvalu studies Book published on the *Plants of Tuvalu* (2012) and their ethnobotany (258 pp) Funafuti community based survey conducted in 2016 on the cultural importance on conservation status of biodiversity as part of R2R BIORAP	Aichi Targets 1, 18 and 19; SDG 4 Aichi Targets 1, 18 and 19

	3. Undertake a comprehensive analysis of all unsustainable cultural practices that degrade the value of biodiversity (such as land clearance, overharvesting, destructive fishing, excessive feasting practices 4. Conduct awareness programmes to increase understanding on the value of traditional knowledge (TK) and sustainable cultural practices	Study published on Punatau the ancient settlement of Vaitupu, Island "writing committees' established on Nanumea, Nanumaga and Vaitupu Book published on Fishes of Tuvalu and Tokelau (2016) Education Dept to document ILK & culture used in Tuvaluan legends and myths Study in progress under the R2R BIORAP of drivers of loss of BES (2016) Culture Dept has consulted with communities in preserving ILK and skills and cultural heritage	Aichi Target 6 Aichi Targets 1 and 18
Objective 2: Preservation of traditional knowledge and cultural practices pertinent to the conservation and management of Tuvalu	1. Develop training and awareness programmes targeting the young generations of Tuvalu to enable them to learn and practice traditional skills 2. Conduct research on dimensions of traditional knowledge and cultural practices which could be modernized by adapting to complement outside technologies	Education department through the review of the Tuvalu studies Conducted as part of NAPA 1 with the establishment of cement-enclosed taro pit gardens (**pela**) to address saltwater incursion.	Aichi Targets 1 and 18; SDG 4 SDG 9

Objective 3: Foster and promote the equitable sharing of benefits derived from biodiversity	1. Conduct analysis to identify elements of biodiversity which could be commercialized 2. Develop strategic plans for the management and implementation of indigenous property rights 3. Establish benchmarks for the equitable sharing of benefits derived from biodiversity	No action Not applicable; most property/land owned by indigenous communities No action	
Theme 3: Conservation of Species, Ecosystems (Marine, Coastal, land terrestrial) and Genetic Diversity			
Objective 1: To protect and conserve diversity of ecosystems	1. Conduct inventory and assessment of ecosystems requiring protection and conservation (to establish baseline data and information on ecosystems) 2. Develop integrated ecosystems management plans 3. Promote ecosystem based adaptation and conduct training and awareness on EIA 4. Conduct training and awareness programmes on ecosystem management	Ongoing - Fisheries Dep, IIB Project, Napa II, R2R BIORAP surveys completed for Funafuti in 2016 In progress under R2R for the management of nearshore marine, coastal and atoll terrestrial ecosystems Completed- SPREP conducted EIA training for Government officials, NGOs & other stakeholders 2015 In 2016, the Environment Department conducted EIA awareness with outer islands communities; to be continued in 2017 Carried out under NAPA 1 Policies and plans developed Coastal protection plants (mangroves and fetau)	Aichi targets 6 and 11, SDG 14 Aichi target 6 and 11, SDGs 14 and 15 Aichi targets 14 and 19, SDGs 16 and 17 SDGs 14 and 15 SDGs 14 and 15

	5. Formulate appropriate policies and legislation on ecosystems services-coastal vegetation, coastal fisheries, mangroves, coral reefs, water, agriculture etc	planted during the NAPA 1 project as a soft measures for coastal protection	
Objective 2: To preserve, protect and conserve diversity of species	1. Conduct comprehensive inventory, and assessment of all species (terrestrial & marine) 2. Conduct training and awareness programmes on species diversity 3. Establish management plans to improve and restore the status of threatened species (strategies, targets, activities, funding and monitoring etc)	Marine surveys by – NAPA II and Fisheries Dept.; on-going creel surveys for some atolls R2R BIORAP Inventory of all culturally important and threatened marine and terrestrial species through in-depth community-based questionnaire surveys Book published on the *Plants of Tuvalu* 2012 and a Flora published in 2016 Book published on Fishes of Tuvalu and Tokelau in 2016 Training of teachers on Biodiversity carried out by the IIB project Community based discussions of preliminary results of the R2R Biorap on the conservation status of BES 1st Fisheries Monitoring and Management Consultation held to present results of the creel surveys to the Funafuti community. Summary results of R2R BIORAP also presented. In process under Fisheries department, R2R and NAPA II projects	Aichi target 6, and 7; SDGs 14 and 15 Aichi target 1, 18 and 19 SDGs 14 & 15 Aichi target 11& 12 SGD 4 SDGs 14 and 15 SDG 14 SDG 14

Objective 3: To protect and conserve the genetic diversity of Tuvalu	1. Conduct inventory and assessment of genetic diversity of Tuvalu 2. Formulate policy on intellectual property rights and relevant legislation to protect and conserve the genetic diversity of Tuvalu 3. Conduct awareness and training programmes to enhance the understanding and management of genetic diversity	Limited work on recording cultivar diversity and conservation status of major staple food crops (taros, coconut, breadfruit and edible pandanus) under R2R BIORAP No action taken (See 3.2.2 above)	SDG 2
Theme 4: Community- Empowerment, Involvement, Awareness and Understanding and Ownership			
Objective 1: Building capacities of Falekaupule and their respective people to manage and conserve their island ecosystems to provide sustainable benefits and livelihoods	1. Prepare training materials, posters, booklets etc on biodiversity 2. Conduct at least one training workshop for all islands every 2 years 3. Conduct one national symposium every 2 years where islands would share	Completed - already done by current, completed and pipeline projects that are related to Biodiversity Action plans were developed for schools during the Training of Teachers on Biodiversity Workshops conducted to share and discuss Funafuti R2R BIORAP results and conservation actions needed to conserve BES National Climate Change Resilience Workshop in Nov. 2016 and a Cumminity Consulation workshop and biodiversity and ecosystem services in late 2016	Aichi target 1 Aichi targets 1,6,7,8,9 and 10 Aichi target 19 SDG 13 Aichi target 2; SDG 15

	experiences and jointly review achievements of targets	Completed - GCCA organized a training workshop on Agroforestry	SDG 16
	4. Establish a financing framework for island biodiversity	Government SDE (Special Development Expenditure) and VDS (vessel daily scheme)	
Objective 2: Empowering communities to lead in the management and conservation of their island biodiversity	1. Mapping of island ecosystems, identifying endangered species, potential areas for conservation, processes involved and inter-linkages among them	Fisheries department, NAPA 2, IIB, R2R projects all have GIS components to assess various aspects of BES, such as the location of existing and potential LMMA, conservation areas, threatened species and outbreaks of IAS	Aichi targets 11 and 12; SDGs 14 and 15 Aichi targets 1 and 19
	2. Develop and implement community awareness and understanding programmes on biodiversity	Fisheries department, NAPA 2, IIB, R2R projects Some teachers identified as biodiversity champions during the Training of Teachers (ToT) workshop on Biodiversity	Aichi targets 1 and 19
	3. Create biodiversity champions to lead and advocate the importance of biodiversity		SDGs 14 and 15
	4. Conduct youth capacity training programmes on formulation and implementation of biodiversity activities	Biodiversity awareness stressed on World Environment and Biodiversity Day each year Planned under R2R	
	5. Formulate community-based monitoring and reporting systems	In process under the R2R Project-	
	6. Establish a framework where islands would share experiences,		

	lessons, sustainable practices, skills and knowledge by 2012		
Objective 3: Review of existing by-laws and relevant national legislations impacting on biodiversity and align them so communities are effectively empowered to protect and conserve biodiversity	1. Establish an inventory of all by-laws relating to biodiversity throughout the nation 2. Determine which ones that could not be executed due to clashes with national laws and a review them accordingly 3. Facilitate amendment of national laws to allow for the effective enforcement of biodiversity by-laws 4. Explore practicality of formulating a consolidated national law for biodiversity and if determined most suitable, formulate a National Biodiversity Act	In process under the R2R project In process under the R2R project In process under the LMMA programme Not implemented	Aichi target 18l; SDG 16 Aichi target 18; SDG 16 Aichi target 18; SDG 16
Theme 5: Sustainable Use of Natural Resources			
Objective 1: Augment the management of existing conservation areas throughout the nation	1. Develop management plans for all existing conservation areas by 2012 2. Formulate and enforce relevant legislation to enhance the protection of conservation areas 3. Conduct baseline surveys to determine potential areas throughout Tuvalu where conservation areas and protected areas could be established	Not completed. In process under the NAPA II and R2R projects In process under the R2R project- for Locally Managed Marine Areas NAPA II and Fisheries Department community based consultation In process under the fisheries department and R2R programmed In progress	Aichi target 11; SDG 14 and 15 Aichi target 11 Aichi target 11

	4. Acquire the necessary equipment and funding to support the augmentation of the management of conservation areas.		
Objective 2: Increase the number of new conservation areas throughout the nation	1. Train more people in the management of conservation areas so that by the year 2013 all islands will have trained people	In process under the fisheries department, NAPA II and R2R project.	Aichi target 1, 11 and 19; SDGs 14 and 15
	2. Establish necessary benchmarks whereby conservation areas are used and managed sustainably (for instance to know when to open them up for consumption and eco-tourism)	Ongoing consultation by Fisheries Department with communities in establishing and maintaining LMMAs Fisheries Department, IIB, NAPA 2, R2R projects	Aichi target 11 Aichi target 11
	3. Establish protected areas throughout the nation to enhance biodiversity in Tuvalu	In process under fisheries department, NAPA II and R2R projects	Aichi target 1 and 19; SDG 16
	4. Empower Kaupule member/capacity on management plan	Completed under the fisheries department and NAPA II creel survey	
	5. Establish baseline data survey		
Objective 3: Create alternative livelihoods through the sustainable use of relevant biodiversity to provide sustainable livelihood and income to communities and families	1. Conduct an economic valuation of biodiversity	No action	
	2. Mainstreaming of biodiversity into the national policy framework and sector plans	Tuvalu Marketing Strategy Action Plan developed and published No action	Aichi target 4; SDG 12
	3. Conduct feasibility study on alternative livelihoods (aquaculture, eco-tourism, pearl farming, etc)	In process under the Environment Department – To consider to include environmental social	Aichi target 14; SDG16

	4. Review EIAs and enforce relevant legislation to ensure protection and conservation of biodiversity	safeguard elements in the EIA	
Theme 6: Trade, Biosecurity and Food security			
Objective 1: Foster and promote traditional agriculture and agro forestry	1. Establish and encourage organic home-gardening so that all households have some gardens by the year 2012	Completed through NAPA I project; also promoted by the Agricultural Department Established 9 nurseries for all island Kaupule and distributed garden fence, fork, watering can to every households EU-SPC GCCA:PSIS project and TNCW (Tuvalu National Council of Women) organized a competition for home garden to all islands	Aichi targets 1 and 7; SDGs 2 and 3 SDG 5 Aichi target 1
	2. Raise awareness and understanding on the importance of agro forestry and its contribution to biodiversity	Completed through GCCA PSIS project (2013—2015) as pilot projects in Nukufetau and Funafuti	Aichi target 1 and 19; SDGs 5 and 10 Aichi target 2
	3. Raise awareness and understanding on the value of organic farming as opposed to inorganic farming for example the use of chemical fertilizers and pesticides	Completed under Agriculture Department awareness program and GCCA PSIS project. Pamphlet produced in both English and Tuvaluan on how to make compost under the GCCA PSIS project	Aichi target 2; SDGs 2 and 11 SDGs 2, 3, 14, and 15
	4. Increase cultivation and preservation of traditional food crops	Local crops promoted as part of the NAPA 1 Home garden component and the Department of Agriculture programmes	
	5. Integrate biodiversity into trade related policies	GCCA:PSIS project developed the Tuvalu	

	6. Work with relevant agencies and organizations to assess marketable food crops and other local produce and establish an inter-island trading network 7. Formulate, strengthen and enforce a biosecurity policy and legislation for the whole of Tuvalu covering inter-island transport and with outside 8. Develop Plant Protection and Quarantine Bill	Marketing Strategy Action Plan Plans to have local farmers market their local crops along with vegetables from the Taiwan Food garden during a weekly market day Tuvalu Biosecurity Act still in draft. Planned action No action yet	
Objective 2: Foster and promote the production and consumption of local food	1. Contribute to the review national food policy and strengthen those elements fostering biodiversity 2. Work with relevant agencies and organizations to document and disseminate the nutritious value of all local food crop 3. Document traditional food preservation and cooking methods and practices that are significant to biodiversity conservation	Tuvalu National Food and Nutrition Policy Developed in 1996, although little systematic follow-up A Tuvalu Agriculture Strategic Marketing Plan 2016-2025 has been developed Radio programmes promoting local foods Go Local Campaign organized by GCCA PSIS project Talofa Trade Fair Not implemented Little action and contradicted by the current situation of increasing dependence on imported	Aichi target 2; SDG 2 Aichi target 19; SDG 2 SDG 16

	4. Establish a consumer protection and awareness and understanding programme that reduces the importation of non-nutritious and unhealthy food by 2012 5. Make it mandatory that all imported food items are clearly labeled showing ingredients, nutritious values & expiry dates in English and Tuvaluan	white flour, sugar, biscuit, oil, rice, which are imported tax free, a situation complicated by very high population densities, limited agricultural land, poor soil, limited freshwater and extremely high dependence on imported foods No action	
Objective 3: To increase awareness and understanding of the people on the linkage between food security and biodiversity	1. Work with the Ministry of Agriculture to examine status of food security in Tuvalu and contribute to the formulation of a National Food Security Policy that integrates biodiversity 2. Facilitate better coordination of key agencies with mandates impacting on biodiversity and food security 3. Conduct awareness and understanding activities at all levels of the society on the linkages between food security and biodiversity	Completed through Department of Agriculture programmed Completed – Agriculture Department, one of the key stakeholders of the Department of Environment, and the Environment Department jointly implemented the GCCA PSIS , reporting directly to the SPC Completed through radio programmes and community based consultations carried out by the Department of Agriculture, Environment during past and current project related to biodiversity (See 4.3.4)	Aichi target 4, and 7; SDG 2 Aichi target 4; SDG 2 SDG 17

	4. Formulate, strengthen and enforce a biosecurity policy and legislation		
Theme 7: Waste and Pollution Management			
Objective 1: To ensure the impacts of waste on biodiversity is minimized	1. Contribute to the review, of the "waste management plan' for Funafuti to ensure biodiversity impacts from waste are reflected	Documentary by Ursula Kayla "Funafuti Master Plan" highlighted the impact of human waste on the lagoon pollution and the need for a centralized sewage system and sealed septic tanks. Building code is still in draft to enforce having sealed septic tanks Falevatie Project promotes the use of composting toilets on Funafuti and outer islands	Aichi target 8; SDGs 6 and 11
	2. Work with relevant agencies to integrate biodiversity criteria to the review of existing waste management plans and the formulation of new ones for all islands	No action	Aichi target 8; SDG 6
	3. Work with relevant agencies to encourage use of organic waste for composting purposes and production of biogas	Completed - the SWAT sells compost to the public. Biogas is a current project under the Energy Dept funded by the GIZ Taiwan Technical Mission uses chipper to break down green waste collected by the Funafuti Kaupule into compost that is sold to farmers and households for fertilizer.	
Objective 2: Enhance capacity and understanding on impact of waste on biodiversity	1. Formulate green taxes policy by 2011	Planned action – to consider as part of revised NBSAP No action	
	2. Put in place a relevant legislation framework for green taxes by 2011	The SWAT is assessing the feasibility of a Waste Levy.	Aichi target 8; SDG 6

	3. Review importation and disposal mechanisms of goods that generate waste so to become more environment friendly by 2012	Completed- activities through radio programmes and during Environment Day	Aichi target 8; SDGs 3, 6, 14 and 15
	4. Conduct training and awareness activities on the impacts of waste on biodiversity	In part – Awareness through R2R component No action	Aichi target 8; SDG 6
	5. Conduct a survey and research on the impact of waste on biodiversity		
	6. Produce a policy paper to inform cabinet and other relevant agencies on the findings from the survey etc.		
Theme 8: Management of Invasive Species			
Objective 1: Establish management plans to control and eradicate invasive species	1. Conduct surveys to identify invasive species and the extent of damage to biodiversity and economy of Tuvalu overall	Yellow crazy ant (YCA) outbreak in Nukulaelae, Funafuti, and Nui. Complaints received from islands but no actions been taken so far except for a study of locations. Nukulaelae communities report mortality of coconut and land crabs due to Study carried out by PACE-USP of the sargassum outbreak on Funafuti lagoon and the feasibility of using sargassum residue for fertilizer. Communities on Funafuti and civil servants are conducted clean up sargassum	Aichi target 9 SDG Aichi target 9
	2. Develop, Review, strengthen and enforce legislation to better	Kou leaf worn outbreak in Nanumea. Recently, there is an outbreak on Funafala islet in Funafuti. No action done	

	manage and control invasive species 3. Develop and implement invasive species management plan(s)	so far from the Agriculture Department No action Tuvalu Invasive Species Committee to be coordinated by DOE established in 2015 at a workshop facilitated by SPREP	
Objective 2: Upgrade capacity, equipment and infrastructure to enforce biosecurity at all points of entry including inter island transportation	1. Training at least 2 to 4 personnel to effectively manage and execute the basic biosecurity routines 2. Acquire the necessary machines at the earliest preferably by the end of 2010 (through the preparation of a proper project proposal) 3. Review and upgrade existing legislation to manage and control the introduction of foreign, alien and invasive species 4. Develop awareness programmes and disseminate information to enhance understanding of the people on biosecurity	GCCA project supported one officer to go for biosecurity attachment in Fiji. Biosecurity understaffed and no control of terrestrial IAS Not completed Planned activities Planned activities Ongoing activities for the Department of Agriculture	Aichi target 9 and 19 Aichi target 9 Aichi target 9 and 19