TUVALU R2R BIORAP

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Table of Contents

ABBREVIATIONS

AON – Adults only nesting

BioRAP – Biodiversity Rapid Assessment Program

CITES – Convention on the Trade of Endangered Species

EEZ – Exclusive Economic Zone

FMCA – Funafuti Marine Conservation Area

GEF – Global Environment Fund

IUCN – International Union of the Conservation of Nature

LMMA – Locally Managed Marine Areas

R2R – Ridge-to-Reef

UVC – Underwater Visual Census

EXECUTIVE SUMMARY

In 2021, the Tuvalu R2R Project partners undertook a Biodiversity Rapid Assessment (BioRAP) on selected islands/atolls in the Tuvalu archipelago (Funafuti, Nukulaelae, Niutao and Vaitupu). Biodiversity surveys conducted at these four locations, involved baseline field ecological surveys of plants, vegetation, avifauna, and marine habitats, in addition to collection of information on other terrestrial species such as reptiles.

The Funafuti Atoll survey was carried out from the 12th to the 16th of April 2021. The islets within the atoll that were surveyed included Fongafale, Fuafatu, Fualopa, Funafala, Telelee, Tepuka and Tefualiki. In summary, 201 plant species were recorded, and four vegetation systems were sampled over 12 gentry transects in the flora and vegetation survey. A total of 21 terrestrial vertebrate fauna species (four land birds, seven seabirds, five shorebirds, four reptiles and one mammal) were recorded. There were 60 marine taxa recorded in the Funafuti UVCs, more than were recorded for the other three islands/atolls surveyed. The only records for species within the Pomacentridae, Acanthuridae and Chaetodontidae, as well as the only recorded shark, occur within the FMCA. Coral bleaching within the FMCA was relatively low and coral species diversity was proportionately greater for Funafuti Atoll.

The BioRAP survey of Nukulaelae Atoll took place between the 21st and the 25th of April 2021. The surveys were carried out on the islets of Fenualago, Fenua, Fakai, and Fagauna. In summary, 165 plant species were recorded within 11 gentry transects, covering four vegetation systems. Fifteen terrestrial vertebrate fauna species (two land birds, six seabirds, three shorebirds, three reptiles and one mammal) were recorded. A total of 52 marine taxa were recorded from the six transects surveyed on Nukulalaelae. There were more species of Mullidae, Balistidae, and holothurians recorded on Nukulaelae in comparison to the other three atolls/islands. The proportion of bleached coral at the Nukulalaelae marine sites was relatively low, ranging from one to 15% of the area surveyed.

The Niutao Island BioRAP survey was conducted from the 27th to the 30th of April 2021. In summary, 158 plant species were recorded within 12 gentry transects, covering four different vegetation systems. A total of 14 terrestrial vertebrate fauna species (two land birds, five seabirds, three shorebirds, three reptiles and one mammal) were recorded. Marine diversity was concentrated in only a few fish families. Of the 38 marine taxa recorded from the UVCs conducted on Niutao, the Acanthuridae and Balistidae occurred in relatively higher densities than on the other three islands. The lack of benthic invertebrates was notable with only one taxa. Coral bleaching was more widespread on Niutao, with bleached coral making up an average of 31% of the surveyed coastal substrate. The level of bleaching was relatively greater on the leeward reef compared to the windward reef.

The BioRAP of Vaitupu Island was carried out from the 3rd to the 7th of May 2021. Like Niutao Island, all the survey sites were on the main Island of Vaitupu. In summary, 235 plant species were recorded within 14 gentry transects, covering three vegetation systems. A total of 16 terrestrial vertebrate fauna species (seven seabirds, three shore birds, three reptiles, two land birds and one mammal) were recorded. Marine species richness was lowest on Vaitupu Atoll, with only 27 taxa recorded. However, the only record of a cephalopod (octopus) was made on Vaitupu, and along with

Nukulaelae, Vaitupu was the only other surveyed location where sea cucumbers occurred. There was evidence of past coral bleaching followed by recent recovery of some hard corals. The high nutrient input inferred from the presence of macroalgae and sponge species, and from the visible turbidity of the water, are probable reasons for the lack of diversity in the inner lagoon.

The inhabited islands show a greater dominance of introduced plants and disturbed habitats as compared to the uninhabited islands. The presence of introduced invasive species needs to be monitored and controlled in existing protected areas like the FMCA. A management plan/tool of how to monitor and control the spread of invasive species needs to be developed and adopted. It is recommended that the less-disturbed remnant natural vegetation systems like 'Inland broadleaf woodland', 'Littoral forest and scrub' and 'Mangrove and wetland' systems on each island be placed under some form of conservation management in order to preserve the ecological functions and ecosystem services provided by these vegetation systems.

In the marine environment, populations of globally threatened species such as the Hawksbill turtle, Bumphead parrotfish, Humphead wrasse, Baramundi cod, and Herman sea cucumber, are flagged for systematic long term monitoring. Particularly as both species occur in small populations recorded at only one island/atoll site. The occurrence of species such as the Black-tipped reef shark and the Chevroned butterly, which are considered 'Near Threatened' according to current IUCN Red List assessment, are also of note. Population management within the current marine protected area network in the Tuvalu archipelago would contribute to conservation efforts for the aforementioned marine species as well as for globally declining populations of the Threadfin, Bluespot and Redfin butterflyfish.

The results presented in this report, document the current state of the biodiversity on the four islands surveyed. The data presented should be treated as baseline information for successive surveys. A long-term monitoring program should ideally be developed to monitor the biodiversity in the existing protected areas. It is through long-term monitoring that a more thorough understanding of the existing biodiversity and natural heritage may respond to habitat modification, climate change and species introductions in the future.

BACKGROUND

Ridge-to-Reef Programme

The "R2R- Pacific Islands Ridge-to-Reef National Priorities – Integrated Water, Land, Forest and Coastal Management to Preserve Biodiversity, Ecosystem Services, Store Carbon, Improve Climate Resilience and Sustain Livelihoods" initiated by GEF in the last decade to provide an opportunity for Small Island Developing States (SIDS) in the Pacific, seeks to ensure the sustainable development of island economies and communities in the region. For Tuvalu, a sub-component of the larger Pacific R2R programme was initiated in 2015, the "Implementing 'Ridge to Reef' approach to protect biodiversity and ecosystem functions in Tuvalu (Tuvalu R2R Project)" which has the main aim "to preserve ecosystem services, sustain livelihoods and improve resilience in Tuvalu using a 'ridge-to-reef' approach".

The Tuvalu R2R programme has four components: "enhancing and strengthening conservation and protected areas (Component 1); rehabilitating degraded coastal and inland forests and landscapes and supporting the delivery of integrated water resource management (IWRM) and integrated coastal management (ICM) at a national scale whilst piloting hands-on approaches at the island scale (on three selected pilot islands) (Component 2); enhancing governance and institutional capacities at the national, island, and community levels for enhanced inland and coastal natural resource management (Component 3); and improving data and information systems that would enable improve evidence-based planning, decision-making, and management of natural resources in Tuvalu (Component 4)".

"There are multiple outcomes of this programme with the most relevant to a BioRAP survey, being the establishment of formal community management systems of conservation sites across the archipelago, each with functional management plans, sustainable land management and agroforestry interventions; and enhanced awareness and capacity building on the Ridge to Reef approach."

Country Profile

Tuvalu lies in the central Pacific between the latitudes 5° and 10.5° S, and the longitudes 176 and 179.5° E (Figure 1). The nation comprises of nine small low islands, six of which are coral reef atolls and three low raised limestone or reef table islands (Rodgers 1991). The combine total combine area of the nine islands is around 275 km² but the total land mass is only about 1% of the total area (26 km²). In contrast, the total EEZ of Tuvalu covers an area of over 1,000,000 km² (Thaman *et al.* 2012, Hemstock and Manuela-Morris 2012). The archipelago is made up of 129 atoll motus and reef islands, of which only 6% have land areas of over 100 ha, and around 67% have land areas of below 5 ha (McLean and Hosking 1991).

Geologically, the islands of Tuvalu are young having been formed an estimated 3000 years ago (McLean and Hosking 1991). The islands are made up of coralline sand and gravel that have accumulated over time from the lagoons and surrounding reef systems. The islands of Tuvalu are often characterized as low-lying, and a depauperate terrestrial biota due to the nutrient-deficient soils (McLean and Hosking 1991).

Tuvalu has a tropical maritime climate, generally influenced by the South-East Tradewinds belt. The climate is hot with relative high humidity, with average daily temperature range of 25°C (minimum) to 31°C (maximum) and annual rainfall from 2500mm to 3500mm (Rodgers 1991; Thaman *et al.* 2012). The wettest season lies between December and March (Rodgers 1991).

The island group is thought to have been settled about 2000 years by Polynesians (Thaman *et al.* 2012). The estimated population of Tuvalu is around 11000, with a population density of 425 people per km² (Thaman *et al.* 2012, Hemstock and Manuela-Morris 2012). Well over 50% of the population of Tuvalu resides on Fongafale in Funafuti Atoll, which is the main administrative center for Tuvalu (Tuvalu 2017).

Tuvalu's main food source is the ocean and subsistence farming. However, farming has recently been affected by climate change and seawater encroachment (Hemstock and Manuela-Morris 2012). The impact of the environmental change is visible in remnant coastal habitats and the inherent biodiversity (Thaman *et al.* 2012).

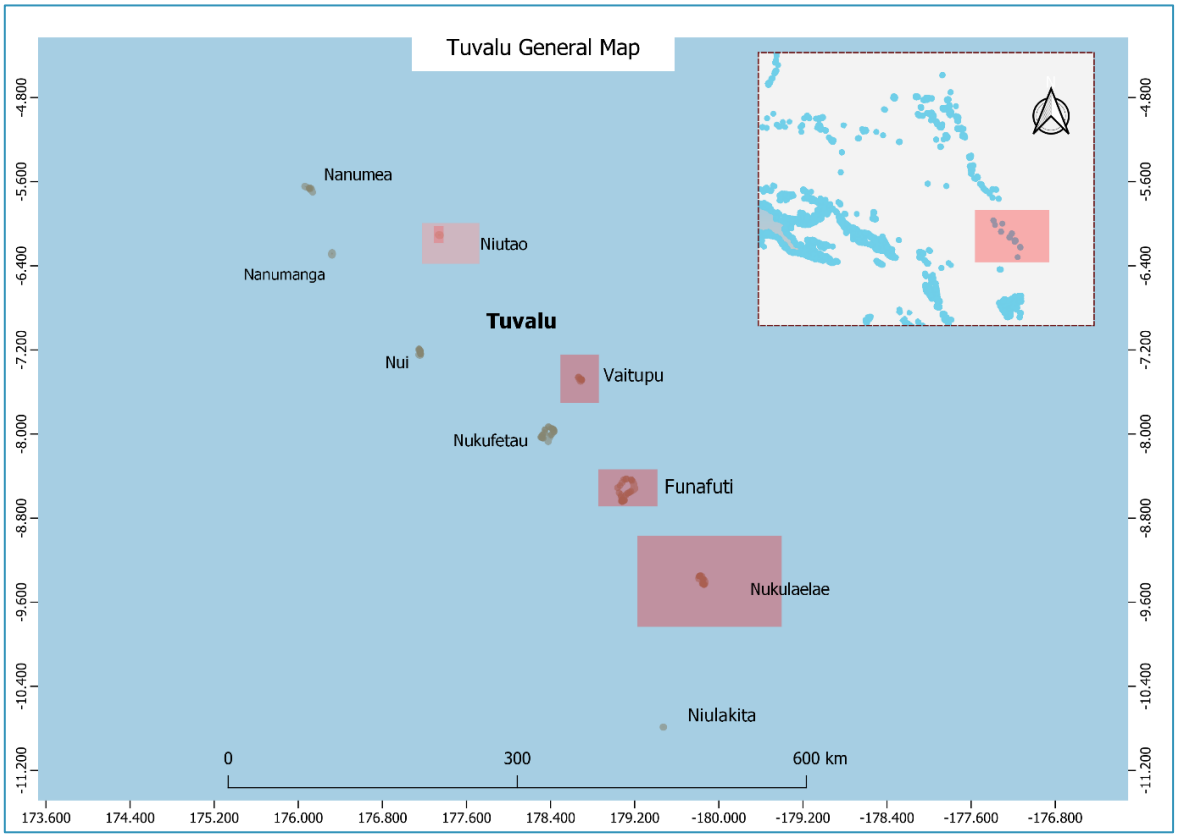


Figure 1. *Map of the Tuvaluan archipelago; inset map indicates general location within the central western Pacific. The highlighted islands are the four islands selected for the R2R BioRAP survey herein documented.*

The Biodiversity of Tuvalu

The terrestrial biodiversity, in terms of flora and fauna of Tuvalu, is relatively less diverse when compared to the rich marine biota found within the national maritime boundaries. The terrestrial vertebrate fauna is mostly made up of birds, rats, and lizards (Rodgers 1991), and the flora is dominated by introduced species (Thaman *et al.* 2012).

Flora and Vegetation

A compilation of the vegetation types and list of plants recorded from Tuvalu has been documented by Woodroffe (1991), Thaman *et al.* (2012) and Thaman (2016). The list of terrestrial plants for Tuvalu stands at 356 species, of which 18% are indigenous and 82% are plants species that have been introduced by humans in the past. There are no endemic plant species recorded for Tuvalu and all the recorded indigenous species are common, widespread species across the Pacific. The recent past flora and vegetation surveys have been mostly focused on Funafuti Atoll (Thaman *et al.* 2012, 2016), Vaitupu and Nui Island (Woodroffe 1991) and it is possible that most of the other islands in Tuvalu have not been properly covered for botanical and vegetation studies.

Woodroffe (1991) recognizes three major indigenous vegetation types for Tuvalu which are 'Coconut Woodland', 'Scrub – Coastal and Inland', and 'Inland Broadleaf Woodland'. Woodroffe also mentions another vegetation type which is a combination of 'Human modified and disturbed vegetation'. In addition to the major vegetation types, Woodroffe further stratified them into 'Vegetation Units' and based on work that was carried out on the islands of Nui and Vaitupu, 49 vegetation units were recognised and described.

Thaman *et al.* (2012) recognises eight major vegetations on Funafuti atoll, which are classified from the most natural to most highly disturbed vegetation:

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. Disturbed Ruderal Vegetation

Terrestrial Vertebrate Fauna

Birds

The birds of Tuvalu were previously documented in surveys by Rodgers and Cantrell (1987), and Watling (1998, 2001). From these surveys, 42 species of birds were recorded for Tuvalu, of which 14 are breeding species and the rest are visitors who breed outside Tuvalu. The seabirds are the most diverse comprising 52%, shorebirds make up 29% and the land birds are the least diverse making up the remaining 19% of the documented bird species. Like the flora, there are no endemic bird species in Tuvalu.

Funafuti Atoll is likely the only location in the Tuvalu Group where a detailed bird study was conducted and 26 species of birds were recorded (Watling 1998).

Lizards

Lizards or reptiles are an important group for Tuvalu because it contains Tuvalu's only endemic vertebrate fauna species. Watling (1998) recorded seven species of reptiles from within the islets in the Funafuti Marine Conservation Area (FMCA) including four skinks and three gecko species. The Tuvalu endemic reptile is a gecko (*Lepitodactylus tepukavili*) which was only recorded from Tepuka and Fuagea Island located within the FMCA (Zug *et al.* 2003, Watling 1998).

Rats

Rats are introduced mammal species regarded as pests. Pacific rat and the Black/Ship rat are two species that would be expected to be present in Tuvalu. House mice and the Norwegian rat, if they are present in Tuvalu, would be associated with disturbed areas and human residential places.

Marine Biodiversity

Unlike the terrestrial biota, the marine biota of Tuvalu is rich and highly diverse. Previous surveys have produced international scientific publications and technical reports. A recent review by Job and Ceccarelli (2012) provided a good summary of the status of the marine biodiversity of Tuvalu. To date, 1453 marine species have been identified and documented, including 532 fish species belonging to 72 families, 411 macro-invertebrate species, 379 species of Cnidarians, 59 species of marine algae, 21 species of marine mammals and four species of marine sponges (*Ibid*.).

In total, 442 marine species are listed on the IUCN Red List, of which 79 species are vulnerable and four species are classified as endangered. In addition, 90 marine species are now listed on the CITES list, with 88 species listed on Appendix II and two on Appendix I (Job and Ceccarelli 2012). Marine reserves and LMMAs have now been set up on almost all of the nine islands of Tuvalu with the main purpose of conservation of marine biodiversity as well as for long-term sustainable management. The largest of these reserves is the FMCA, which protects about 33 km² of coastal inshore area of the Funafuti Atoll.

The BioRAP Strategy

Tuvalu R2R Project partners undertook a Biodiversity Rapid Assessment (BioRAP) on selected islands/atolls in the Tuvalu archipelago. The biodiversity surveys conducted at these four locations, involved baseline field ecological surveys of plants, vegetation, avifauna, and marine habitats, in addition to collection of information on other terrestrial species such as reptiles.

The four islands/atolls selected for the Tuvalu R2R BioRAP surveys: Funafuti, Nukulaelae, Niutao and Vaitupu. Three of these islands are classified as reef atoll islands (Funafuti, Nukulaelae and Vaitupu) and the fourth is classified as a raised table reef island (Niutao). Vaitupu is sometimes also classified as being a mixture of a reef atoll and a table island (McLean and Hosking 1991).

The aim of this project was to carry out a BioRAP and assess the status of the ecosystems of the four islands mentioned above. To achieve this, the following objectives were set out:

i. To compile Inventories of flora and fauna, indicating the status and distribution.
ii. To assess the status of habitats/ecosystems present.
iii. To make recommendations that national and local stakeholders could use to strengthen existing conservation and management of biodiversity on the four islands.
iv. To discuss any lessons learnt and make recommendations for national biodiversity surveys and local capacity building within the Pacific R2R program.

The BioRAP surveys on the four islands/atolls were conducted over the months of April and May 2021, and involved local stakeholders and biodiversity experts. The methodology applied in these surveys are based on the Tuvalu R2R BioRAP Field Guide (Naikatini 2021). The following chapters detail the results of the BioRAP surveys for the conservation of native biodiversity and sustainable management of Tuvalu's natural resources.

Funafuti Atoll

Funafuti Atoll: Summary

The Funafuti Atoll was the first of the four selected islands for the Tuvalu R2R Project to be surveyed. The survey was carried out from the 12th to the 16th of April 2021. The islets within the atoll that were surveyed included Fongafale, Fuafatu, Fualopa, Funafala, Telelee, Tepuka and Tefualiki. In total, 201 plant species were recorded during the terrestrial vegetation survey. Four vegetation systems were sampled over 12 gentry transects (Figure 2). A total of 21 terrestrial vertebrate fauna species (four land birds, seven seabirds, five shorebirds, four reptiles and one mammal) were recorded during the BioRAP. In total, there were 60 taxa recorded in the Funafuti UVCs, more than were recorded for the other three islands/atolls surveyed. The only records for species within the Pomacentridae, Acanthuridae and Chaetodontidae, as well as the only recorded shark, occur within the FMCA. Coral bleaching was low and coral species diversity was notably higher for Funafuti than the other three surveyed islands/atolls.

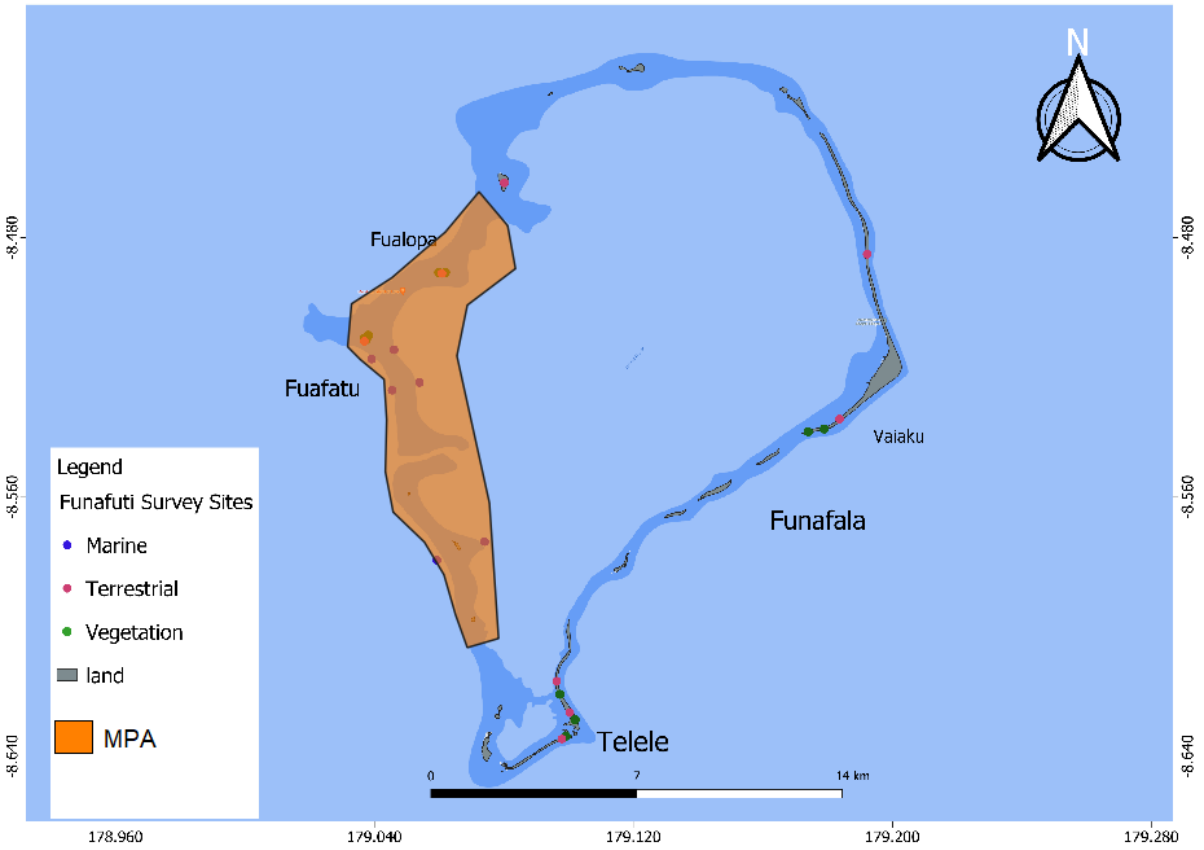


Figure 2. *Funatuti Atoll – existing protected areas, terrestrial and marine sample sites.*

FUNAFUTI TERRESTRIAL FLORA

A total of 201 species of plants were recorded during the survey: 7 ferns, 2 gymnosperms, 66 monocotyledons and 126 dicotyledons (Figure 3). The extant flora of Funafuti is dominated by introduced species (73%) with the remaining 27% made up of indigenous species. A checklist of the plant species recorded from the survey sites is summarised in Appendix 1.2. The plant species from the different vegetation types surveyed were also recorded (Appendix 1.2, Figure 4). The 'Disturbed-human modified vegetation' was the most diverse recording 157 species, followed by 'Littoral

forest and scrub vegetation' (68 species), 'Coconut woodland vegetation' (39 species) and 'Inland broadleaf woodland vegetation' (34 species). The 'Mangrove-wetland vegetation' recorded the least number of species (16 species). Although the 'Disturbed-human modified vegetation' is the most diverse, many of these species are introduced or alien species. This trend, observed in other vegetation types, is absent for 'Inland broadleaf forest', a vegetation system that is notably dominated by native species. Species distributions for each vegetation type are detailed in Appendix 1.2.

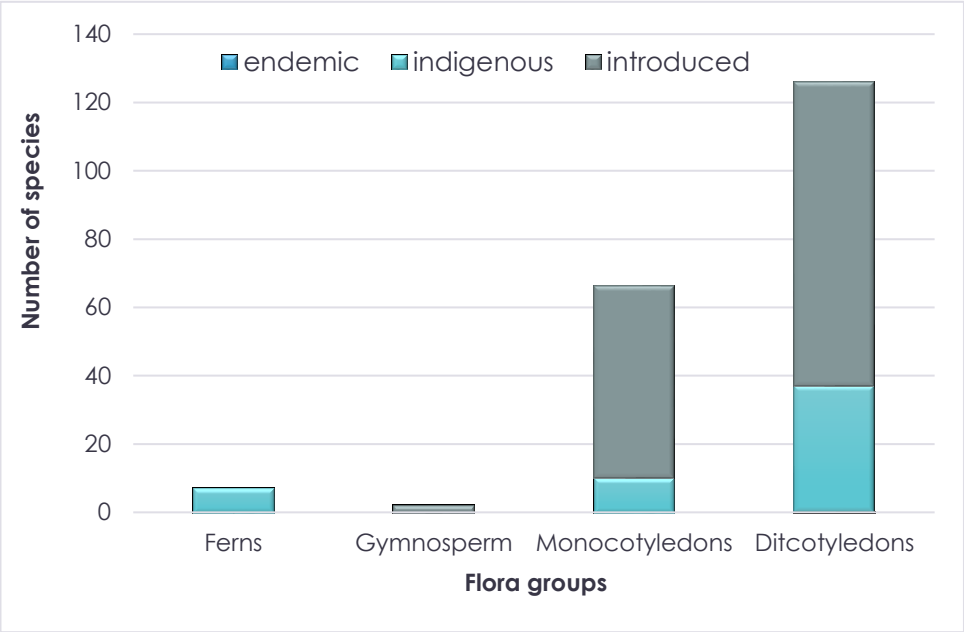


Figure 3. *Summary of the floral diversity of Funafuti Atoll.*

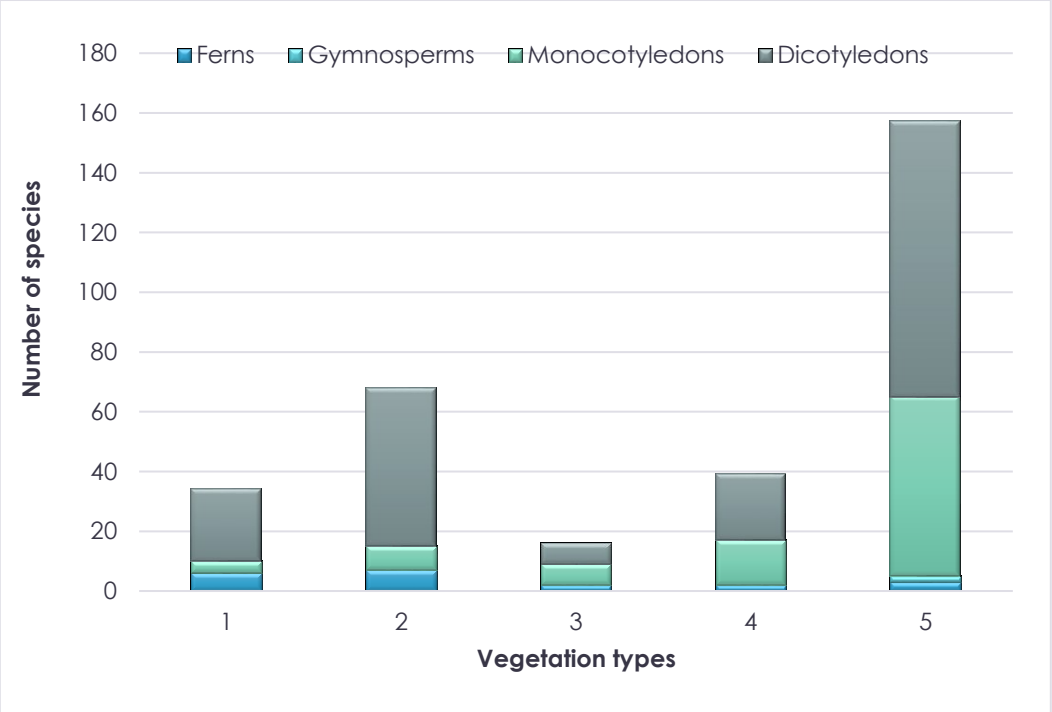


Figure 4. *Plant species diversity recorded in each vegetation type on Funafuti. Vegetation type codes: 1 – Inland broadleaf woodland, 2 – Littoral forest and scrub, 3 – Mangrove and wetland, 4 – Coconut woodland and agroforest, 5 – Disturbed human modified vegetation.*

FUNAFUTI VEGETATION

In all, 12 Gentry transects were surveyed in the Funafuti atoll during the BioRAP (Table 1, Appendix 1.3). Five islets were surveyed, namely Fongafale, Fuafatu, Fualopa, Telelee and Funafala. Out of the five main vegetation types identified for Tuvalu, the four surveyed at these sites were Broadleaf-woodland forest, Littoral scrub and forest, Mangrove wetland forest, Coconut woodland and agro-forest and Disturbed-human modified habitat. The Broadleaf-woodland forest was the most commonly encountered habitat with six transects, followed by Littoral forest (four transects), and Coconut woodland and Human modified forest with one transect each.

Table 1. Details of Gentry Transects Surveyed On Funafuti Atoll.

Transect #	Site	Vegetation code	Species Diversity	No. of trees	Basal Area (m^2)	Volume (m^3)
1	Fongafale	1	7	37	1.64	3.18
2	Fongafale	4	8	20	0.37	0.47
3	Fongafale	2	5	20	1.44	5.69
4	Fongafale	2	5	19	0.58	0.94
5	Fuafatu	1	4	16	1.14	4.2
6	Fuafatu	1	4	17	1.71	8.81
7	Fuafatu	1	2	18	0.93	3.46
8	Fualopa	1	4	19	0.7	3.11
9	Fualopa	1	5	26	1.43	6.5
10	Funafala	2	3	13	0.47	1.4
11	Funafala	5	3	5	0.74	1.47
12	Telelee	2	4	17	1.84	6.03

Note: Each transect covers an area of 100 m^2 (50 x 2 m). Vegetation types: 1 – Inland broadleaf woodland, 2 – Littoral forest and scrub, 3 – Mangrove and wetland, 4 – Coconut woodland and agroforest, 5 – Disturbed human modified vegetation.

Fongafale Island is probably the most disturbed and modified islands on Funafuti and Tuvalu, being the main economic center for the atoll and the country, and the highest population density for the country. The high disturbance level makes 'Human modified-disturbed vegetation' the dominant vegetation cover for Fongafale (100%), even though remnants or pockets of the other vegetation types are still present but in a more disturbed state.

Funafala is dominated by Coconut woodland (62% cover) and Disturbed-human modified vegetation (23% cover), as it is also an inhabited island like Fongafale (Figure 5). The 'Littoral forest and scrub' made up the remaining 15% cover of Funafala islet (Figure 6). Telelee Islet is dominated by 'Coconut woodland and agroforest' (40% cover) and 'Littoral forest and scrub' (39%). The 'Broafleaf woodland' makes up 19% land cover and the remaining 2% is classed as 'Disturbed and human modified' system.

The two islands located in the FMCA, Fuafatu and Fualopa, show intact systems with little signs of disturbance or human modification like the other three islets surveyed for Funafuti. In Fualopa islet, 'Inland broadleaf woodland' was the dominant vegetation making up 56% of the land cover and the other 44% cover consisted of the 'Littora forest and scrub'. This was also similar for Fualopa with 'Inland broadleaf woodland'

making up 75% of the vegetation cover and the remmaing 25% was by the 'Littoral forest and scrub' (Figure 5).

In summary, from the five islets surveyd, over 90% of the vegetation cover of Funafuti Atoll is disturbed made up of 'Disturbed+human modified' and 'Coconut woodland+agroforest'. The remaining vegetation cover is made up of 'Broafleaf woodland', 'Littoral forest and scrub' and 'Mangrove+wetland' vegetation types.

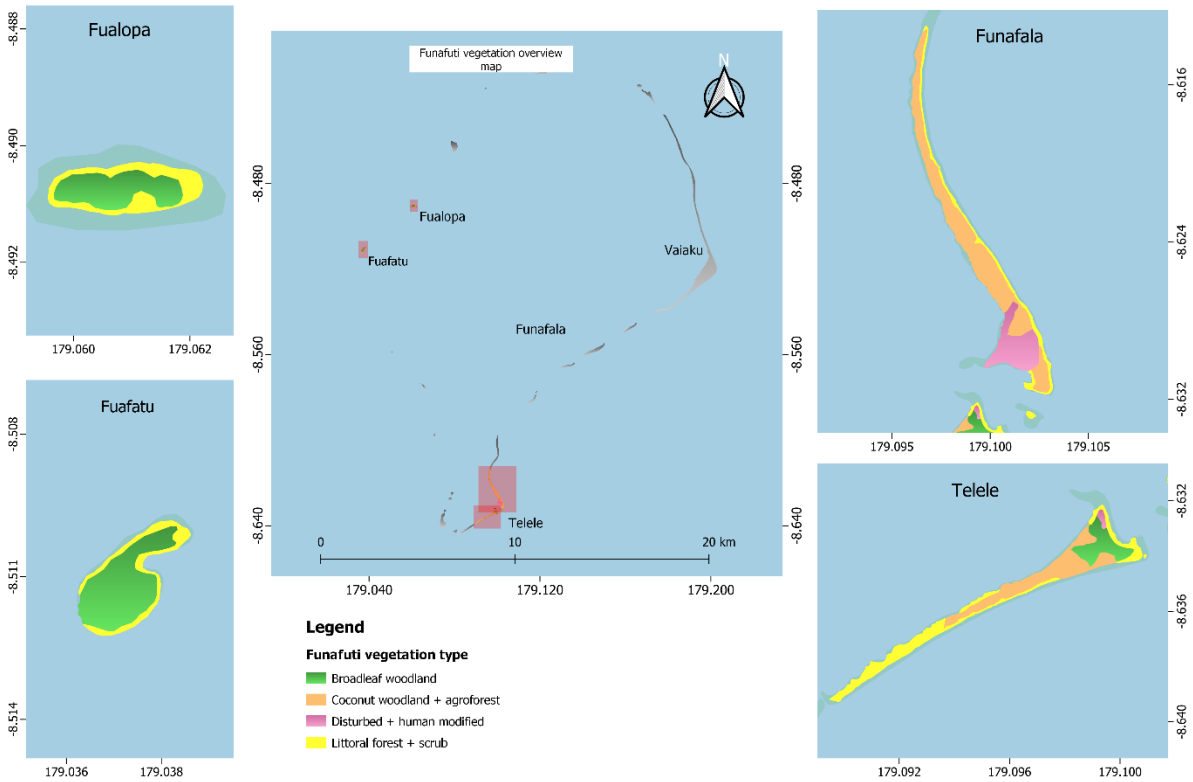


***Figure 5**. Vegetation types on the four islets: Fualopa, Fuafatu, Telele and Funafala.*

Inland broadleaf woodland forest

This was the most sampled vegetation type during the survey as it is being regarded as one of the more pristine vegetation systems of Tuvalu. This vegetation system is still dominant on the island of Fuafatu and Fualopa. The species diversity in a 100 m², area ranged from two to seven tree species with 18 to 37 trees. In a disturbed system, 'Niu' was the common species and 'Fala' was dominant in terms of basal area and volume content (Appendix 1.3). In pristine locations, 'Pukavai' was the most common species and the dominant species in terms of basal area and volume.

Littoral forest and scrub

A total of four transects in this vegetation system was sampled. The species diversity in a 100 m² area ranged from three to five tree species with 13 to 20 trees. The survey mainly targeted forested systems dominated by trees whereas littoral scrubs dominated by shrubs where not sampled. The common tree species recorded in this

system included 'Niu' and 'Fala' and the more dominant species in in both basal area and volume were 'Niu', 'Fala' and 'Pukavaka' (Appendix 1.3).

Figure 6. *Vegetation team measuring tree diameters in a Littoral forest system.*

Coconut woodland and agroforest

Only one transect was sampled for this vegetation type. In a 100 m² area, the species diversity was eight tree species, and 20 trees were recorded. The common species were 'Niu' and 'Pua' and the dominant trees in terms of basal area and volume were 'Pua', 'Fala' and 'Niu' (Appendix 1.3). This system is now probably the most common or even the dominant vegetation type in the Funafuti atoll. One transect is a small sample and more transects will need to be surveyed to have a better understanding of this system.

Disturbed and human modified

Like the Coconut-woodland and agroforestry vegetation type, only one transect was sampled for this vegetation type. In a 100 m² area, only three trees species were recorded with only five trees. Fala' and 'Niu' were the common species however 'Fala' was the dominant species in terms of basal area and volume (Appendix 1.3). However, further surveys are necessary to present a clearer and realistic picture of this vegetation type.

FUNAFUTI TERRESTRIAL FAUNA

During the survey, 21 vertebrate fauna species were recorded (Table 2). The seabirds were the most diverse comprising 33% of the total species. The shorebirds made up 24%, the land birds 19%, the reptiles 19% and the land mammals, which was the least diverse, only made up 5% of the total species.

Table 2. Terrestrial Vertebrate Fauna Species Recorded on Funafuti Atoll.

Tuvalu Name	Common Name	Scientific Name	Family
Land birds			
Kaleva	Long tailed cuckoo	*Eudynamis taitensis*	Cuculidae
Lupe	Pacific pigeon	*Ducula pacifica*	Columbidae
Moa	Domestic fowl	*Gallus gallus*	Phasianidae
Moa saveu	Red junglefowl	*Gallus gallus*	Phasianidae
Taki	Muscovy Duck	*Cairina moschata*	Anatidae
Seabirds			
Gogo	Brown noddy	*Anous stolidus*	Sternidae
Lakia	Black noddy	*Anous minutus*	Sternidae
Akiaki	White tern	*Gygis alba*	Sternidae
Talaliki	Sooty tern	*Sterna fuscata*	Sternidae
Katafa	Frigatebird	*Fregata minor/ariel*	Fregatidae
Matapula	Black napped tern	*Sterna sumatrana*	Sternidae
Kanapu	Masked booby	*Sula dactylatra*	Sulidae
Shorebirds			
Tuli	Pacific golden plover	*Pluvialis dominica*	Charadidae
Kolili	Ruddy Turnstone	*Arenaria interpres*	Charadiae
Kilikilitai	Wandering Tattler	*Heteroscelus incanus*	Scolopaidae
Matuku	Pacific reef heron	*Egretta sacra*	Ardeida
Grey tail	Grey-tailed Tattler	*Heteroscelus brevipes*	Scolopaidae
Reptiles			
	White-bellied Copper-striped Skink	*Emoia cyanura*	Scincidae
	Dark-bellied Copper-striped Skink	*Emoia impar*	Scincidae
	Pygmy Snake-eyed Skink	*Cryptoblepharus eximius*	Scincidae
	Pacific Moth Skink	*Lipinia noctua*	Scincidae
Mammals			
	Black/Ship Rat	*Rattus rattus*	Muridae

Funafuti Land Birds

The land bird diversity for Tuvalu is low when compared to other islands in the South Pacific region. During the survey, a total of four land bird species were recorded (Table 2). Two of the species are introduced ('Moa' and 'Taki') one is an annual visitor ('Kaleva') and one indigenous ('Lupe') species. During the survey, the team surveyed 10-point count stations to capture quantitative data of the 'Lupe' population in Funafuti. The 'Lupe' density for island surveyed in the Funafuti Atoll was calculated to be 37 birds/ha for the less disturbed sites and 36 birds/ha for the more disturbed sites (Appendix 1.4).

Funafuti Seabirds

Seabirds were the most diverse vertebrate terrestrial fauna recorded during the survey. Of the seven species recorded in Funafuti Atoll, five were observed nesting in distinctive colonies. There were five 50 x 2 m transects surveyed in the five seabird nesting colonies (one transect/nesting colony).There were at least three nesting

seabird species in four of the nesting colony islands except for one island, Tefualiki, where only one nesting species was recorded (Table 3). The Fualopa and Fuafatu seabird colonies were dominated by nesting 'Lakia' (Black Noddy) with density counts of 13 and nine nesting adults per 100 m² area respectively (Table 3). The Telele and Tepuka seabird colonies on the other hand were dominated by 'Gogo' (Brown Noddy) with density counts of 15 and 12 nesting adults per 100m² area, respectively. The Tefualiki seabird colony was dominated by a single species, 'Talakiki '(Sooty Tern) with densities of 2 nesting adults and 28 juveniles per 100 m² area (Table 3; Figure 7).

Table 3. Density of Nesting Seabirds in Seabird Colonies on Funafuti Atoll.

Species	Density (#/100 m²)	Projected density (#/ha)
Fualopa colony		
Lakia	13	1300
Gogo	3	300
Akiaki	4	400
Fuafatu colony		
Lakia	9	900
Matapula	5	500
Gogo	3	300
Tefualiki colony		
Talakiki	2	200
Juvenile Talakiki	28	2800
Telele colony		
Lakia	8	800
Gogo	15	1500
Akiaki	4	400
Tepuka colony		
Lakia	5	500
Gogo	12	1200
Akikai	4	400

Table 4. Point Count Surveys of the Number of Seabirds per Seabird Colony.

Colony	Species							Total
	Gogo	**Lakia**	**Akiaki**	**Talaliki**	**Katafa**	**Matapula**	**Kanapu**	
Fualopa 1	48	228	85	0	0	0	0	361
Fualopa 2	25	29	20	0	0	0	0	74
Teafualiki	0	0	0	280	0	0	0	280
Fuafatu 1	0	10	29	0	1	0	0	40
Fuafatu 2	38	46	10	0	3	4	0	101
Fuafatu 3	32	10	8	0	2	45	2	99
Tepuka 1	40	35	18	0	0	0	0	93
Tepuka 2	45	30	18	0	0	0	0	93
Telele	50	38	29	0	2	0	0	119

Figure 7. *Talakiki, Sooty Tern (Sterna fuscata) recorded from Tefualiki Islet, FMCA, Funafuti. A – adult Sooty Tern, B – Juvenile Sooty Tern and C – Sooty Tern egg. This was the only seabird species recorded on Tefualiki Islet, in the FMCA.*

In addition to the adult nesting counts, point counts were also carried out for all the seabird colonies that were observed during the survey. A total of nine seabird colonies were surveyed (Table 4). The 'Gogo' (Brown Noddy) and 'Lakia' (Black Noddy) were the dominant species in six of the colonies. The 'Talaliki' (Sooty Tern) was the only species recorded in the Tefualiki colony and recorded the highest count during the survey with 280 birds. The 'Akiaki' (White Tern) was the dominant seabird species for Fuafatu 1 colony. 'Matapula' (Black Naped Tern) was dominant seabird species for the Fuafatu 3 colony. The diversity of seabird species ranged from one (Tefualiki) to six (Fuafatu 3) per seabird colony and the number of birds ranged from 40 (Fuafatu 1) to 280 (Tefualiki) per seabird colony.

Funafuti Shorebirds

Shorebirds are essentially migratory species that come down to the South Hemisphere between October and March annually, escaping the winter conditions. They return to the Northern Hemisphere to their feeding grounds between April to September. When the survey was carried out, most of these migratory species would have returned to the North. However, to collate baseline data, the team conducted a count of shorebirds on Funafuti during the BioRAP.

Table 5. Shorebirds Abundances at Ten Sites in the Funafuti Atoll Survey.

Site	Species					Total
	Tuli	**Kolili**	**Kilikilitai**	**Matuku**	**Grey tail**	
Fualopa East Beach	4	7	1	0	0	12
Fualopa West Beach	1	3	0	1	0	5
Fuafatu NE Beach	3	8	0	2	0	13
Tepuka East Beach	1	2	0	0	0	3
Tepuka East Beach	0	1	0	1	0	2
Telele North Beach	7	8	0	3	2	20
Funafala West Beach	3	4	0	1	0	8
Funafala NE Rocks	2	4	0	0	0	6
Fongafale SE Rocks	3	0	0	4	1	8
Fongafale West Beach	2	0	0	1	0	3

The shorebird populations at ten independent observation sites on Funafuti were surveyed (Table 5) and five shorebird species were recorded. The number of species per site ranged from two (Fongafale West Beach) to four (Telele North Beach) species and the number of birds ranged from three (Fongafale West Beach) to 20 (Telele North Beach). The Kolili (Ruddy Turnstone) was the most dominant species in eight of the sites.

Funafuti Terrestrial Reptiles

During the Funafuti BioRAP, six sites were surveyed for reptiles. In all three species were recorded which were all skinks (Table 2). No gecko species were recorded during the survey. The Dark-bellied Copper-striped Skink and Pygmy Snake-eyed Skink were abundant in all the six sites surveyed. The Pacific Moth Skink was rare and recorded in only one site (Table 6; Figure 8).

Table 6. Reptile Surveys at Six Sites on Funafuti Atoll.

Site	Species	Density (#/100 m²)
Fualopa	Dark-bellied Copper-striped Skink	5
	Pygmy Snake-eyed Skink	7
Fuafatu	Pygmy Snake-eyed Skink	10
	Dark-bellied Copper-striped Skink	11
Tepuka	Dark-bellied Copper-striped Skink	10
	Pygmy Snake-eyed Skink	10
	Pacific Moth Skink	1
Telele	Pygmy Snake-eyed Skink	17
	Dark-bellied Copper-striped Skink	14
Funafala	Pygmy Snake-eyed Skink	12
	Dark-bellied Copper-striped Skink	5
Fongafale	Pygmy Snake-eyed Skink	10
	Dark-bellied Copper-striped Skink	15

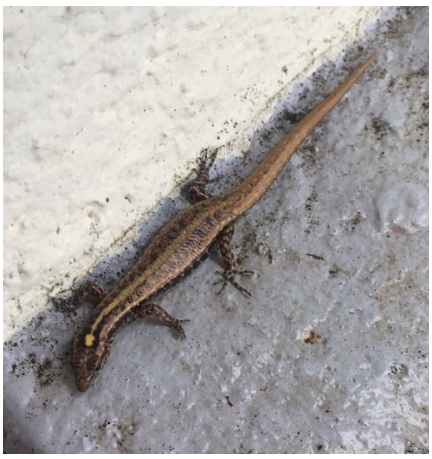


Figure 8. *The Pacific moth skink, Lipinia noctua*

Funafuti Land Mammals

There are no indigenous terrestrial mammals recorded for Tuvalu. During the BioRAP, 10 rat/rodent traps were set for three nights. Only one species of rat was recorded from the rattraps, which is the introduced Black or Ship Rat. This species is a pest and was common on Fongafale Island.

FUNAFUTI MARINE BIODIVERSITY

Marine species assemblages and habitat structure was assessed with six UVC surveys at Fualopa, Fuafatu and Fuakea islets during the Funafuti BioRap. At the three sites, a UVC was conducted in the inner lagoon with another survey of the coral reef/ coastal shelf on the outside of the atoll. The UVCs focussed on identifying iconic species in the resident fish and invertebrate assemblages, as well as evaluating the benthic substratum to assess habitat structure of the coral reefs. The following sections detail the results of the UVC surveys and opportunistic observations.

Fish and Invertebrate Assemblages

A total of 14 fish families were recorded, out of the 16 families recorded throughout the four islands (Appendix 2.1). The two families (recorded in the other islands) for which no species were recorded in the Funafuti UVCs were the Kyphosidae (Sea chubs) and Nemipteridae (Threadfin bream). Two fish families were notably diverse, namely the Acanthuridae and Chaetodontidae, with eight and nine species respectively. The species richness of the Scaridae (parrotfish), Labridae (wrasses), and Serranidae (groupers) are likely underestimated due to sampling constraints however, these families constitute a major proportion of the fish biomass at all sites. The only shark species recorded throughout the four islands was sighted in Funafuti – a single Black tip (*Carcharhinus limbatus*).

The presence of herbivore, corallivore, and carnivorous fishes, as well as the top predator (shark) indicates a suitably diverse vertebrate fauna with primary consumer, secondary consumer and tertiary consumer trophic levels represented within the fish assemblage. The high relative abundance of damselfishes (Figure 9; Appendix 2.1) was a notable occurrence in the FMCA fish assemblage.

The benthic community was relatively speciose, with 11 of the 24 taxa (~45%) recorded overall for the BioRAP (all four locations included), present in the Funafuti survey sites. However, of concern is the presence of bio-eroders such as the Long-spined black sea urchin (*Diadema* spp.), vermetid gastropod *Dendropoma maxima* (Great coral worm) and *Drupella* snails. The drupes however, were found in relatively lower abundance than the other two species. A resident status of the corallivorous Horn drupe (*Drupella cornus*) was not confirmed by the survey team. Of note, there were no sand-cleaning holothurians recorded in the 600 m^2 surveyed during the Funafuti BioRAP.

Benthic Substratum

The most common substratum recorded at all three sites was hard coral followed by rock (Figure 10). The sites surveyed were within the FMCA and were selected for the presence of a healthy coral reef, so this observation was to be expected. There was no discernable pattern in the coral assemblages of the inner lagoon and the outer coral reef shelf, and species diversity was relatively similar. Most of the benthic substrate was comprised of *Acropora, Echinopora, Favia* and *Montipora* corals (Figure 11). Both the inner and outer coral reefs on Funafuti Atoll display a greater taxonomic diversity than the other three islands. Coral bleaching was only observed along the inner coastal lagoon UVCs, and ranged from 2% to 9% (Table 7).

Taxon	Common name	Scientific Name	Funafuti	Nukulaelae	Niutao	Vaitupu
Fish						
Pomacentridae	Lemon Damsel	*Pomacentrus muccensis*				
	Princess Damsel	*Pomacentrus vaiuli*				
	Other Damsel spp.	Unidentifed spp.				
Haemulidae	Grunts/Sweetlips/Margates	Unidentifed spp.				
Acanthuridae	Whitecheek surgeonfish	*Acanthurus nigricans*				
	Convict tang	*Acanthurus triostegus*				
	Striped surgeon fish	*Acanthurus lineatus*				
	Striated surgeonfish	*Ctenochaetus striatus*				
	Pacific orange-spine unicorn fish	*Naso lituratus*				
	Bluespine unicornfish	*Naso unicornis*				
	Epaulette surgeonfish	*Acanthurus nigricauda*				
	Brown tang	*Acanthurus nigrofuscus*				
	Two toned tang	*Zebrasoma scopas*				
	Blueline Surgeonfish	*Acanthurus nigroris*				
	Achilles Tang/Surgeon fish	*Acanthurus achilles*				
	Marine reef tang	*Ctenochaetus cyanocheilus*				
	Orange band surgeonfish	*Acanthurus olivaceus*				
	Surgeon Fishes/Tangs/Unicorn fishes	Unidentifed spp.				
Lutjanidae	One spot snapper	*Lutjanus monostigma*				
	Small toothed jobfish	Aphareus furca				
	Bluestripe snapper	*Lutjanus kasmira*				
	Humpback red snapper	*Lutjanus gibbus*				
	Snapper spp.	Unidentifed spp.				
Lethrinidae	Humpnose big-eye bream	*Monotaxis grandoculis*				
	Yellowlip emperor	*Lethrinus xanthochilus*				
Nemipteridae	White-shouldered whiptail	*Pentapodus bifasciatus*				
Scaridae	Parrotfish spp.	Unidentifed spp.				
	Bumphead parrotfish	*Bolbometopon muricatum*				

Taxon	Common name	Scientific Name	Funafuti	Nukulaelae	Niutao	Vaitupu
Labridae	Wrasse spp.	Unidentifed spp.				
	Humphead/Napoleon wrasse	*Cheilinus undulatus*				
Serranidae	Grouper spp.	Unidentifed spp.				
	Barramundi cod/Humpback grouper	*Cromileptes altivelis*				
	Brown-banded rockcod	*Cephalopholis boenak*				
Balistidae	Pinktail triggerfish	*Melichthys vidua*				
	Black triggerfish	*Melichthys niger*				
	Halfmoon triggerfish	*Rhinecathus chrysopterus*				
	Orangestripe triggerfish	*Balistapus undulatus*				
	Reef triggerfish	*Rhinecathus rectangulus*				
	Lagoon triggerfish	*Rhinecanthus aculeatus*				
	Redtoothed triggerfish	*Odonus niger*				
	Yellow margin triggerfish	*Pseudobalistes flavomarginatus*				
	Blackbelly triggerfish	*Rhinecanthus verrucosus*				
Carangidae	Bluefin travelly	*Caranx melampygus*				
Siganidae	Rabbitfish spp.	Unidentifed spp.				
	Streamlined spinefoot	*Siganus argenteus*				
Kyphosidae	Brassy chub	*Kyphosus vaigiensis*				
Zanclidae	Moorish Idol	*Zanchus Cornutus*				
Mullidae	Dash-and-dot goatfish	*Parupeneus barberinus*				
	Yellowstripe goatfish	*Mulloidichthys flavolineatus*				
	Goldsaddle goatfish	*Parupeneus cyclostomus*				
	Manybar goatfish	*Parupeneus multifasciatus*				
Chaetodontidae	Pennant coralfish	*Heniochus acuminatus*				
	Vagabond butterflyfish	*Chaetodon vagabundus*				
	Threadfin butterflyfish	*Chaetodon auriga*				
	Chevroned butterflyfish	*Chaetodon trifascialis*				
	Lined butterflyfish	*Chaetodon linoelatus*				
	Spot-nape butterflyfish	*Chaetodon oxycephalus*				
	Ornate butterflyfish	*Chaetodon ornatissimus*				

Taxon	Common name	Scientific Name	Funafuti	Nukulaelae	Niutao	Vaitupu
	Bennett's butterflyfish	*Chaetodon bennetti*				
	Dotted butterflyfish	*Chaetodon semeion*				
	Bluespot butterflyfish	*Chaetodon plebius*				
	Speckled butterflyfish	*Chaetodon citrinellus*				
	Forceps butterflyfish	*Forcipiger flavissimus*				
	Klein's butterflyfish	*Chaetodon kleinii*				
	Reticulated butterflyfish	*Chaetodon reticulates*				
	Double-saddled butterflyfish	*Chaetodon ulietensis*				
	Teardrop butterflyfish	*Chaetodon unimaculatus*				
	Dot-and-dash butterflyfish	*Chaetodon pelewensis*				
	Redfin butterflyfish	*Chaetodon lunulatus*				
	Saddled butterflyfish	*Chaetodon ephippium*				
	Racoon butterflyfish	*Chaetodon lunula*				
	Fourspot butterflyfish	*Chaetodon quadrimaculatus*				
	Black butterflyfish	*Chaetodon flavirostris*				
	Long-nose butterflyfish	*Forcipiger longirostris*				
	Pyramid butterflyfish	*Hemitaurichthys polyepsis*				
Sharks						
Carcharhinidae	Black-tip shark	*Carcharhinus limbatus*				
Echinoderms						
Diadematidae	Long-spined Black Sea Urchin	*Diadema spp.*				
Echinometridae	Red pencil urchin	*Heterocentrotus mammillatus*				
	Burrowing urchin	*Echinometra mathaei*				
Oreasteridae	Cushion star	*Culcita novaeguineae*				
Holothuriidae	Herman sea cucumber	*Stichopus herrmanni*				
	Leopard sea cucumber	*Bohadschia argus*				
	Lollyfish	*Holothuria atra*				
	Sea cucumber spp.	Unidentifed spp.				
Crustaceans						

Taxon	Common name	Scientific Name	Funafuti	Nukulaelae	Niutao	Vaitupu
Coenobitidae	Coenobita spp.	*Hermit crabs*				
Diogenidae	Anemone hermit crab	*Dardanus pedunculatus*				
Molluscs	**Gastropods**					
Muricidae	Sea snail	*Drupella spp*				
	Horn drupe	*Drupella cornus*				
	Bituberculate rock snail	*Reishia bitubercularis/Thais kieneri*				
Cardiidae	Clam	*Tridacna maxima*				
Strombidae	Lambis/Large sea snail	*Spider conchs*				
	Strawberry conch or Tiger conch	*Conomurex luhuanus*				
Vermetidae	Great coral worm	*Ceraesignum maximum/ Dendropoma maximum*				
Turbinellidae	Common Pacific Vase	*Vasum turbinellus/ Vasum turbinellum*				
Conidae	Soldier cone	*Conus miles*				
	Flag/ Vexillum cone	*Conus vexillum*				
Spondylidae	Imperialis seashells	*Spondylus ducalis*				
Turbinidae	Rough turban	*Turbo setosus*				
Other Molluscs						
-	Bivalve spp.	Unidentifed spp.				
Octopodidae	Octopus	Unidentifed spp.				

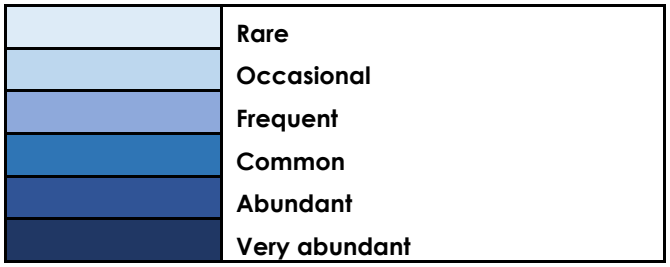


Figure 9. *Distribution and relative abundance of marine taxa recorded for all four islands surveyed in the Tuvalu R2R BioRAP. Occurrence categories (rare = 0 – 50 individuals per ha, occasional = 51 – 100 individuals per ha, frequent = 101 – 1000 individuals per ha, common = 1001 – 5000 individuals per ha, abundant = 5001-10,000 individuals per ha, very abundant = 10,000+ individuals per ha) are based on a measure of relative abundance, specifically density or number of individuals per hectare (10,000 m^2).*

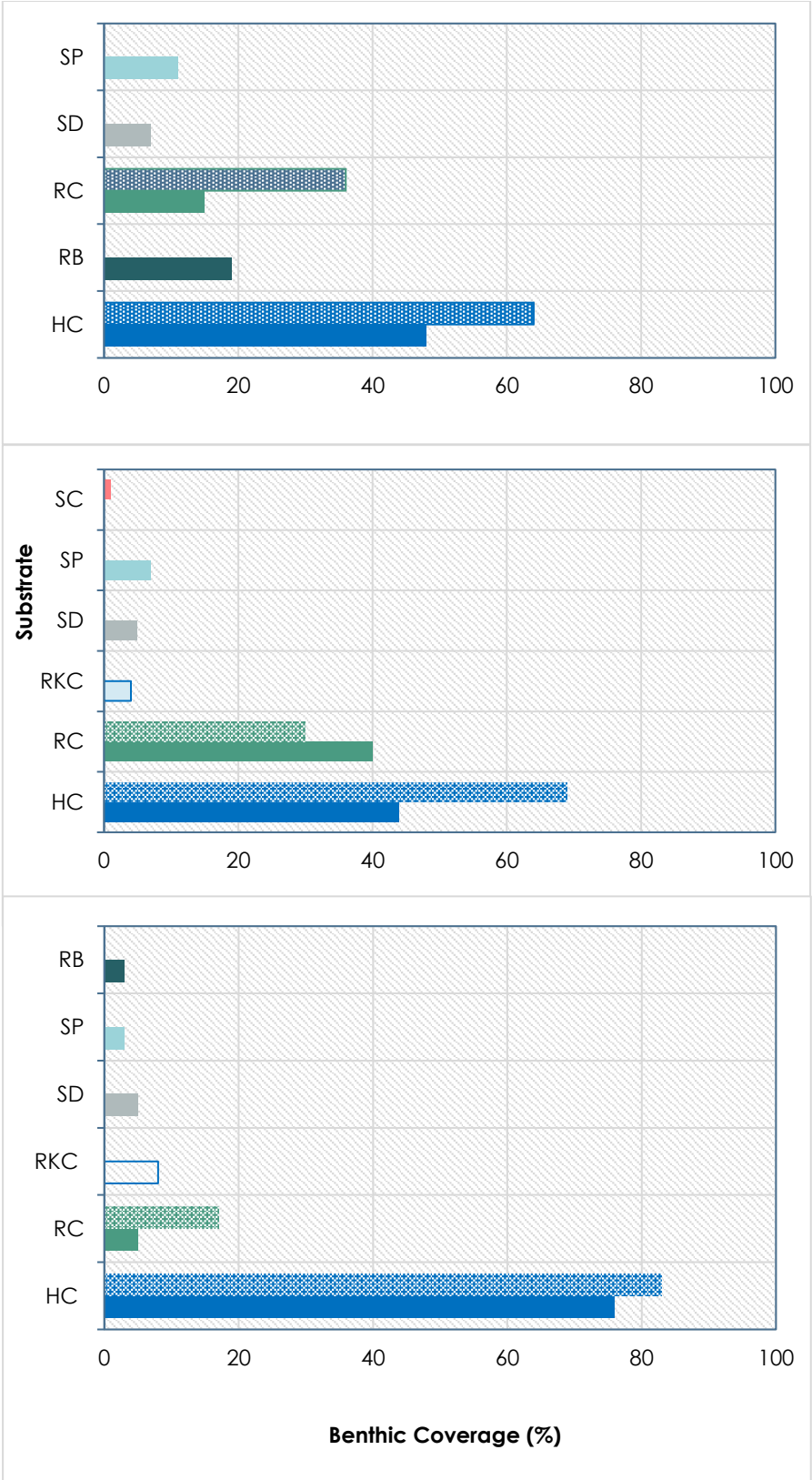


Figure 10. *Substrates found on the inner (solid bars) and outer (hatched bars) coral reefs, with proportional coverage; Fuafatu – top, Fualopa – middle and Fuakea – bottom graph. Category codes are; HC – hard coral, RB – rubble, RC – rock, RKC – recently killed coral, SC – soft coral, SD – sand, and SP – sponge.*

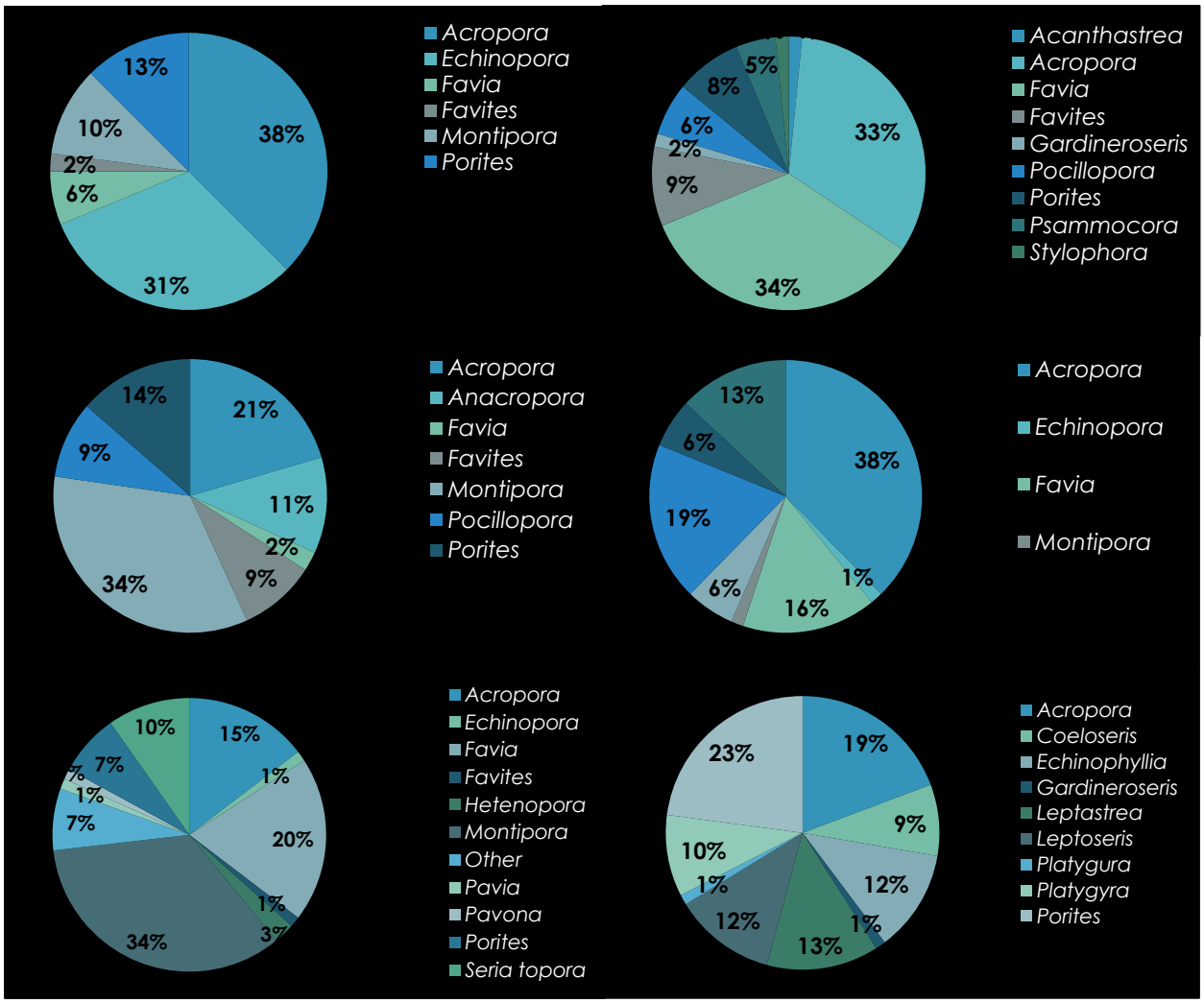


Figure 11. *Proportional substrate coverage by hard coral taxa at Fuafatu – top, Fualopa – middle and Fuakea – bottom graph. Graphs on the left show the inner coral lagoon and graphs on the right show the outer coral shelf substratum.*

Species Diversity & Habitat Structure

It is notable that the diversity in the fish and invertebrate assemblage in coral reefs on Funafuti Atoll may be associated with a greater diversity in the coral species assemblage. There was a comparatively greater species richness in the fish and invertebrate fauna (Table 7) recorded for the inner coral reef assemblage, in comparison to the outer assemblage.

In total, there were 60 taxa recorded in the Funafuti UVCs, more than were recorded for the other three islands/atolls surveyed. The dominance of massive corals such as *Acropora, Favia* and *Porites* in the exposed outer coral reef, and the presence of foliose corals such as *Montipora* in the more sheltered inner coastal lagoon, may be associated with high wave energy/ low wave energy habitats.

A clear pattern in species diversity at the Funafuti sites, as indicated by the Shannon-Wiener (*H'*) index values, was not distinct however, generally the inner coral reef biological community was more diverse compared to the outer coral reef (Table 7). This pattern was only evident at Fuakea and Fuafatu, but does not apply to Fualopa islet, where there was very little difference in species richness (*S*) and diversity (*H'*).

Table 7. Coral Cover, Fish & Invertebrate Species Community Richness in Funafuti.

Site	Transect	Coral	Percent Cover	*S*	*H'*
Fuafatu	Leeward	*Acropora*	10%	28	2.77
		Acropora (bleached)	8%		
		Echinopora	15%		
		Favia	2%		
		Favia(bleached)	1%		
		Favites	2%		
		Montipora	5%		
		Porites	6%	22	1.85
	Windward	*Acanthastrea*	1%		
		Acropora	21%		
		Favia	22%		
		Favites	6%		
		Gardineroseris	1%		
		Pocillopora	4%		
		Porites	5%		
		Psammocora	3%		
		Stylophora	1%		
Fualopa	Leeward	*Acropora*	9%	20	1.99
		Anacropora	5%		
		Favia	1%		
		Favites	4%		
		Montipora	15%		
		Pocillopora	4%		
		Porites	6%		
		Bleached	4%		
	Windward	*Acropora*	26%	22	2.23
		Echinopora	1%		
		Favia	11%		
		Montipora	1%		
		Platygyra	4%		
		Pocillopora	13%		
		Pocillopora woodjonesi	4%		
		Porites	9%		
Fuakea	Leeward	*Acropora*	12%	32	2.62
		Echinopora	1%		
		Favia	16%		
		Favites	1%		
		Hetenopora	2%		
		Montipora	28%		
		Other	6%		
		Pavia	1%		
		Pavona	1%		
		Porites	6%		
		Seria topora	8%		
		Bleached	2%		
	Windward	Acropora	16%	22	2.14
		Coeloseris	7%		
		Echinophyllia	10%		
		Gardineroseris	1%		
		Leptastrea	11%		
		Leptoseris	10%		
		Platygura	1%		
		Platygyra	8%		
		Porites	19%		

Nukulaelae Atoll

Nukulaelae Atoll: Summary

BioRAP surveys of Nukulaelae Atoll took place between the 21st and the 25th of April 2021. The surveys were carried out on the islets of Fenualago, Fenua, Fakai, and Fagauna. A summary of the survey effort is recorded in Appendix 3.1 and the geographic locations of survey sites is in Figure 12. A total of 165 plant species were recorded during the survey. In all, 11 gentry transects were sampled for the vegetation survey covering four vegetation systems (Figure 12). Fifteen terrestrial vertebrate fauna species (two land birds, six seabirds, three shorebirds, three reptiles and one mammal) were recorded during the BioRAP. A total of 52 marine taxa were recorded from the six transects surveyed on Nukulalaelae. There were more species of Mullidae, Balistidae, and holothurians recorded on Nukulaelae in comparison to the other three atolls/islands. Bleaching was low occurring at 1-15% of the 50 m transect.

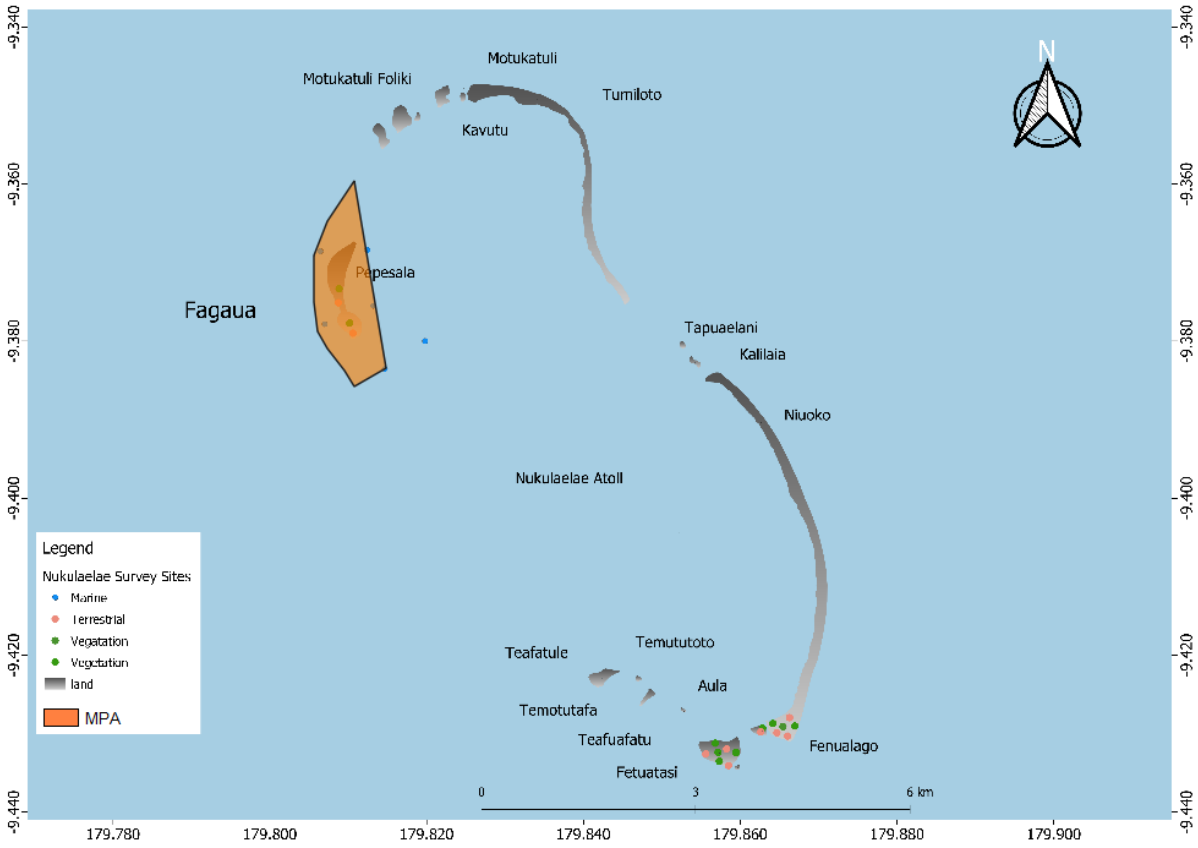


Figure 12. *Nukulaelae Atoll – existing protected areas, terrestrial and marine sample sites.*

NUKULAELAE TERRESTRIAL FLORA

A total of 165 plant species were recorded from the different sites that were surveyed in Nukulaelae (Appendlx 3.2). The dicotyledons were the dominant plant species recorded (110 species), 48 species were monocotyledons, one gymnosperm and six fern species (Figure 13). 118 species recorded were introduced species and only 47 species recorded were indigenous.

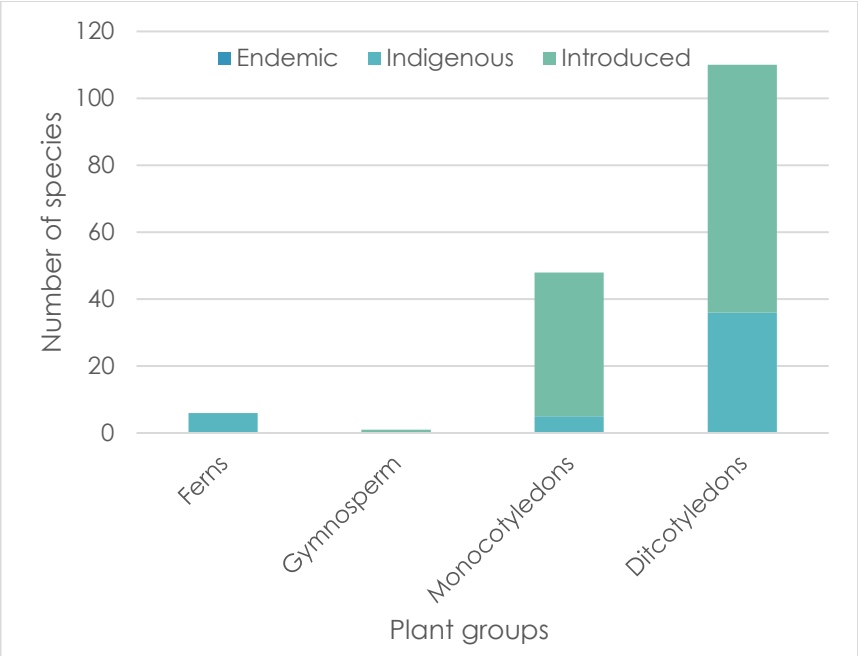


Figure 13. *Summary of the floral diversity of Nukulaelae Atoll.*

In terms of the five major vegetation types, the 'Disturbed-human modified vegetation' was the most diverse with 121 species recorded (Figure 14); however many of these species are introduced to Nukulaelae. *Littoral forest and scrub* recorded 60 species, followed by the 'Coconut woodland and agroforest (42 species), and 'Inland broadleaf woodland with 30 species. The 'Mangrove and wetland vegetation' was the least diverse with 17 species (Figure 14). The breakdown of species distribution for each vegetation type can be accessed in Appendix 2.2.

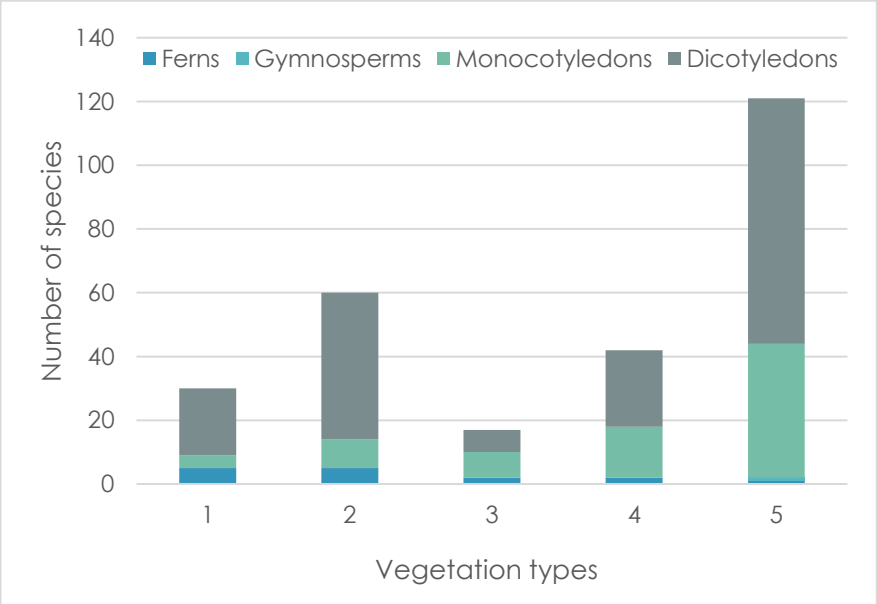


Figure 14. *Plant species diversity recorded in each vegetation type in Nukulaelae Atoll. Vegetation codes: 1 – Inland broadleaf woodland, 2 – Littoral forest and scrub, 3 – Mangrove and wetland, 4 – Coconut woodland and agroforest, 5 – Disturbed human modified vegetation).*

NUKULAELAE VEGETATION

In all, 11 gentry transects were surveyed on Nukulaelae atoll during the BioRAP. Only three vegetation types were identified: 'Littoral forest and scrub', Inland broadleaf forest' and 'Disturbed human modified vegetation' (Table 8, Appendix 3.3). The 'Littoral forest and scrub' was the most common habitat occurring on seven of the 11 transects.

Table 8. Details of Gentry Transects Surveyed On Nukulaelae Atoll.

Transect #	Site	Vegetation code	Species Diversity	No. of trees	Basal Area (m^2)	Volume (m^3)
1	Fagaua	2	4	12	0.74	4.56
2	Fagaua	2	5	25	1.3	5.44
3	Fagaua	5	4	4	3.32	8.08
4	Fakai	2	3	17	1.25	6.02
5	Fakai	1	4	38	1.2	4.48
6	Fakai	2	4	14	0.77	3.69
7	Fakai	1	2	19	3.19	16.09
8	Fenualago	2	4	16	0.7	1.41
9	Fenualago	1	3	12	0.89	4.22
10	Fenualago	2	3	17	0.74	4.71
11	Fetutasi	2	5	12	0.57	1.75

Note: Each transect covers an area of 100 m^2 (50 x 2 m). Vegetation types: 1 – Inland broadleaf woodland, 2 – Littoral forest and scrub, 3 – Mangrove and wetland, 4 – Coconut woodland and agroforest, 5 – Disturbed human modified vegetation.

The inhabited islet of Fagaua was dominated by 'Disturbed and human modified' vegetation covering 46% of the island (Figure 15). The 'Littoral forest and scrub' vegetaion covered 35% of the island and the remaining 19% was covered by 'Coconut woodland and agroforest' vegetation. Fetuatasi islet was dominated by 'Inland broadleaf woodland' (46%) and 'Littoral forest and scrub' (45%). The remaining area of Fetuatasi islet was covered by a mixture of 'disturbed' and 'wetland' vegetation. Fenualago islet was covered by two vegetation types: 'Inland broadlead woodland' (58%) and 'Littoral forest and scrub' (42%). The islet of Niuoka was domined by 'Littoral forest and scrub' vegetation cover (73%). The other two vegetation types present on the islet were 'Inland broadleaf woodland' (23%) and 'disturbed/wetland' vegetation (4%).

In summary, based on the islets that were surveyed, Nukulaelae Atoll is mostly covered by 'Littoral forest and scrub' vegetation (64% of the land area). The 'Inland broadleaf woodland' was the second most dominant vegetation with 25% cover. The remaining area is covered by 'Disturbed and human modified' vegetation (9%) and 'Coconut woodland and agroforest (2%). Nukulaelae Atoll vegetation appears to be more intact with less evidence of human disturbance as observed for Funafuti Atoll.

Littoral forest and scrub

Seven gentry transects were sampled for this habitat. This seemed to be the most dominant vegetation on Nukulaelae Atoll. In a 100 m^2 area the tree species diversity

ranged from three to five species, and the number of individual trees recorded was between 12 to 25. The tree basal area in a transect area ranged from 0.57 to 1.3 m² and the timber volume from 1.41 to 5.44 m³ (Table 7). The common tree species recorded in this habitat were 'Niu', 'Nonu' and 'Fala'. The dominant tree species in both the basal area and volume were 'Fala', 'Niu' and 'Pukavai' Appendix 3.3).

Inland broadleaf woodland

Three gentry transects were sampled for this vegetation system. In a 100 m² transect area the number of tree species ranged from two to four species, and the number of individual trees recorded was from 12 to 38 (Table 8). The tree basal area was between 0.89 to 3.19 m² and the estimated timber volume between 4.22 to 16.09 m³. Common tree species recorded were 'Pukavai', 'Fao' and 'Niu'. The dominant trees in term of both the basal area and volume were 'Pukavai', 'Puka' and 'Pua' (Appendix 3.3). The highest number of trees and volume content per 100 m² area, was recorded for this vegetation system.

Modified- disturbed vegetation

Only one transect was sampled for this vegetation system. On this transect, only four tree species and four trees were recorded. The basal area recorded was 3.32 m² and the volume was 8.08 m³. In terms of size (basal area and volume), the 'Fetau' and Breadfruit trees were the most dominant (Appendix 3.3). This vegetation system although disturbed, will become more common in the future due to human related activities.

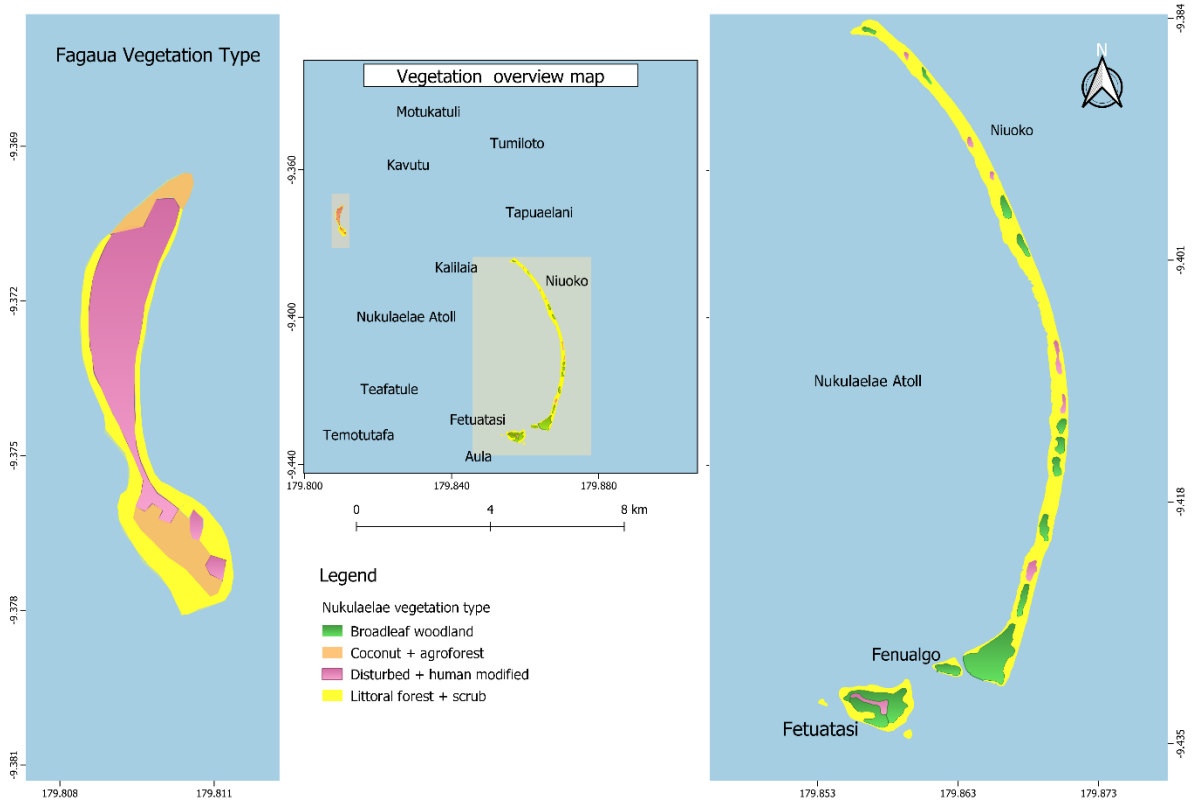


Figure 15. *Vegetation types on the four islets: Fagaua, Fetuatasi, Fenualago and Niuoko.*

NUKULAELAE TERRESTRIAL FAUNA

During the Nukulalae BioRAP a total of 15 terrestrial vertebrate fauna species were recorded (Table 9). The seabirds were the most diverse comprising 40% of the total species recorded. The shorebirds made up 20%, reptiles 20% and land birds comprised 13% of the total terrestrial fauna. Only one species of mammal was recorded, which made up 7% of the total terrestrial fauna.

Table 9. Terrestrial Vertebrate Fauna Species Recorded on Nukulaelae Atoll.

Tuvalu Name	Common Name	Scientific Name	Family
Land birds			
Lupe	Pacific pigeon	*Ducula pacifica*	Columbidae
Moa	Domestic fowl	*Gallus gallus*	Phasianidae
Seabirds			
Gogo	Brown noddy	*Anous stolidus*	Sternidae
Lakia	Black noddy	*Anous minutus*	Sternidae
Akiaki	White tern	*Gygis alba*	Sternidae
Tavakelau	White tailed tropic bird	*Phaethon lepturus*	Phaetontidae
Kotaa	Masked booby	*Sula dactylatra*	Sulidae
Katafa	Frigatebird	*Fregata minor/ariel*	Fregatidae
Shorebirds			
Tuli	Pacific golden plover	*Pluvialis dominica*	Charadidae
Kolili	Ruddy Turnstone	*Arenaria interpres*	Charadidae
Matuku	Pacific reef heron	*Egretta sacra*	Ardeidae
Reptiles			
	White-bellied Copper-triped Skink	*Emoia cyanura*	Scincidae
	Dark-bellied Copper-striped Skink	*Emoia impar*	Scincidae
	Pygmy Snake-eyed Skink	*Cryptoblepharus eximius*	Scincidae
Mammals			
	Black/Ship Rat	*Rattus rattus*	Muridae

Nukulaelae Land Birds

Ten point stations were surveyed for land birds on Nukulaelae Atoll. Only two species of land birds were recorded, the introduced 'Moa' and the indigenous 'Lupe' (Table 10). A total of 13 'Lupe' birds were detected from the 10 survey stations. From this data the density of 'Lupe' for the islands surveyed in Nukulaelae is estimated at 26 birds/ha (Appendix 3.4).

Nukulaelae Seabirds

The seabirds recorded the highest diversity of the terrestrial vertebrate fauna with six species on Nukulaelae. Ten known seabird nesting colonies were surveyed, however only eight recorded a presence of nesting adults and the other two colonies did not have any nesting adults (Table 11). In the eight nesting colonies the species diversity

ranged from one to three species per colony and the numbers of nesting adults per transect (100 m²) ranged from one to six birds. 'Lakia' (Black Noddy) was the dominant seabird in three of the Fenualago colonies, 'Tavakelau' (White tailed topic bird) was dominant in one of the Fakai2 seabird colonies and 'Akiaki' (White Tern) was the dominant nesting seabird in the Fakai 4 colony. Generally, 'Lakia' (Black Noddy) seemed to the dominant nesting seabird in Nukulaelae.

Table 10. Density of Nesting Seabirds in Seabird Colonies in Nukulaelae.

Species	Density (#/100 m²)	Projected density (#/ ha)
Fenualago 1		
Akiaki	1	100
Lakia	5	500
Fenualago 2		
Lakia	6	600
Fenualago 3		
Gogo	2	200
Lakia	5	500
Fenualago 4		
(No nesting adult)		
Fenualago 5		
Akiaki	1	100
Fakai 1		
Lakia	2	200
Akiaki	2	200
Fakai 2		
Gogo	1	100
Akiaki	1	100
Tavakelau	3	300
Fakai 3		
Lakia	1	100
Akiaki	4	400
Fagaua 1		
Gogo	1	100
Fagaua 2		
(No nesting adult)		

In addition to the seabird nesting adult transect survey, the team also carried out point counts for each known seabird colony to estimate the number of birds and species present in a colony. Ten colonies were surveyed (Table 10). The diversity of the seabird species in each colony ranged from zero (none) to six species. The abundance of birds ranged from zero to 12 birds per seabird colony.

Nukulaelae Shorebirds

A total of three sites were used as observation sites to estimate the number of species and birds present. Three species of shorebirds were recorded from each of the three sites surveyed (Table 12). The 'Kolili' (Ruddy Turnstone) was the most dominant

shorebird species recorded, and the highest number of shorebirds was recorded at Fagaua West Beach.

Table 11. Point Count Surveys of Seabirds in Seabird Colonies at Nukulaelae Atoll.

Colony	Species						Total
	Gogo	**Lakia**	**Akiaki**	**Tavakelau**	**Kotaa**	**Katafa**	
Fenualago1	1	0	1	0	0	0	2
Fenualago2	0	2	0	0	0	0	2
Fenualago3	1	2	0	1	0	0	4
Fenualago4	0	0	0	0	0	0	0
Fenualago5	0	0	1	0	0	0	1
Fakai1	0	2	3	0	0	6	11
Fakai2	1		2	7	1	1	12
Fakai3	1	1	5	2	0	5	14
Fagaua1	2	0	0	0	0	0	2
Fagaua2	0	0	0	0	0	0	0

Table 12. Shorebird Abundances at Ten Sites in the Nukulaelae Atoll Survey.

Site	Species					Total
	Tuli	**Kolili**	**Kilikilitai**	**Matuku**	**Grey tail**	
Fagaua	4	3	0	1	0	8
Fagaua NE Rocks	2	3	0	0	0	5
Fagaua West Beach	2	50	0	1	0	53

Table 13. Reptile Surveys at Six Sites on Funafuti Atoll.

Site	Species	Density (#/100 m²)
Fenualago1	Pygmy Snake-eyed Skink	1
	Dark-bellied Copper-striped Skink	1
Fenualago2	Pygmy Snake-eyed Skink	1
Fenualago3	Pygmy Snake-eyed Skink	1
	Dark-bellied Copper-striped Skink	1
Fenualago 4	Dark-bellied Copper-striped Skink	1
Fenua 5	Dark-bellied Copper-striped Skink	1
	White-bellied Copper-striped Skink	1
Fakai 6	Dark-bellied Copper-striped Skink	1
	Pygmy Snake-eyed Skink	1
Fakai 7	Pygmy Snake-eyed Skink	1
	Dark-bellied Copper-striped Skink	1
Fakai 8	Dark-bellied Copper-striped Skink	1
	White-bellied Copper-striped Skink	1
	Pygmy Snake-eyed Skink	1
Fakai 9	Pygmy Snake-eyed Skink	1
Fagaua 10	Pygmy Snake-eyed Skink	1

Nukulaelae Terrestrial Reptiles

In all, 10 transects were surveyed for reptiles in Nukulaelae. All the transects were surveyed during the day and there was no night survey. A total of three species were recorded from these transects (Table 13). There were no geckos recorded during the survey. The Pygmy Snake-eyed Skink and the Dark-bellied Copper-striped Skink were the most abundant reptiles recorded. The White-bellied Copper-striped Skink was rare and only recorded from one of the transects.

Nukulaelae Land Mammals

During the BioRAP, a total of 10 rat/rodent traps were set for three nights. Only one species of rat was recorded from the rat traps, which is the introduced Black or Ship Rat (Table 9). This species is a pest and is considered a threat to the native biodiversity.

NUKULAELAE MARINE BIODIVERSITY

Marine species assemblages and habitat structure was assessed with six UVC surveys at Fatuomanu, Menigi and Kaualai islets during the Nukulau BioRap. At the three sites, a UVC was conducted in the inner lagoon with another survey of the coral reef/ coastal shelf on the outside of the atoll (as was done for Funafuti Atoll). The UVCs focussed on identifying iconic species in the resident fish and invertebrate assemblages, as well as evaluating the benthic substratum to assess habitat structure of the coral reefs. The following sections detail the results of these surveys.

Fish and Invertebrate Assemblages

A total of 14 fish families were recorded, out of the 16 families recorded throughout the four islands (Appendix 2.1). Similar to Funafuti Atoll, the two fish families (recorded in the other islands) for which no species were recorded in the Nukulaelae UVCs were the Kyphosidae (Sea chubs) and Nemipteridae (Threadfin bream). Three fish families were notably diverse, namely the Acanthuridae, Balistidae, and Chaetodontidae with eight, six species and nine respectively. Again similar to Funafuti, the species richness of the Scaridae (parrotfish) and Labridae (wrasses), are likely underestimated due to sampling constraints however, these families constitute a major proportion of the fish biomass at all three sites surveyed at Nukulaelae Atoll. It is interesting that aside from the Damselfish (classed as "common" based on relative abundance) the majority of taxa were recorded at lower densities than for the other islands. A quick scan of the heat map of Figure 9, confirms this observation for Nukulaelae Atoll.

The benthic community of the Nukulaelae sites were relatively more speciose than Funafuti Atoll, with 14 of the 24 taxa (~60%) recorded for the BioRAP (all four locations included). Of the four islands/atolls, the greatest invertebrate diversity was recorded in the Nukulaelae surveys. In all, 14 invertebrate species were recorded (~58% of all the invertebrate taxa recorded during the four BioRAP surveys). The densities of bio-eroders such as the Long-spined black sea urchin and *D. maxima* (Great coral worm) were relatively lower than at Funafuti. The presence of the corallivorous Horn drupe (*Drupella cornus*) was confirmed by the survey team, however this species was considered rare based on estimated number (Figure 9; Appendix 2.1).

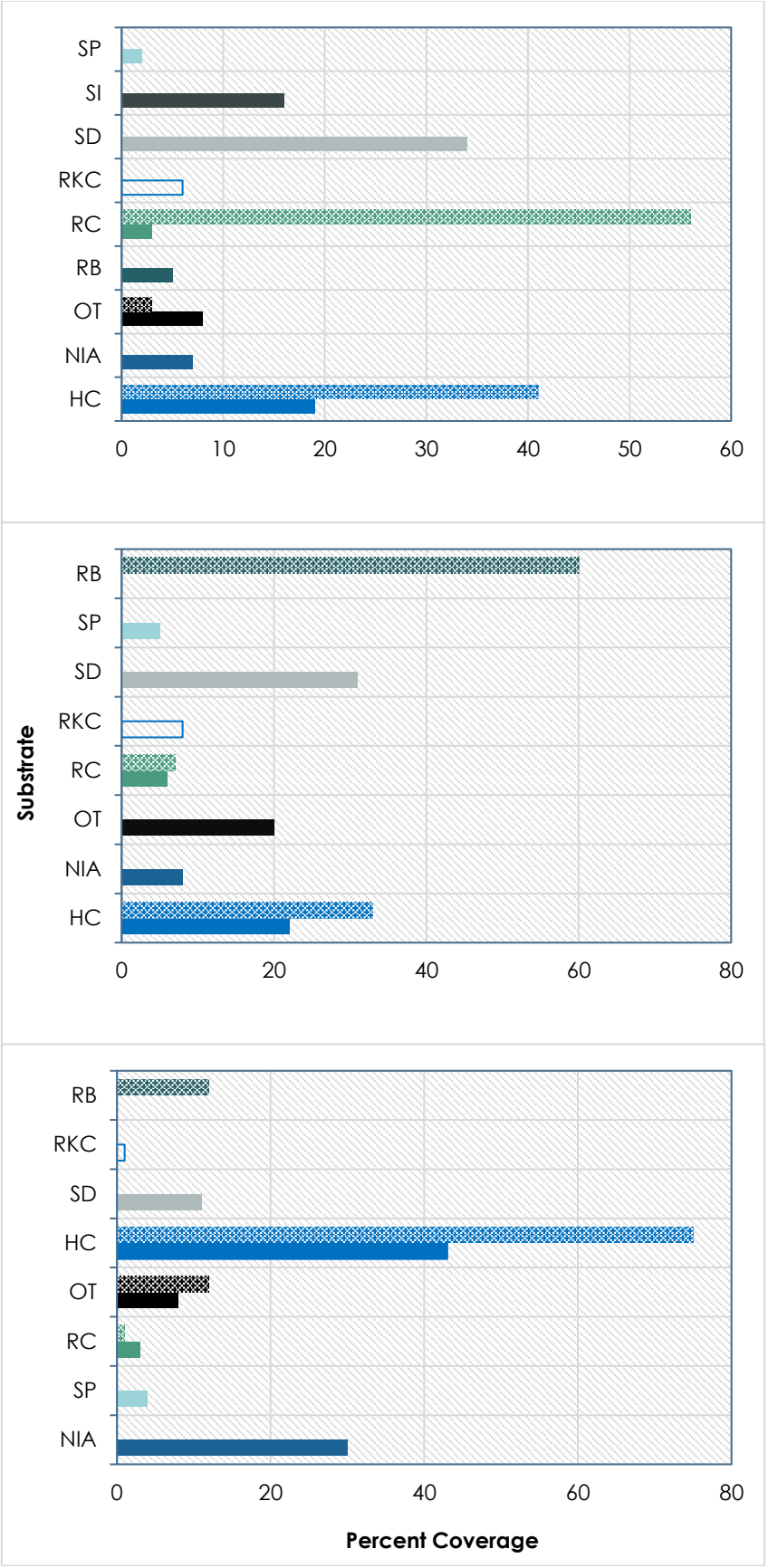


Figure 16. *Substrates found on the inner (solid bars) and outer (hatched bars) coral reefs, with proportional coverage; Fatuomanu – top, Menigi – middle and Kaualai – bottom graph. Category codes are; HC – hard coral, RB – rubble, RC – rock, RKC – recently killed coral, SC – soft coral, SD – sand, and SP – sponge.*

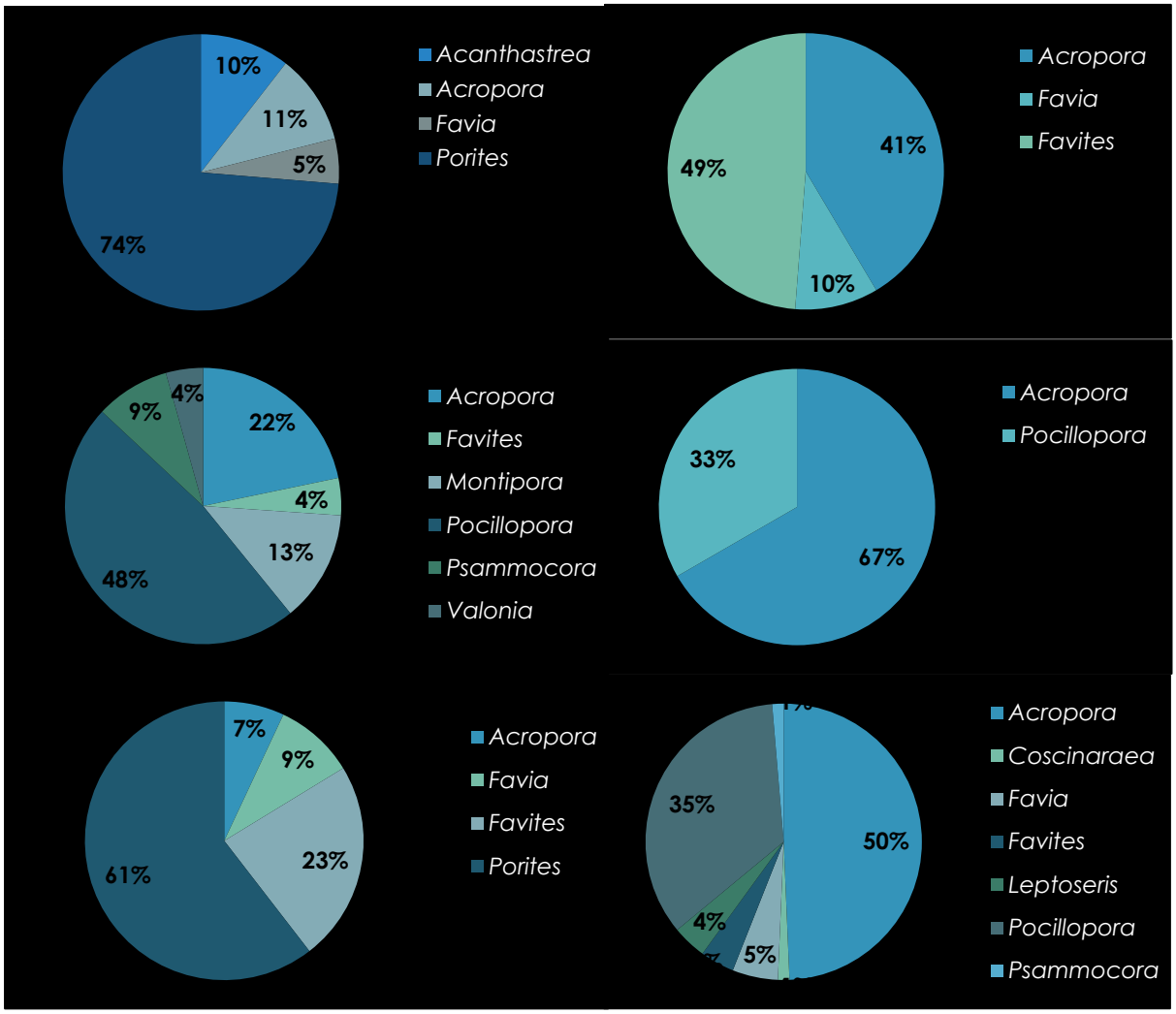


Figure 17. *Proportional substrate coverage by hard coral taxa at Fatuomanu – top, Menigi – middle and Kaualai – bottom graph. Graphs on the left show the inner coral lagoon and graphs on the right, the outer coral shelf substratum.*

All three sea cucumber species that were identified to species level (*Stichopus herrmanni, Bohadschia argus,* and *Holothuria atra*) were present only at the Nukulaelae sites, occurring as 'rare' to 'occasional' members of the echinoderm community. Notablyy, the Herman sea cucumber, is considered threatened according the IUCN Red List. In all, 85 unidentified holothurian species were recorded. The only other island/atoll where holothurians were recorded was on Vaitupu. Another sand-cleaner, the Tiger conch (*Conomurex luhuanus*), was relatively abundant.

Benthic Substratum

There was a greater variety in substratum recorded at the three sites on Nukulaelae atoll (Figure 16). Percent coverage of rock was greatest in Fatuomanu, rubble in Menigi and hard coral in Kaualai. There was a comparatively greater proportion of hard corals in the outer lagoon for all three surveyed sites. Of the hard corals, *Acropora* was most common, making up to 67% of the benthic substratum at one of the three sites (Menigi outer reef; Figure 17). Coral bleaching was generally low at the three sites (ranging from 1-5%), with the distinctive exception of the Menigi outer reef – 15% (Table 14).

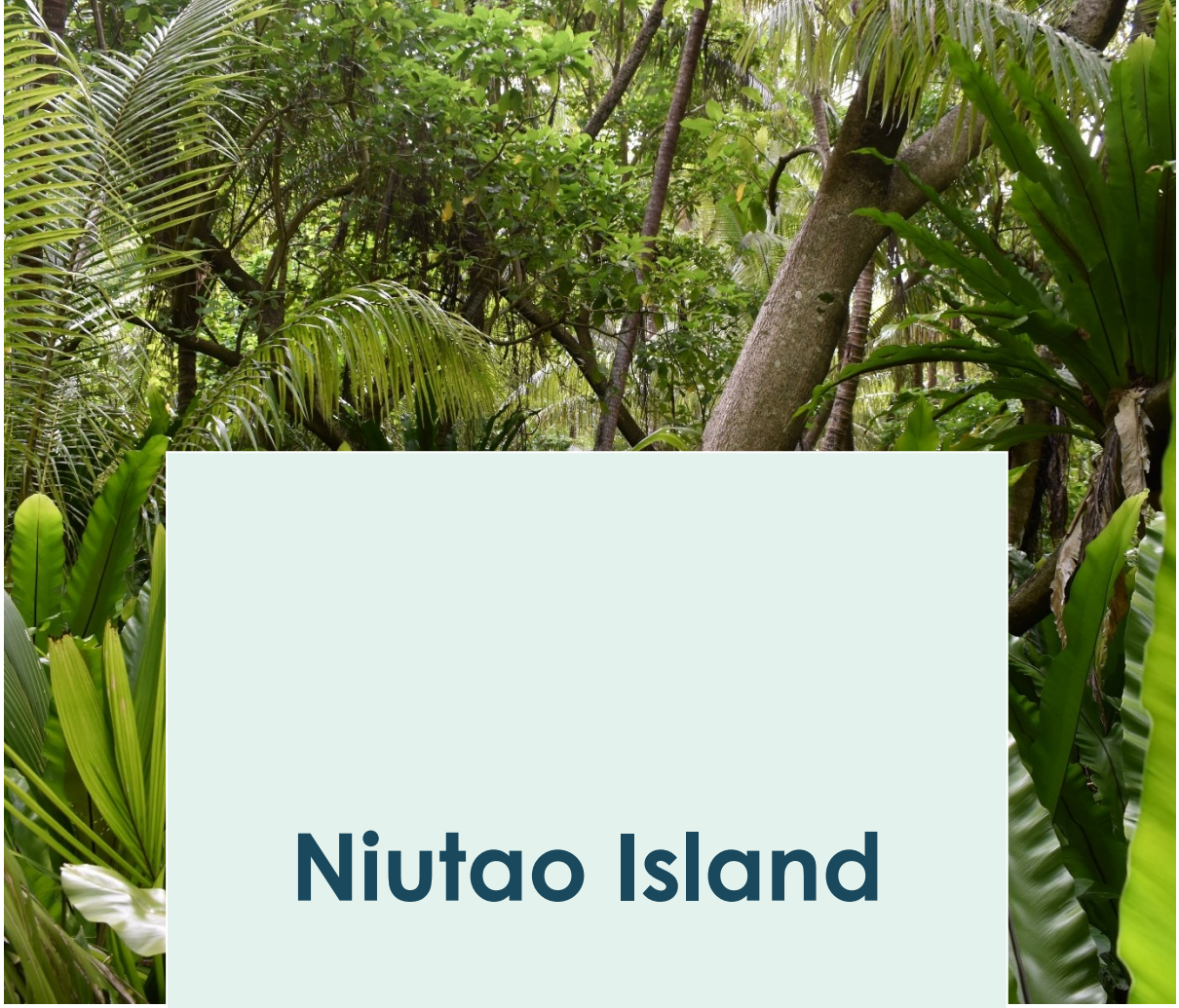
Species Diversity & Habitat Structure

Again, it may be suggested that the diversity in the fish and invertebrate assemblage in coral reefs on Nukulaelae is associated with a greater diversity in the coral species assemblage; however this pattern is not as clear as for Funafuti. In contrast to Funafuti Atoll, there was a comparatively greater species richness in the fish and invertebrate fauna (Table 14) recorded for the outer coral reef assemblage, in comparison to the inner reef assemblage for Nukulaelae. Unlike Funafuti, the association between species richness and diversity was less well defined. The higher wave energy of the outer reef may favour the dominance of massive corals such as the brain corals (Favia and Favites), in addition to Porites and Acropora.

As for Funafuti, a clear pattern in species diversity in the marine biological community of the Nukulaelae Atoll, was not distinct. However, unlike the general pattern determined on Funafuti, the outer coral reef biological community was a little more diverse compared to the inner coral reef although the distinction is minimal (Table 14).

Table 14. Coral Cover, Fish & Invertebrate Species Community Richness in Nukulaelae.

Site	Transect	Coral	Percent Cover	*S*	*H'*
Fatuomanu	Leeward	*Acanthastrea*	2%	18	1.58
		Acropora	2%		
		Favia	1%		
		Porites	14%		
		Bleached	2%		
	Windward	*Acropora*	17%	19	2.43
		Favia	4%		
		Favites	20%		
Menigi	Leeward	*Acropora*	5%	24	1.99
		Favites	1%		
		Montipora	3%		
		Pocillopora	11%		
		Psammocora	2%		
		Valonia	1%		
		Bleached	5%		
	Windward	*Acropora*	12%	21	2.44
		Pocillopora	6%		
		Bleached	15%		
Kaualai	Leeward	*Acropora*	3%	17	1.47
		Favia	4%		
		Favites	10%		
		Porites	26%		
		Bleached	1%		
	Windward	*Acropora*	37%	19	2.24
		Coscinaraea	1%		
		Favia	4%		
		Favites	3%		
		Leptoseris	3%		
		Pocillopora	26%		
		Psammocora	1%		



Niutao Island

Niutao Island: Summary

The Niutao Island BioRAP survey was conducted from the 27th to the 30th of April 2021. A summary of the survey effort is present in Figure 13 and Appendix 4.1. A total of 158 plant species were recorded during the survey. Owing to the relatively greater spatial heterogeneity and landmass, 12 gentry transects were sampled for the vegetation survey covering four different vegetation systems (Figure 18). A total of 14 terrestrial vertebrate fauna species (two land birds, five seabirds, three shorebirds, three reptiles and one mammal) were recorded during the NiuTao BioRAP. Marine diversity was concentrated in certain fish families. Of the 38 marine taxa recorded from the UVCs conducted on Niutao, the Acanthuridae, Balistidae and occurred in relatively higher densities than on the other three islands. The lack of benthic invertebrates was notable with only one taxa. Coral bleaching was more widespread on Niutao, with an average of 31% of bleached coral substrate from the six transects. Bleaching was greater on the leeward reef compared to the windward reef.

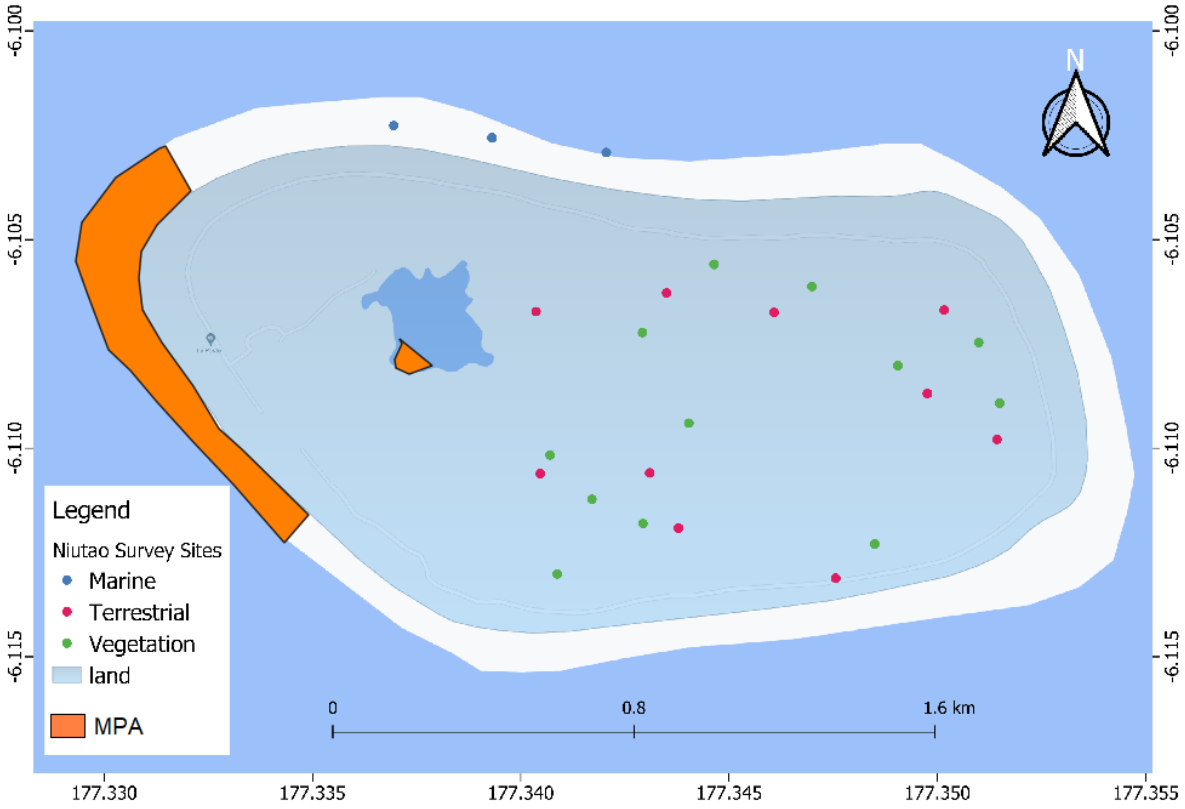


Figure 18. *Niutao Atoll – existing protected areas, terrestrial and marine sample sites.*

NIUTAO TERRESTRIAL FLORA

During the survey, a total of 158 species of plants were recorded from the survey sites. Like Funafuti and Nukulaelae, dicotyledons were dominant recording 107 species, followed by the monocotyledons with 44 species and six species of ferns (Figure 19). Only one species of gymnosperm was recorded. In general, the flora of Niutao like the other islands of Tuvalu is dominated by introduced species. The introduced

species alone comprised 109 species compared to the indigenous species with only 49 species.

The 'Disturbed-human modified vegetation' recorded the highest number of plant species (115 species), followed by the 'Littoral forest and scrub' (61 species), and the 'Coconut woodland and agroforest' vegetation recorded 38 species. However, most of the plants recorded in these vegetation systems are introduced species. The 'Inland broadleaf woodland vegetation' recorded 30 plant species and the lowest number of species was recorded in the 'Mangrove and wetland vegetation' (Figure 20). The breakdown of the species distribution for each vegetation type can be accessed in Appendix 4.2.

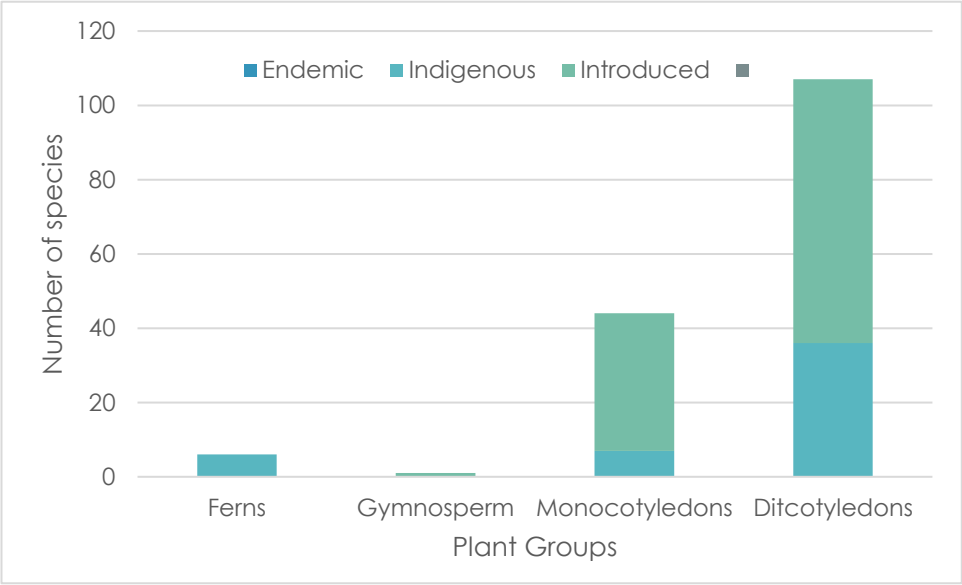


Figure 19. *Summary of the floral diversity of Niutao Atoll.*

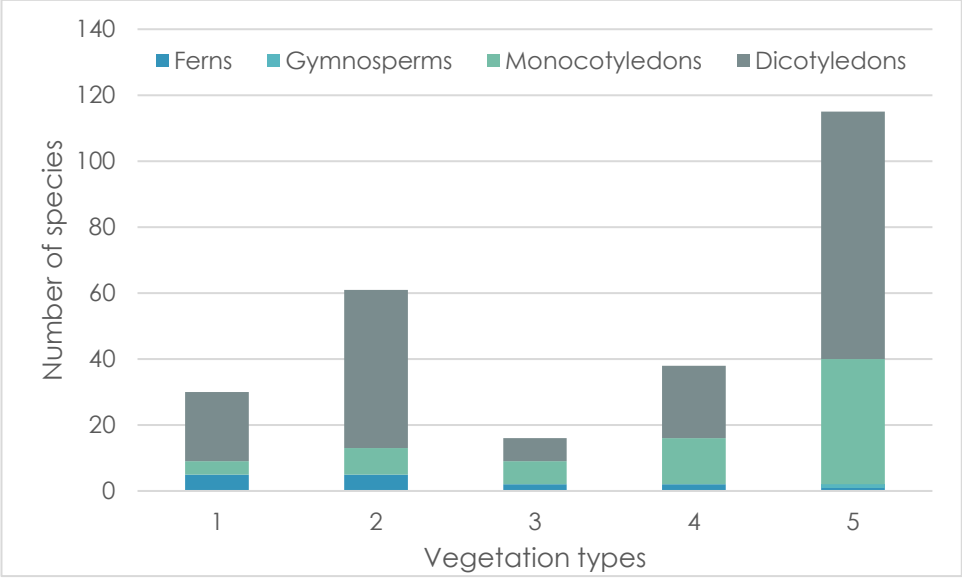


Figure 20. *Plant species diversity recorded in each vegetation type in Niutao Atoll. Vegetation codes: 1 – Inland broadleaf woodland, 2 – Littoral forest and scrub, 3 – Mangrove and wetland, 4 – Coconut woodland and agroforest, 5 – Disturbed human modified vegetation).*

NIUTAO VEGETATION

A total of 12 gentry transects were surveyed in Niutao Island (Table 15). The 'Littoral forest and scrub vegetation' was the most sampled system with seven transects. The transects sampled in the 'Coconut woodlands and agroforest vegetation' recorded the highest diversity of tree species and the highest number of trees per 100m² surveyed area compared to other transects. In terms of dominance, the 'Inland broadleaf woodland vegetation' recorded the highest basal area of 4.21 m² and volume of 9.1 m³ per 100 m² of surveyed area.

Table 15. Details of Gentry Transects Surveyed On Niutao Atoll.

Transect #	Site	Vegetation code	Species Diversity	No. of trees	Basal Area (m²)	Volume (m³)
1	Niutao	4	7	28	0.73	2.34
2	Niutao	2	4	12	0.68	3.54
3	Niutao	2	4	21	0.78	1.79
4	Niutao	2	5	20	0.72	2.43
5	Niutao	2	5	18	1.06	6.6
6	Niutao	2	3	14	0.72	3.63
7	Niutao	2	4	22	0.58	2.08
8	Niutao	2	5	19	1.44	4.32
9	Niutao	1	5	20	1.24	3.09
10	Niutao	1	5	14	4.21	9.1
11	Niutao	3	4	12	0.91	1.48
12	Niutao	4	8	21	1.01	3.8

Note: Each transect covers an area of 100 m² (50 x 2 m). Vegetation types: 1 – Inland broadleaf woodland, 2 – Littoral forest and scrub, 3 – Mangrove and wetland, 4 – Coconut woodland and agroforest, 5 – Disturbed human modified vegetation.

All the five vegetation types were recorded on Nutao Island. The 'Disturbed human modified' and 'Coconut woodland and agroforest' vegetation were dominant covering 62% of the island (31% each) (Figure 21). The 'Inland broadleaf woodland' vegetation covered 17% of the island. The least dominant habitats were the 'Littoral forest and scrub' (9% cover) and 'Mangrove and wetland' vegetation (8% cover). In summary, more than 60% of the vegetation cover of Niutao is disturbed and less than 40% of the island is still made up of intact or more natural habitats.

Littoral forest and scrub

Seven gentry transects surveyed were in the 'Littoral forest and scrub vegetation'. The average number of species sampled in a transect ranged from three to five and the number of trees from 12 to 22. The basal area ranged from 0.58 to 1.44 m² and volume content from 1.71 to 4.32 m³ for a surveyed area of 100 m². The common trees recorded in this vegetation system were 'Niu', 'Falavao', 'Felo' and 'Lafau'. In terms of basal area and volume the dominant trees recorded were 'Falavao' and 'Niu' (Appendix 3.3). This vegetation system is one of the most common vegetation types present on Niutao and in most instances 'Littoral forest and scrub' overlaps with the 'Coconut woodland and agroforest vegetation'.

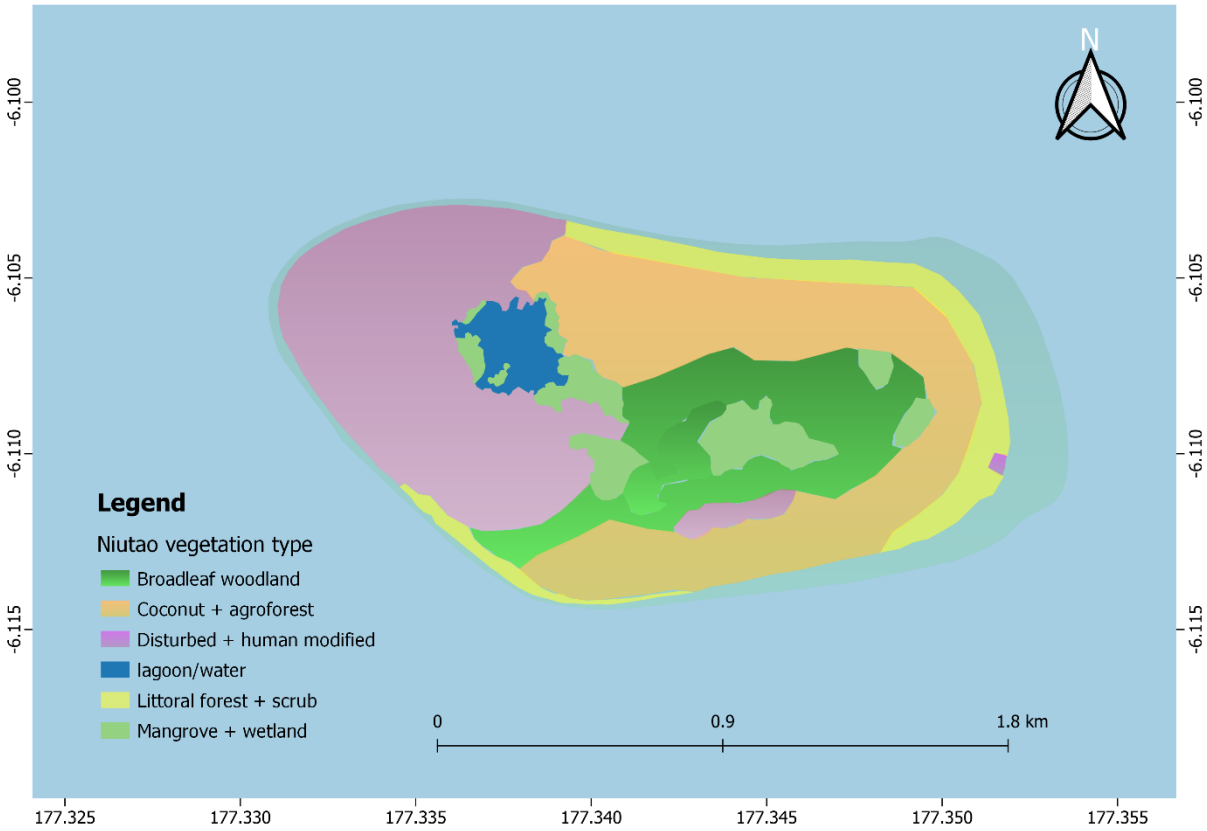


Figure 21. *Vegetation types on Niutao Island.*

Inland broadleaf woodland

There were only two gentry transects sampled in this vegetation system. This vegetation system recorded the highest basal area and volume for the island of Niutao, meaning that larger trees dominate this system. The average number of tree species recorded in each transect was five and the number of trees ranged from 14 to 20. The basal area recorded ranged from 1.24 to 4.21 m² and the volume ranged from 3.09 to 9.10 m³ for a surveyed area of 100 m². The common trees recorded were 'Pua' and 'Fala' and the more dominant trees in terms of their size (basal area and volume) were 'Fetau', 'Pua' and 'Niu' (Appendix 4.3). For this vegetatation type, on Niutao 'Fetau' becomes a dominant species instead of 'Pukavai', which was observed on Funafuti and Nukulaelae.

Coconut woodland and agroforest

There were two gentry transects sampled for this vegetation system. The average number of species was seven to eight and the number of trees was 21 to 28 in each transect sampled. This vegetation system recorded the highest number of tree species per transect. The basal area recorded ranged from 0.73 to 1.01 m² and volume from 2.34 to 3.8 m³ for a surveyed area of 100 m². The most common tree sampled was 'Valovalo' and 'Niu'. The dominant trees sampled in terms of basal area and volume were 'Niu' and 'Pukavai' (Appendix 4.3). This vegetation system was the most common vegetation type on Niutao Island, as well as for the islands in Tuvalu.

Mangrove and wetland

Only one gentry transect was sampled in this vegetation system. In that transect four tree species and 12 trees altogether were recorded. The basal area for the transect was 0.91 m² and the timber volume was 1.48 m³. The common tree sampled in this transect was 'Mangrove' and dominant trees in terms of basal area was 'Mangrove' and volume was 'Kanava' (Appendix 3.3). This vegetation system is the least common out of the five vegetation systems present on Niutao Atoll.

NIUTAO TERRESTRIAL FAUNA

A total of 14 terrestrial vertebrate fauna species were recorded during the Niutao BioRAP (Table 16). The seabirds were the most diverse comprising 37% of all of the species recorded. The shorebirds and reptiles both each made up 21% of the total species. The land birds and the mammals were the least diverse making up 14% and 7% respectively, of all of the species recorded on Niutao Atoll.

Table 16. Terrestrial Vertebrate Fauna Species Recorded on Niutao Atoll.

Tuvalu Name	Common Name	Scientific Name	Family
Land-birds			
Lupe	Pacific pigeon	*Ducula pacifica*	Columnidae
Moa	Domestic fowl	*Gallus gallus*	Phasinnidae
Sea-Birds			
Gogo	Brown noddy	*Anous stolidus*	Sternndae
Lakia	Black noddy	*Anous minutus*	Sternndae
Akiaki	White tern	*Gygis alba*	Sternndae
Katafa	Frigatebird	*Fregata minor/ariel*	Freganidae
Tavakelau	White tailed tropic bird	Phaethon lepturus	Phaetontidae
Shore-Birds			
Tuli	Pacific golden plover	*Pluvialis dominica*	Charaniidae
Kolili	Ruddy Turnstone	*Arenaria interpres*	Charanidae
Matuku	Pacific reef heron	*Egretta sacra*	Ardeinae
Reptiles			
	White-bellied Copper-triped Skink	*Emoia cyanura*	Scincidae
	Dark-bellied Copper-striped Skink	*Emoia impar*	Scincidae
	Pygmy Snake-eyed Skink	*Cryptoblepharus eximius*	Scincidae
Mammals			
	Black/Ship Rat	*Rattus rattus*	Muridae

Niutao Land Birds

A total of 11 sites were surveyed for land bird abundance on Niutao Ayoll during the BioRAP. There were two species of land birds (the introduced 'Moa' and the indigenous 'Lupe') detected during the land bird survey. A total of 29 'Lupe' birds were detected from the 11 survey sites and from this data were able to determine the

density of 'Lupe' birds in two habitats on Niutao. In human disturbed habitats ('Coconut woodland & agroforest' and 'Disturbed & human modified' vegetation) we calculate a density of 45 birds/ha (Appendix 4.4). In less disturbed habitats ('Littoral forest and scrub' and 'Inland broadleaf woodland' vegetation) we calculated a density value of 57 birds/ha (Appendix 4.4). The indigenous 'Lupe' birds showed more preference for less disturbed habitats with more tree cover on Niutao Atoll.

Niutao Seabirds

A total of 10 known seabird nesting colonies were surveyed (Table 17) on Niutao. The number of nesting adult species ranged from one to three species per colony and the number of nesting adult birds ranged from one to 14 per colony. The 'Gogo' (Brown Noddy) was the dominant nesting adult seabird in all the 10 surveyed colonies.

Table 17. Density of Nesting Seabirds in Seabird Colonies on Niutao.

Species	Density (#/100m²)	Projected density (#/ha)
Colony 1		
Gogo	12	1200
Colony 2		
Gogo	**13**	**1300**
Colony 3 (Talo)		
Gogo	13	1300
Akiaki	4	400
Colony 4 (Talipoiaki)		
Gogo	11	1100
Colony 5 (Tefuti)		
Tavakelau	5	500
Gogo	14	1400
Akiaki	3	300
Colony 6 (Agaia 1)		
Gogo	5	500
Akiaki	1	100
Colony 7 (Agaia 2)		
Gogo	14	1400
Colony 8		
Gogo	12	1200
Colony 9 (Tamana)		
Gogo	11	1100
Colony 10 (Teulufala)		
Gogo	4	400

A point count survey was conducted at 13 seabird colonies in Niutao Atoll. The diversity of species ranged from one to four species per colony and the number of birds ranged from nine to 110 per colony (Table 18). Tefuti, Matagi and Pukapuka seabird colonies were the most diverse with four species of seabirds at each site. Tefuti recorded the highest number of birds out of the 13 seabird colonies. In 11 of the colonies the 'Gogo' (Brown Noddy) was the dominant species, and in only two of the colonies, the 'Lakia' (Black Noddy) was the more dominant species.

Table 18. Point Count Surveys of Seabirds in Seabird Colonies at Niutao Atoll.

Site	Species							Total
	Gogo	Lakia	Akiaki	Talaliki	Katafa	Matapula	Kanapu	
Tefuti 5	35	25	25	0	25	0	0	110
Agaia6	40	1	7	0	0	0	0	48
Matagi11	40	2	5	0	1	0	0	48
Talo3	25	2	6	0	0	0	0	33
Samatua2	50	3	1	0	0	0	0	54
Transect1	0	7	2	0	0	0	0	9
Talipoiaki	35	2	3	0	0	0	0	40
Pukapuka	45	9	9	0	5	0	0	68
Teulfala10	35	7	3	0	0	0	0	45
Tamana9	35	5	4	0	0	0	0	44
Transect8	35	4	2	0	0	0	0	41
Agaia7	36	13	5	0	0	0	0	54
Maumatagi	25	35	1	0	0	0	0	61

Niutao Shorebirds

Five sites were surveyed to estimate the number and the diversity of seabirds present. Three species of shorebirds were recorded from these five sites (Table 19). The diversity ranged from one to three species and the number of birds ranged from three to 11 for each site. The 'Kolili' (Ruddy Turnstone) was again the most commonly recorded species at most of the sites surveyed on Niutao Atoll/Island.

Table 19. Shorebird Abundances at Ten Sites in the Niutao Atoll Survey.

Site	Species					Total
	Tuli	Kolili	Kilikilitai	Matuku	Grey tail	
NW Agaia Beach	1	0	0	7	0	8
NE Tamana Beach	2	8	0	1	0	11
East Tegie Rocks	2	4	0	0	0	6
South East Sagasaga	1	1	0	1	0	3
South Beach	1	8	0	1	0	10

Niutao Terrestrial Reptiles

A total of 11 reptile transects were surveyed during the Niutao BioRAP. Three species of reptiles (skinks) were detected (Table 20). All the transects were surveyed during the day and there was no night survey carried out. The 'Pygmy Snake-eyed Skink' and 'Dark-bellied Copper-striped Skink' were the two most abundant species detected from the transects. The 'White-bellied Copper-triped Skink' was common but not as abundant as the other two species (Table 20). The diversity of reptiles

ranged from two to three species per transect/site and the number of reptiles ranged from three to seven per transect/site.

Table 20. Reptile Surveys at Six Sites on Funafuti Atoll.

Site	Species	Density (#/100 m²)
Maumataga 1	Pygmy Snake-eyed Skink	3
	Dark-bellied Copper-striped Skink	2
Agaia 2	Dark-bellied Copper-striped Skink	1
	Pygmy Snake-eyed Skink	1
	White-bellied Copper-triped Skink	1
T3	Pygmy Snake-eyed Skink	2
	Dark-bellied Copper-striped Skink	3
T4	Pygmy Snake-eyed Skink	3
	Dark-bellied Copper-striped Skink	3
Te futi 5	Pygmy Snake-eyed Skink	2
	Dark-bellied Copper-striped Skink	1
	White-bellied Copper-triped Skink	1
Agaia 6	Pygmy Snake-eyed Skink	3
	Dark-bellied Copper-striped Skink	2
	White-bellied Copper-triped Skink	1
T7	Pygmy Snake-eyed Skink	4
	Dark-bellied Copper-striped Skink	1
T8	Pygmy Snake-eyed Skink	2
	Dark-bellied Copper-striped Skink	2
	White-bellied Copper-triped Skink	3
T9	Pygmy Snake-eyed Skink	3
	Dark-bellied Copper-striped Skink	1
T10	Pygmy Snake-eyed Skink	3
	Dark-bellied Copper-striped Skink	1
	White-bellied Copper-triped Skink	1
Pukapuka 12	Pygmy Snake-eyed Skink	4
	Dark-bellied Copper-striped Skink	2
	White-bellied Copper-triped Skink	2

Niutao Land Mammals

During the BioRAP, a total of 10 rat/rodent traps were set for three nights. Only one species of rat was recorded from the rat traps, which is the introduced Black or Ship Rat (Table 16). This species is a pest and is considered a threat to the native biodiversity.

NIUTAO MARINE BIODIVERSITY

Unlike Funafuti and Nukulaelae, the majority of the land area of Niutao is contained within the main island, so three UVC surveys were conducted on the leeward and three on the windward side of the main island. The UVCs focussed on identifying iconic species in the resident fish and invertebrate assemblages, as well as evaluating the benthic substratum to assess habitat structure of the coral reefs of Niutao Atoll. The following sections detail the results of these surveys.

Fish and Invertebrate Assemblages

A total of 37 taxa from 12 fish families were recorded, out of the 16 families recorded throughout the four islands (Appendix 2.1). The four fish families (recorded in the other islands) for which no species were recorded in the Niutao UVCs were the Haemulidae (Grunts/Sweetlips), Nemipteridae (Threadfin bream), Zanclidae (Moorish Idol) and Mullidae (Goatfish). A good number of fish families were relatively abundant, namely the Pomacentridae, Acanthuridae, Balistidae, Lutjanidae, Scaridae and Labridae with estimated densities of 1000+ individuals per hectare. Even the less common Brassy Chub was found at Niutao in estimated densities of 500+ individuals per hectare.

Again similar to Funafuti, the species richness of the Scaridae (parrotfish) and Labridae (wrasses), are likely underestimated due to sampling constraints however, these families constitute a major proportion of the fish biomass at all three sites surveyed at Niutao Atoll. It is important to note that species diversity in the Chaetodontidae (indicator corallivore fish), peaked at Niutao with 24 species recorded. Diversity in this family is an indicator of the overall health of the reef system, although coral species diversity was the lowest of all four islands/atolls surveyed. In addition, the survey team captured a video of a young leatherback turtle that had been encountered outside of the transects (with a shell length of ~50 cm), which could potentially suggest the presence of sub-tidal offshore seagrass meadows.

In contrast, the benthic community of the Niutao sites was starkly less speciose, with only the Long-spined black sea urchin present and recorded as a common inhabitant (Appendix 2.1). The lack of invertebrate records could also be due to the underwater terrain surveyed. The depth of the UVC surveys (2-8 m) and the turbidity of the water visible in underwater imagery captured by the survey team could possibly have constrained surveys of benthic invertebrates. The relative abundance of the wrasses, surgeonfish, and damselfish recorded on the three transects at Niutao, must also be highlighted for further discussion.

Benthic Substratum

There was a contrast in substrate cover on the leeward transects where hard coral was more prevalent than rock (except at the first transect site where rock was more common). On the windward transects, the opposite pattern was observed. Hard/live corals covered less of the substrate in comparison to bare rock, except at the first windward site, where hard corals was more common in the susbstratum compared to rock (Figure 22). There was distinctively more sandy substrate on the leeward coastal sites in comparison to the windward sites

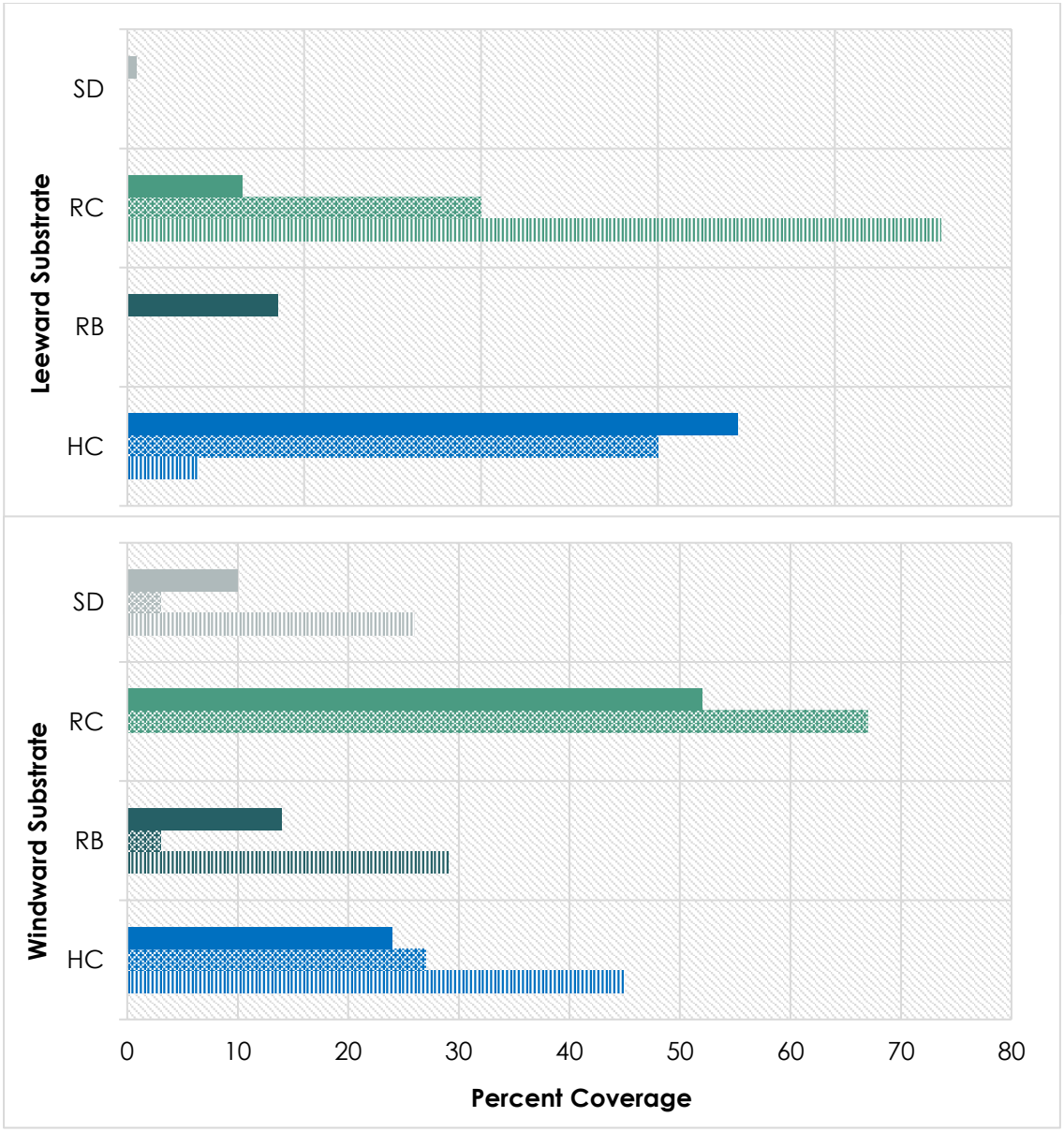


Figure 22. *Coastal substrates on three transects on the leeward (upper graph) and the windward (lower graph) coasts of Niutao island; transect 1 - striped bars, transect 2 – cross-hatched bars, and transect 3 – solid bars. Substrate category codes are; HC – hard coral, RB – rubble, RC – rock, and SD – sand.*

Four massive corals dominated the recovering patch coral at the three sites were hard corals were recorded: Acropora, Montipora, Echinopora and Isopora (Figure 23). Coral bleaching ranged from eight to an alarming 57% at one site, and bleached corals covered an average of 31% of the UVC substratum at Niutao (Table 21). The proportion of bleached corals was higher on the leeward transects than the windward transects.

Species Diversity & Habitat Structure

The diversity in the fish assemblage of the coral reefs of Niutao is clearly not associated with coral species diversity. The loss of live coral substrate to bleaching is obviously linked to a species poor coral fauna, which may have translated to a species depauperate benthic invertebrate fauna. In contrast to Funafuti Atoll, there were

comparatively more fish and invertebrate taxa in the more exposed coral reef assemblage on the windward side of the island. It is just as likely that this pattern is linked to a lower incidence of coral bleaching on the windward coastal shelf. The low species richness (S) and diversity (H') values for the Niutao survey sites (Table 21) are due to the low values measured for the second leeward site in particular. The low values recorded here are clearly linked to the alarming level of coral bleaching (Figure 24).

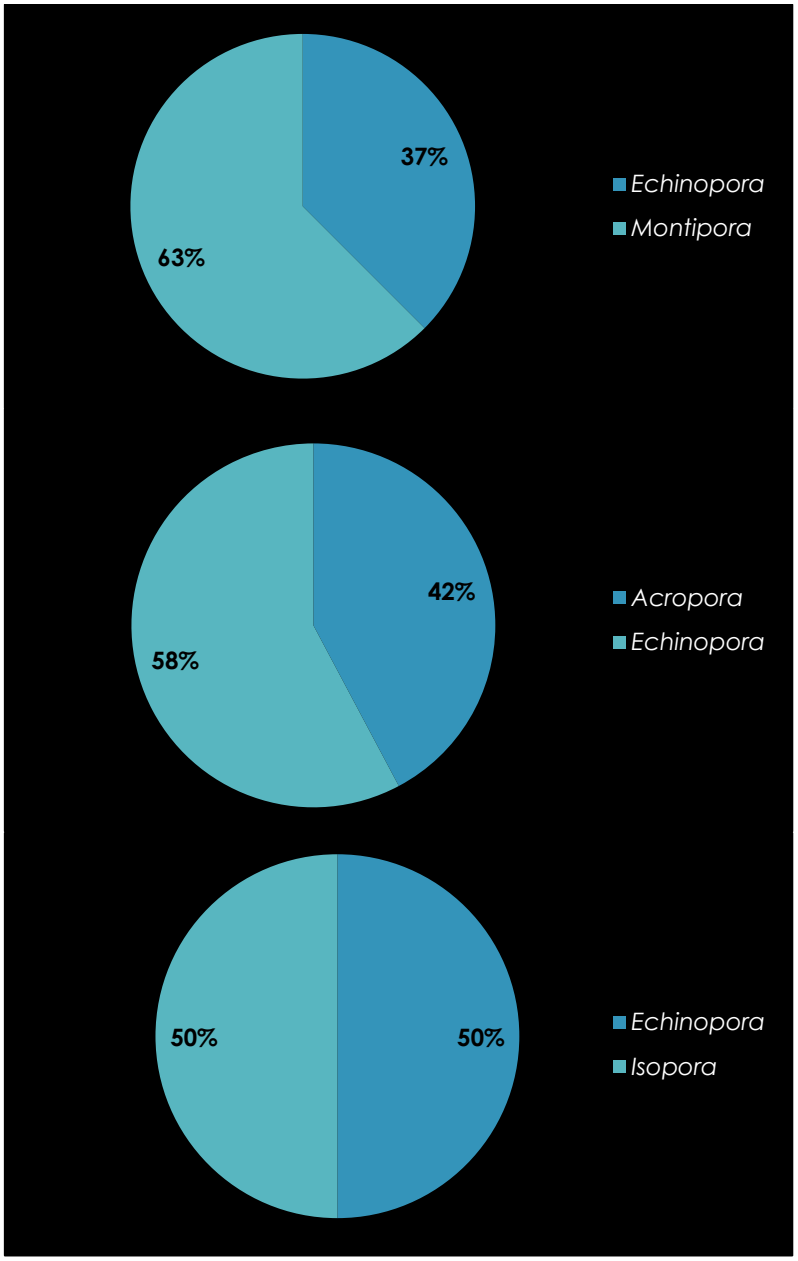


Figure 23. *Proportional substrate coverage on Niutao by hard coral taxa at leeward coastal site 3 – top graph, windward site 2 – middle graph, and windward site 3 – bottom graph. Transects where the hard coral cover was all bleached (leeward site 1 & windward site 3) or mostly bleached (95%; leeward site 2), have been excluded.*

Figure 24. UVC at Niutao showing the depth of water, extent of coral bleaching and patch coral recovery.

Table 21. Coral Cover, Fish & Invertebrate Species Community Richness in Niutao.

Aspect	Transect	Coral	Percent Cover	*S*	*H'*
Leeward	1	Bleached	8%	22	2.28
	2	*Acropora*	3%	9	1.52
		Bleached	57%		
	3	*Echinopora*	9%	12	1.81
		Montipora	15%		
		Bleached	45%		
Windward	4	*Acropora*	19%	16	2.29
		Echinopora	26%		
	5	*Echinopora*	3%	17	2.12
		Isopora	3%		
		Bleached	21%		
	6	Bleached	24%	18	2.36

Vaitupu Atoll

Vaitupu Atoll: Summary

The BioRAP of Vaitupu Island was carried out from the 3rd to the 7th of May 2021. Like Niutao Island, all the survey sites were on the main Island of Vaitupu. A summary of the survey sites and survey effort is shown on the survey map of Vaitupu (Figure 25) and on Appendix 5.1. In summary, 235 plant species were recorded during the survey, from 14 gentry transects covering three vegetation systems. A total of 16 terrestrial vertebrate fauna species (seven seabirds, three shore birds, three reptiles, two land birds and one mammal) were recorded during the BioRAP. Marine species richness was lowest on Vaitupu Atoll, with only 27 taxa recorded. The only record of a cephalopod (octopus) came from Vaitupu Atoll, and along with Nukulaelae, Vaitupu was the only other surveyed location where sea cucumbers occurred. There was evidence of past coral bleaching followed by recent recovery of some hard corals. The high nutrient input inferred from the presence of macroalgae and sponge species, and from the turbidity of the water, is linked to the lack of diversity in the inner lagoon.

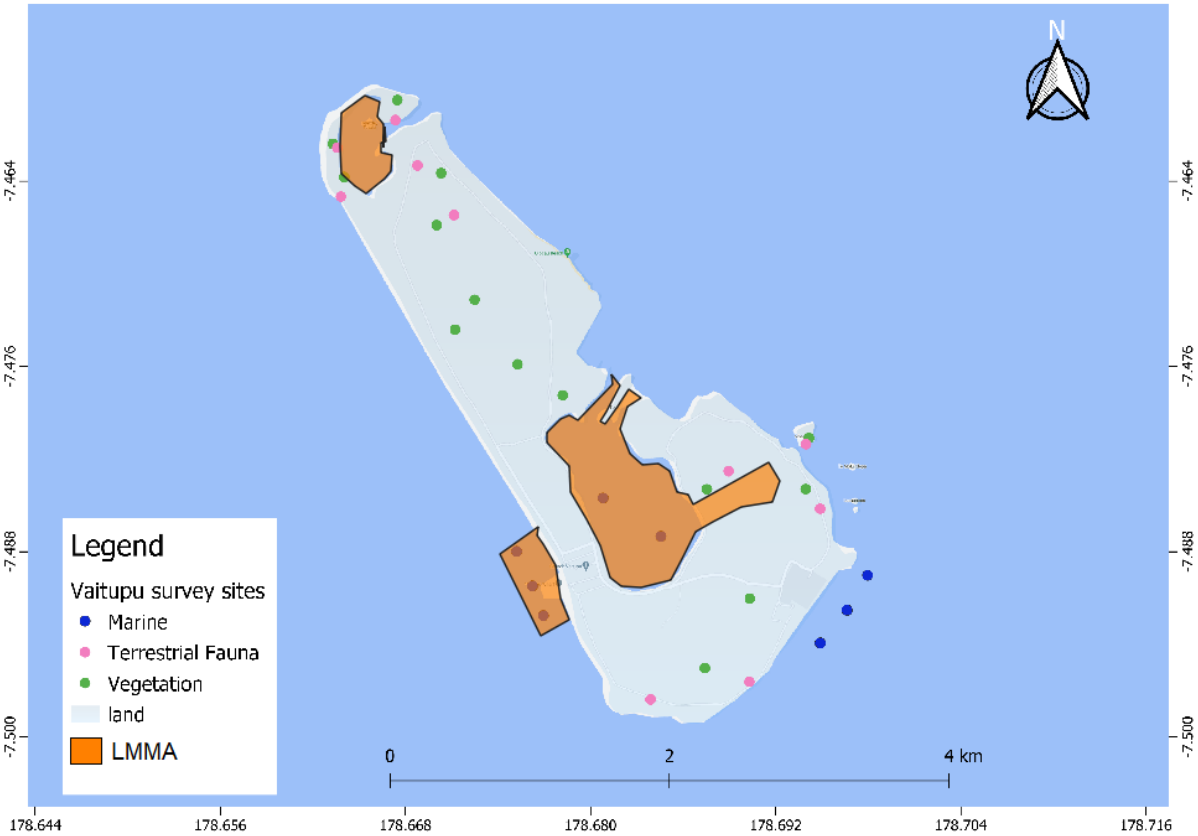


Figure 25. *Vaitupu Island – existing protected areas, terrestrial and marine sample sites.*

VAITUPU TERRESTRIAL FLORA

A total of 235 species of plants were recorded during the BioRAP survey (Appendix 5.2). The most diverse plant group were the dicotyledons with 172 species, however like the other islands many of these species have been introduced to Vaitupu. The monocotyledons recorded the second highest number of species (54 species)

followed by the ferns with seven species and the least diverse group were the gymnosperms with only two species (Figure 26). Introduced species were dominant accounting for 77% of the entire species recorded for Vaitupu. The remaining 23% consists of indigenous plant species.

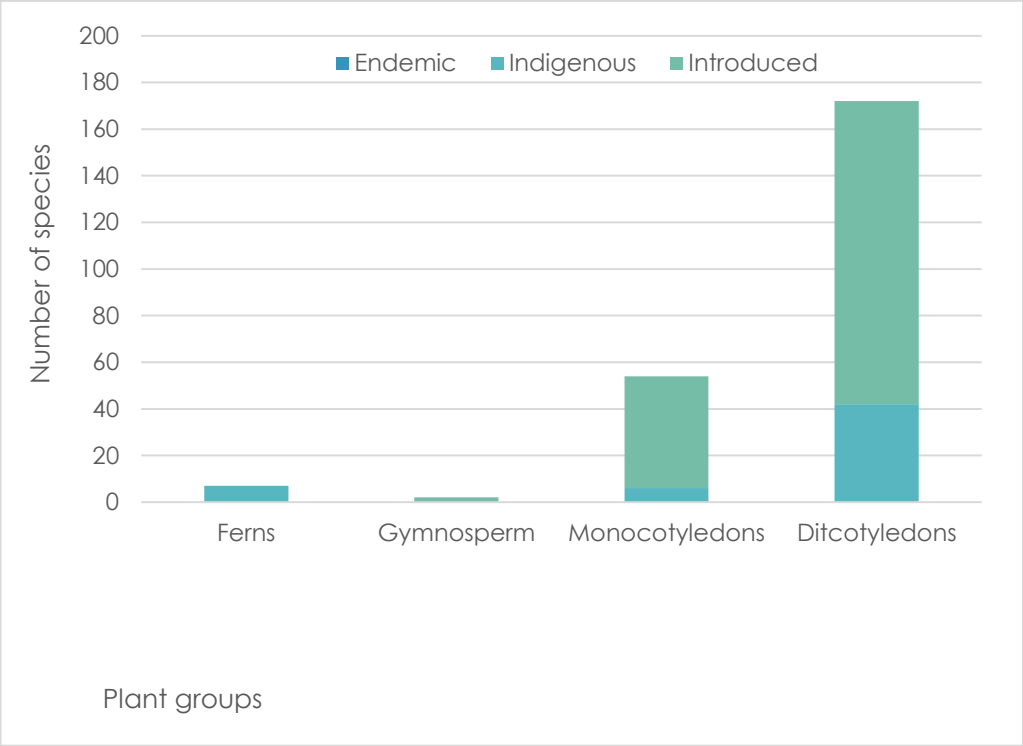


Figure 26. *Summary of the floral diversity of Vaitupu Atoll.*

From the five different vegetation systems present on the island, 'Disturbed/human modified vegetation' was the most diverse recording 138 plant species. The 'Littoral forest and scrub vegetation' recorded 65 species, followed by the 'Coconut woodland and agroforest vegetation' recorded 40 species and the 'Inland broadleaf woodland' recorded 33 species (Figure 27). The 'Mangrove and wetland vegetation' was the least diverse with only 17 species. Only the 'Inland broadleaf woodland vegetation' is still dominated by indigenous species, however, the other four vegetation systems are mostly dominated by introduced plant species

VAITUPU VEGETATION

A total of 14 gentry transects were sampled on Vaitupu Island (Table 15). The 'Littoral forest and scrub vegetation' was the most sampled vegetation during the survey. It also recorded the highest species diversity and tree density scoring nine species and 32 trees in a transect area. In terms of dominance, the 'Inland broadleaf woodland vegetation' recorded the highest basal area (5.69 m^2) and timber volume (13.73 m^3) during the survey (Table 15). The other vegetation systems that was sampled was the 'Coconut woodland and agroforest vegetation'. Like the island of Niutao, Vaitupu Island is mostly covered with a mixture of 'Coconut woodland' and 'Littoral forest and scrub' vegetation. The 'Inland broadleaf woodland vegetation' though still dominates certain areas inland of Vaitupu Island.

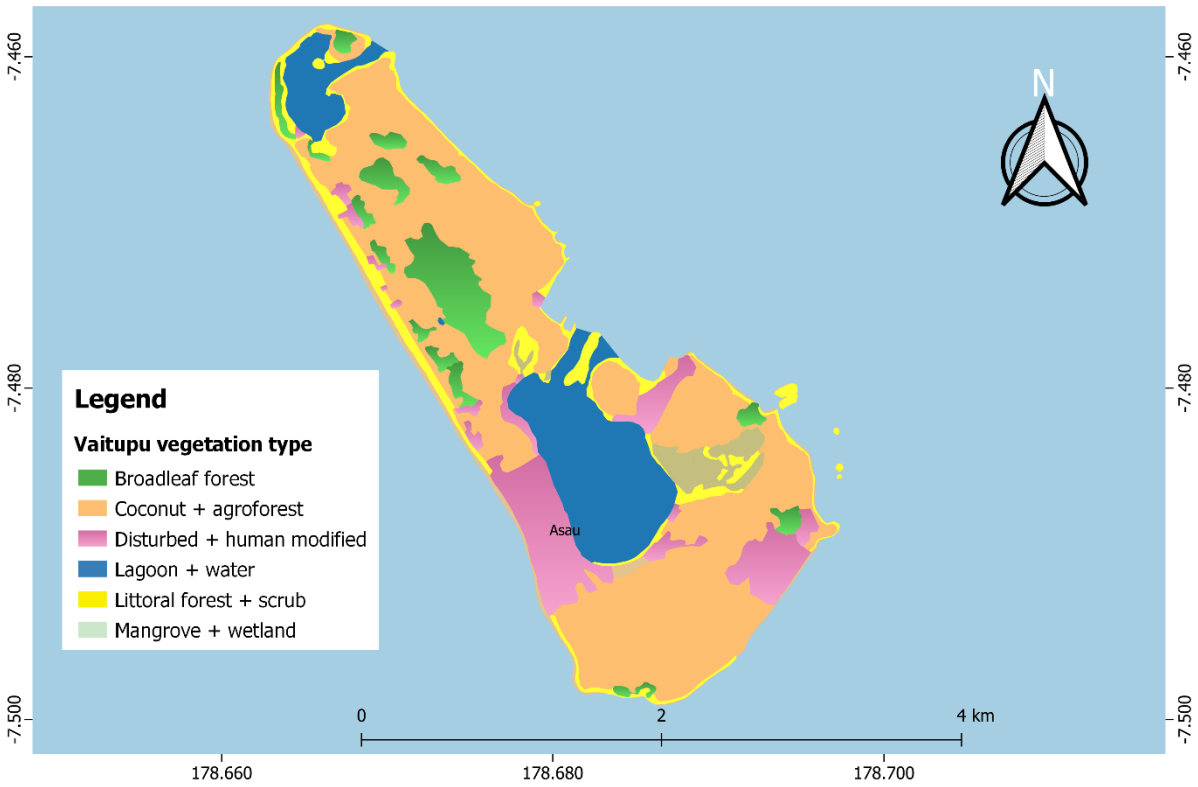


Figure 27. *Vegetation types on Vaitupu Atoll/ Island.*

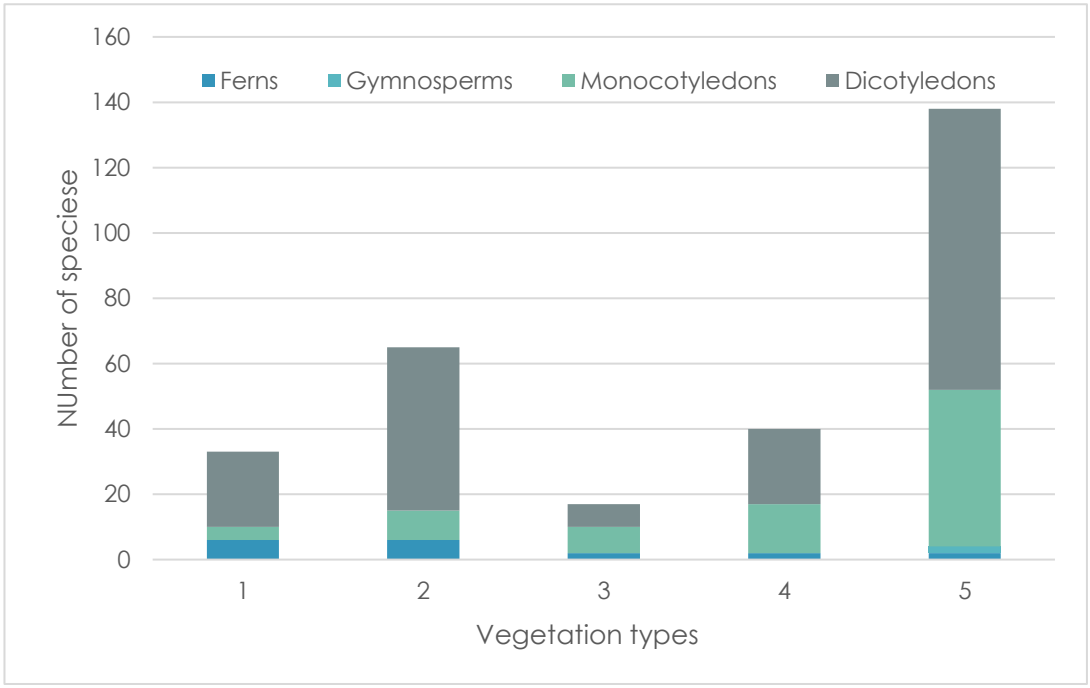


Figure 28. *Plant species diversity recorded in each vegetation type on Vaitupu. Vegetation codes: 1 – Inland broadleaf woodland, 2 – Littoral forest and scrub, 3 – Mangrove and wetland, 4 – Coconut woodland and agroforest, 5 – Disturbed human modified vegetation).*

All of the five vegetation types identified for Tuvalu were recorded on Vaitupu Island. The two more disturbed vegetation types provided the majority of the vegetation

cover of Vaitupu. The 'Coconut woodland and agroforest' vegetation was the most dominant covering about 61% of the dry land area (Figure 28). The 'Disturbed and human modified' vegetation was the second most dominant covering 14% of the island. The 'Inland broadleaf woodland' vegetation was most common with 11% coverage, 'Littoral forest and scrub' vegetation recorded a 10% cover, and the remaining 4% was made up of the 'Mangrove and wetland' vegetation. In summary, more than 70% of the land area of Vaitupu Island is covered by disturbed habitats (Coconut woodland and agroforest and Disturbed human modified vegetations). This observation is similar to that observed for Funafuti Atoll (90% disturbed) and Niutao Island (60% disturbed).

Table 22. Details of Gentry Transects Surveyed On Vaitupu Atoll.

Transect #	Site	Vegetation code	Species Diversity	No. of trees	Basal Area (m^2)	Volume (m^3)
1	Vaitupu	4	7	26	4.12	10.15
2	Vaitupu	2	5	32	1.82	6.76
3	Vaitupu	2	3	28	1.33	4.68
4	Vaitupu	2	8	26	1.43	4.94
5	Vaitupu	1	6	26	3.95	13.72
6	Vaitupu	4	7	25	0.83	4.84
7	Vaitupu	1	5	24	2.49	7.73
8	Vaitupu	2	4	23	1.94	8.34
9	Vaitupu	4	6	15	4.61	10.03
10	Vaitupu	1	6	19	2.58	11.45
11	Vaitupu	1	4	26	5.69	7.19
12	Vaitupu	4	2	7	3.66	9.2
13	Vaitupu	2	7	24	2.83	9.38
14	Vaitupu	2	4	21	0.66	1.03

Note: Each transect covers an area of 100 m^2 (50 x 2 m). Vegetation types: 1 – Inland broadleaf woodland, 2 – Littoral forest and scrub, 3 – Mangrove and wetland, 4 – Coconut woodland and agroforest, 5 – Disturbed human modified vegetation.

Littoral forest and scrub

There were six gentry transects sampled for this vegetation type. The number of tree species recorded in each transect ranged from three to eight, and the number trees in a transect ranged from 21 to 32 (Table 22). The basal area recorded ranged from 0.66 to 2.83 m^2 and the tree volume ranged from 1.03 to 9.38 m^3. The common tree species recorded were 'Niu', 'Nonu' and 'Pukavai'. The dominant trees species recorded in terms of basal area or volume were 'Pukavaka' and 'Niu' (Appendix 5.3).

Inland broadleaf woodland

There were four gentry transects sampled for this vegetation type. The number of tree species recorded ranged from four to six species, and the number of trees from 19 to 26 for each transect sampled (Table 15). The basal area recorded ranged from 2.58 to 5.69 m^2 and volume ranged from 7.19 to 13.73 m^3. This vegetation system recorded the biggest trees in Vaitupu Island as indicated in Table 22. The most common tree species recorded in this vegetation were 'Pukavai', 'Pukavaka', and

'Niu'. The dominant trees species in terms of basal area or volume were 'Pukavai' and 'Pukavaka' (Appendix 5.3).

Coconut Woodland and Agroforest

In this vegetation system, four gentry transects were sampled during the survey. The number of tree species recorded ranged from two to seven species, and number of trees recorded ranged from seven to 26 for each transect sampled (Table 22). Tree basal area recorded ranged from 0.83 to 4.14 m^2 and the volume recorded ranged from 4.84 to 10.15 m^3 for an area of 100 m^2 sampled. The common tree species recorded were 'Niu' and 'Pukavaka'. The dominant tree species recorded in terms of the basal area and volume were 'Pukavaka', 'Niu', 'Fetau' and 'Mei' (Appendix 5.3). This vegetation system is the most common vegetation system present on Vaitupu Island.

VAITUPU TERRESTRIAL FAUNA

A total of 16 terrestrial vertebrate species were recorded during the BioRAP (Table 23). The seabirds were the most diverse group comprising 44% of the total species recorded. The shorebirds and reptiles each made up 19% of the total species. The land birds and mammals were the least diverse comprising 12% and 6%, respectively, of the total species count.

Table 23. Terrestrial Vertebrate Fauna Species Recorded on Vaitupu Atoll.

Tuvalu Name	Common Name	Scientific Name	Family
Land Birds			
Lupe	Pacific pigeon	*Ducula pacifica*	Columbidae
Moa	Domestic fowl	*Gallus gallus*	Phasianidae
Seabirds			
Gogo	Brown noddy	*Anous stolidus*	Sternidae
Lakia	Black noddy	*Anous minutus*	Sternidae
Akiaki	White tern	*Gygis alba*	Sternidae
Talaliki	Sooty tern	*Sterna fuscata*	Sternidae
Matapula	Black napped tern	*Sterna sumatrana*	Sternidae
Katafa	Frigatebird	*Fregata minor/ariel*	Fregatidae
Tavakelau	White tailed tropic bird	*Phaethon lepturus*	Phaetontidae
Shorebirds			
Tuli	Pacific golden plover	*Pluvialis dominica*	Charadiidae
Kolili	Ruddy Turnstone	*Arenaria interpres*	Charadidae
Matuku	Pacific reef heron	*Egretta sacra*	Ardeidae
Reptiles			
	White-bellied Copper-triped Skink	*Emoia cyanura*	Scincidae
	Dark-bellied Copper-striped Skink	*Emoia impar*	Scincidae
	Pygmy Snake-eyed Skink	*Cryptoblepharus eximius*	Scincidae
Mammals			
	Black/Ship Rat	*Rattus rattus*	Muridae

Vaitupu Land Birds

Two species of land birds were recorded from 14 surveys (and sites) on Vaitupu, the introduced 'Moa' and the indigenous 'Lupe'. In total, 28 'Lupe' birds were detected from the 14 sites and this data was used to calculate the density of the 'Lupe' within two habitats on Vaitupu Island. In human disturbed habitats, a density of 24 birds/ha was determined (Appendix 5.4).

Table 24. Density of Nesting Seabirds in Seabird Colonies on Vaitupu.

Species	Density (#/100 m²)	Projected density (#/ha)
Punatau		
Matapula	2	200
Lakia	1	100
Gogo	2	200
Motu Letika		
Lakia	27	2700
Gogo	3	300
Punatau		
Matapula	8	800
Teakega		
Gogo	1	100
Fongamanu		
Lakia	2	200
Tavakelau	2	200
Gogo	2	200
Olokalaga		
Gogo	5	500
Lakia	1	100
Olosau		
Gogo	3	300
Taaga		
Lakia	2	200
Gogo	2	200
Soala		
Matapula	3	300
Gogo	2	200
Elisefou		
Gogo	7	700
Matapula	1	100
Moru Mosana		
Lakia	5	500
Togo		
Gogo	3	300
Dumpsite		
Gogo	1	100
Patamo		
Gogo	4	400
Lakia	8	800

In comparison to the human disturbed habitats ('Coconut woodland & agroforest' vegetation), 'Lupe' was recorded at a density of 66 birds/ha in the less disturbed habitats ('Littoral forest and scrub', 'Inland broadleaf woodland' and 'mangrove & wetland' vegetation; Appendix 5.4). Like Niutao Island, the 'Lupe' shows higher density and higher possibly higher preference for less disturbed habitats with more tree cover and less human interference.

Vaitupu Seabirds

The nesting sites of 13 known seabird colonies were surveyed to detect the number of nesting adult birds (Table 24). The diversity of nesting adults at the survey sites ranged from one to three species and the number of adult nesting birds ranged from three to 30 per transect (10 m²) surveyed for each colony. Motu Letika sea bird colony recorded the highest number of nesting adults (30) for a 100 m² area. 'Lakia' (Black Noddy), 'Gogo' (Brown Noddy) and 'Matapula' (Black Naped Tern) appeared to be more dominant seabird species on Vaitupu.

A total of 14 seabird colonies on Vaitupu were surveyed, where seven seabird species were recorded (Table 25). The diversity ranged from three to six species per colony and the number of birds detected ranged from six to 48 per colony. Punatau and Olokalaga seabird colonies were the most diverse where six species were reported from each colony. Taaga seabird colony on the other hand recorded the highest number of birds (Table 25).

Vaitupu Shorebirds

From the four sites selected for surveys, three species were detected and the 'Kolili' (Ruddy Turnstone) was the most common shorebird present (Table 26). The diversity of shorebirds in each colony was three species however, the total number of birds detected ranged from five to 18 birds per colony.

Table 25. Point Count Surveys of Seabirds in Seabird Colonies on Vaitupu Atoll.

Colony	Species								Total
	Gogo	Lakia	Akiaki	Talaliki	Katafa	Matapula	Kanapu	Tavakelau	
Ounatau3	2	4	5	0	1	0	0	0	**12**
Punatau1	1	2	5	0	2	2	0	1	**13**
Poogamanu	5	4	3	0	0	0	0	4	**16**
Olokalaga	10	3	7	19	5	0	0	1	**45**
Taaga8	4	6	9	0	3	0	0	26	**48**
Soala9	1	2	4	0	0	0	0	6	**13**
Olosau7	3	1	5	0	0	0	0	3	**12**
Teakeaga4	2	1	1	0	0	0	0	2	**6**
Motu Letika	8	28	7	0	0	0	0	2	**45**
Motu Mosana	2	4	6	0	0	2	0	0	**14**
Patamo	15	8	17	0	0	0	0	2	**42**
Dumpsite	5	6	4	0	0	0	0	0	**15**
Elisefou	24	28	25	0	0	0	0	2	**79**
Togo	16	0	18	0	0	0	0	3	**37**

Table 26. Shorebirds Abundances at Survey Sites in the Vaitupu Atoll Survey.

Site	Species					Total
	Tuli	**Kolili**	**Kilikilitai**	**Matuku**	**Grey tail**	
NE Rocks Motu Olepa	2	2	0	1	0	5
SW Beach Rock Te Felo	4	7	0	1	0	12
SW Rocks Wharf side	2	11	0	1	0	14
SE Motufoua Beach	4	12	0	2	0	18

Table 27. Reptile Surveys at Six Sites on Funafuti Atoll.

Site	Species	Density (#/100m²)
Punatau 1	Pygmy Snake-eyed Skink	3
	Dark-bellied Copper-striped Skink	1
	White-bellied Copper-triped Skink	1
Motu Letika 2	Pygmy Snake-eyed Skink	1
	White-bellied Copper-triped Skink	1
Punatau 3	Pygmy Snake-eyed Skink	1
	Dark-bellied Copper-striped Skink	2
	White-bellied Copper-triped Skink	2
Teakega 4	Pygmy Snake-eyed Skink	2
	White-bellied Copper-triped Skink	1
Fongamanu 5	Pygmy Snake-eyed Skink	3
	White-bellied Copper-triped Skink	2
Olokalaga 6	Pygmy Snake-eyed Skink	3
	White-bellied Copper-triped Skink	1
	Dark-bellied Copper-striped Skink	1
Olosau 7	Pygmy Snake-eyed Skink	3
	White-bellied Copper-triped Skink	1
	Dark-bellied Copper-striped Skink	1
Taaga 8	Pygmy Snake-eyed Skink	2
	White-bellied Copper-triped Skink	1
	Dark-bellied Copper-striped Skink	1
Soala 9	Pygmy Snake-eyed Skink	2
	Dark-bellied Copper-striped Skink	1
Elisefou 10	Pygmy Snake-eyed Skink	3
	White-bellied Copper-triped Skink	1
	Dark-bellied Copper-striped Skink	2
Motu Masana 11	Pygmy Snake-eyed Skink	1
	White-bellied Copper-triped Skink	1
Togo 12	Pygmy Snake-eyed Skink	3
	White-bellied Copper-triped Skink	4
	Dark-bellied Copper-striped Skink	1
Dumpsite 13	Pygmy Snake-eyed Skink	2
Patamo 14	Pygmy Snake-eyed Skink	5
	White-bellied Copper-triped Skink	2
	Dark-bellied Copper-striped Skink	3

Vaitupu Terrestrial Reptiles

Three reptile species were recorded from 14 transects (Table 27). All the transects were surveyed during the day and there was no night survey. There were no geckos detected during the survey. The Pygmy Snake-eyed Skink and the Dark-bellied Copper-striped Skink were the most abundant species during the survey.

Vaitupu Land Mammals

During the survey, a total of 10 rat/rodent traps were set for three nights. Only one species of rat was recorded from the rat traps, which is the introduced Black or Ship Rat (Table 23). This species is a pest and is considered a threat to the native biodiversity.

VAITUPU MARINE BIODIVERSITY

Marine species assemblages and habitat structure was assessed with six UVC surveys, in a similar manner to Niutao with three UVCs conducted on the windward side and three on the leeward side of the island. Selection of the UVC sites was restricted by the width of the coral reef flat and the depth off the coral reef crest. The UVCs focussed on identifying iconic species in the resident fish and invertebrate assemblages, as well as evaluating the benthic substratum to assess habitat structure of the coral reef. The following sections detail the results of the Vaitupu marine BioRAP.

Fish and Invertebrate Assemblages

A total of 27 taxa from 9 fish families were recorded, out of the 16 families recorded throughout the four islands (Appendix 2.1). Of the 16 fish families the Lethrinidae (Emperors & Bream), Nemipteridae (Whiptails), Carangidae (Trevally), Siganidae (Rabbitfish), Zanclidae (Moorish Idols), and Mullidae (Mullets). Two fish families were notably diverse, namely the Acanthuridae (Surgeonfish & Tangs) and Chaetodontidae (Butterfly fish), with six and ten species respectively. It is interesting to note that the Pomacentridae (damselfish), Acanthuridae, and Scaridae (parrotfish, in particular the Bumphead parrotfish) were recorded at higher densities than for the atolls, with the exception of damselfish from Funafuti. These groups were also recorded at high densities on Nuitao. A quick scan of Figure 9, confirms this observation for Vaitupu Atoll.

The benthic community of the Vaitupu fringing reef was similar to Niutao in that it was less speciose. The Long-spined black sea urchin was recorded as an occasional member of the biological community at one of the leeward sites. Sea cucumbers (unidentified species) were recorded at one leeward site, and all three windward sites (Appendix 2.1) at relatively low densities, with the exception of one of the unprotected windward sites. The depth of the UVC surveys (4-8 m) may have constrained surveys of benthic invertebrates, resulting in fewer species identified and recorded. The single octopus (from surveys at all four islands/atolls) was recorded at one of the protected leeward sites on Vaitupu.

In the inner protected lagoon, there were only seven species recorded: damselfish, Convict tang (*Acanthurus triostegus*), the Black surgeonfish (*Acanthurus gahhm*), snappers, one butterflyfish species (Threadin; *Chaetodon Auriga*) and a good number of Bumphead parrotfish (*Bolbometopon muricatum*). A sand-cleaner, the Tiger conch (*Conomurex luhuanus*), was notably abundant in the inner lagoon.

Although not recorded on a UVC, a video taken by the survey team shows a small pod of five pantropical spotted dolphins (*Stenella attenuata*) following the marine survey team's boat. Like the hawksbill turtle, also captured on video, the dolphins have been previously reported on a marine species list for Vaitupu (Appendix 2.1).

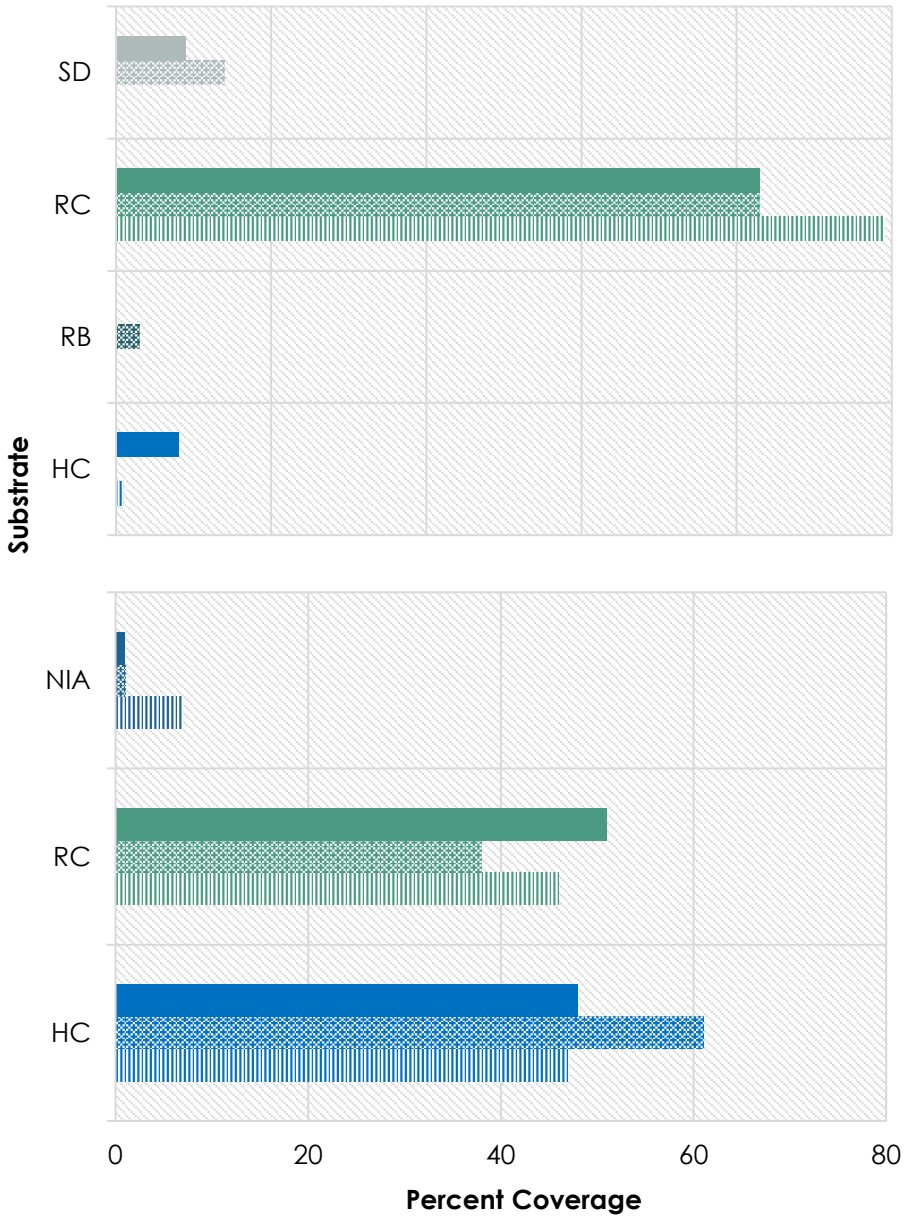


Figure 29. *Coastal substrates on three transects on the leeward (upper graph) and the windward (lower graph) coasts of Vaitupu; transect 1 - striped bars, transect 2 – cross-hatched bars, and transect 3 – solid bars. Substrate category codes are; HC – hard coral, RB – rubble, RC – rock, SD – sand, and NIA – nutrient indicator algae.*

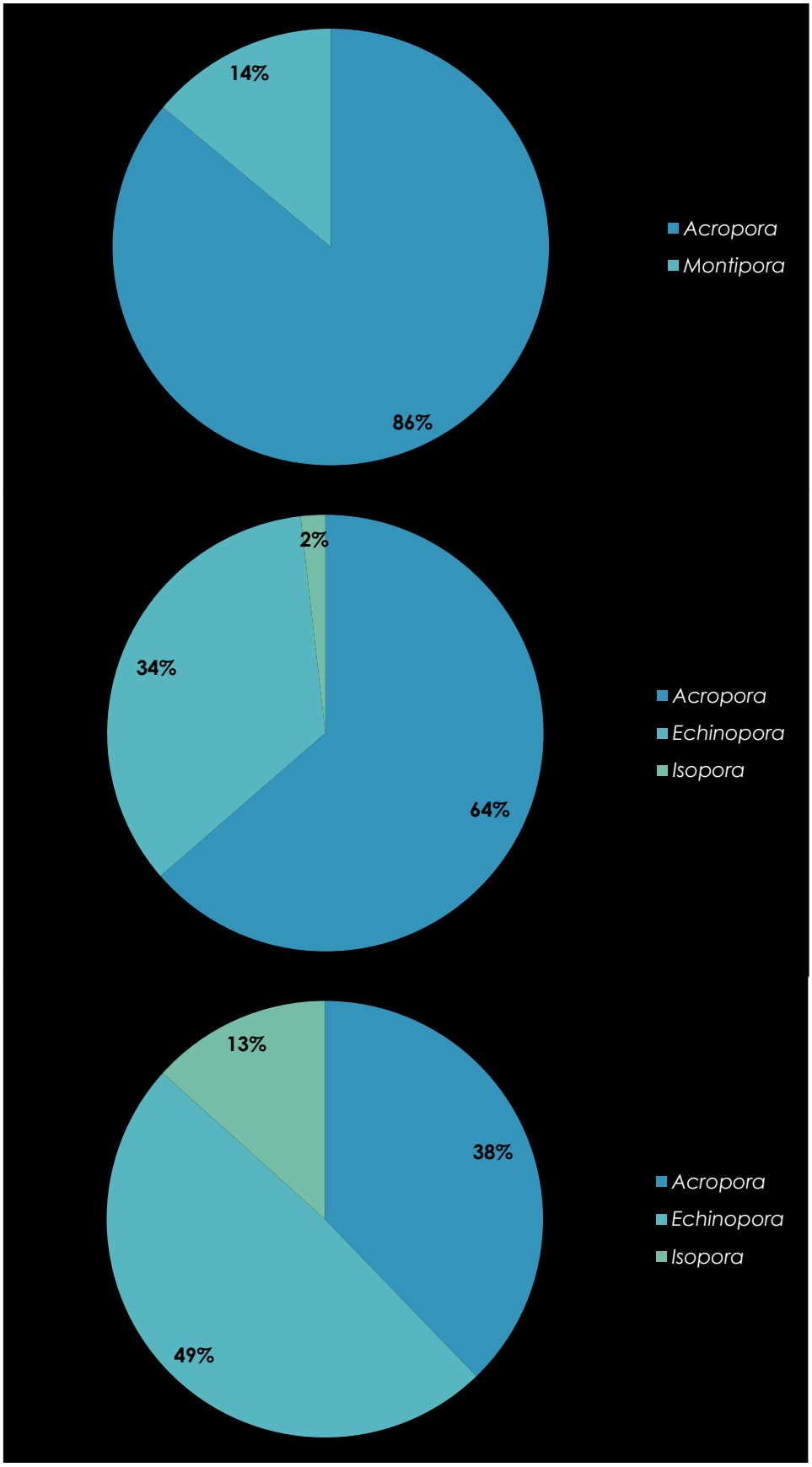


Figure 30. *Proportional substrate coverage by hard coral taxa at the three windward sites on Vaitupu. Transects where the hard coral cover was dominated by one species (leeward site 1), absent (leeward site 2) or all bleached (leeward site 3), have been excluded.*

Benthic Substratum

There was less live coral in the benthic community on Vaitupu's leeward coasts. In the first transect, the main substratum was coralline rock (95%) with only one percent of the 50 m transect where *Pocillopora* coral was recorded (Figure 29). There were no corals on the second and only 8% of hard corals (all bleached) on the third transect. There was a greater proportion of hard corals on the windward coast transects. Of the hard corals, *Acropora* was most common, taking up to 86% of the benthic substratum at one of the three sites (Figure 30). The other three coral species recorded were Echinopora, Isopora and Montipora. Coral bleaching was recorded on one of the three leeward transects (8%), and all of three windward transects, ranging from three to 17% (Table 28).

Species Diversity & Habitat Structure

There was a comparatively greater species richness in the fish and invertebrate fauna (Table 28) recorded for the outer coral reef assemblage, in comparison to the inner reef assemblage for Vaitupu. This could be linked to the greater incidence of coral bleaching for the windward coral reef. Coral rock dominated the substratum with plating corals growing over the rock in a mosaic patch coral network. Images of Vaitupu's fringing coral reef show this mosaic of patch coral and rock (Figure 31).

Species diversity in the inner lagoon was notably low possibly due to the lack of a more complex habitat like the coral reef matrix, which favours diversity, or due to less suitable conditions in the inner lagoon for coral reef species (Figure 32). The high sediment or nutrient input into the inner lagoon from the surrounding land, favours the growth of macroalgae like *Caulerpa* spp. and *Jaspis* sponges (Figure 33).

Table 28. Coral Cover, Fish & Invertebrate Species Community Richness in Vaitupu.

Aspect	Transect	Coral	Percent Cover	*S*	*H'*
Leeward	1	*Pocillopora*	1%	11	2.03
	2	-	-	12	1.89
	3	Bleached	8%	16	2.24
Windward	4	*Acropora*	23%	11	1.68
		Montipora	7%		
		Bleached	17%		
	5	*Acropora*	39%	11	2.03
		Echinopora	21%		
		Isopora	1%		
		Bleached	4%		
	6	*Acropora*	18%	16	1.93
		Echinopora	24%		
		Isopora	6%		
		Bleached	3%		
	Lagoon	-	-	7	0.94

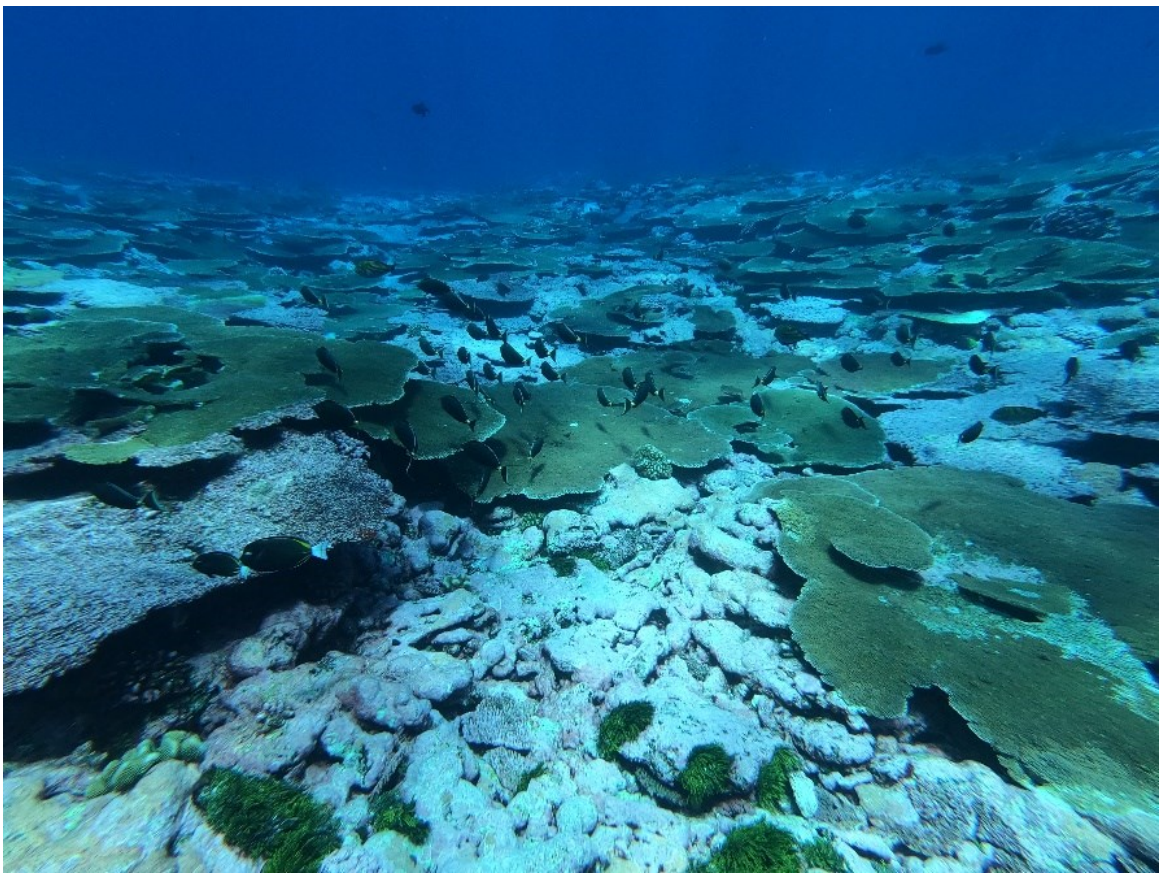


Figure 31. *Underwater image taken on Vaitupu showing the structural complexity of* the coral reef matrix.

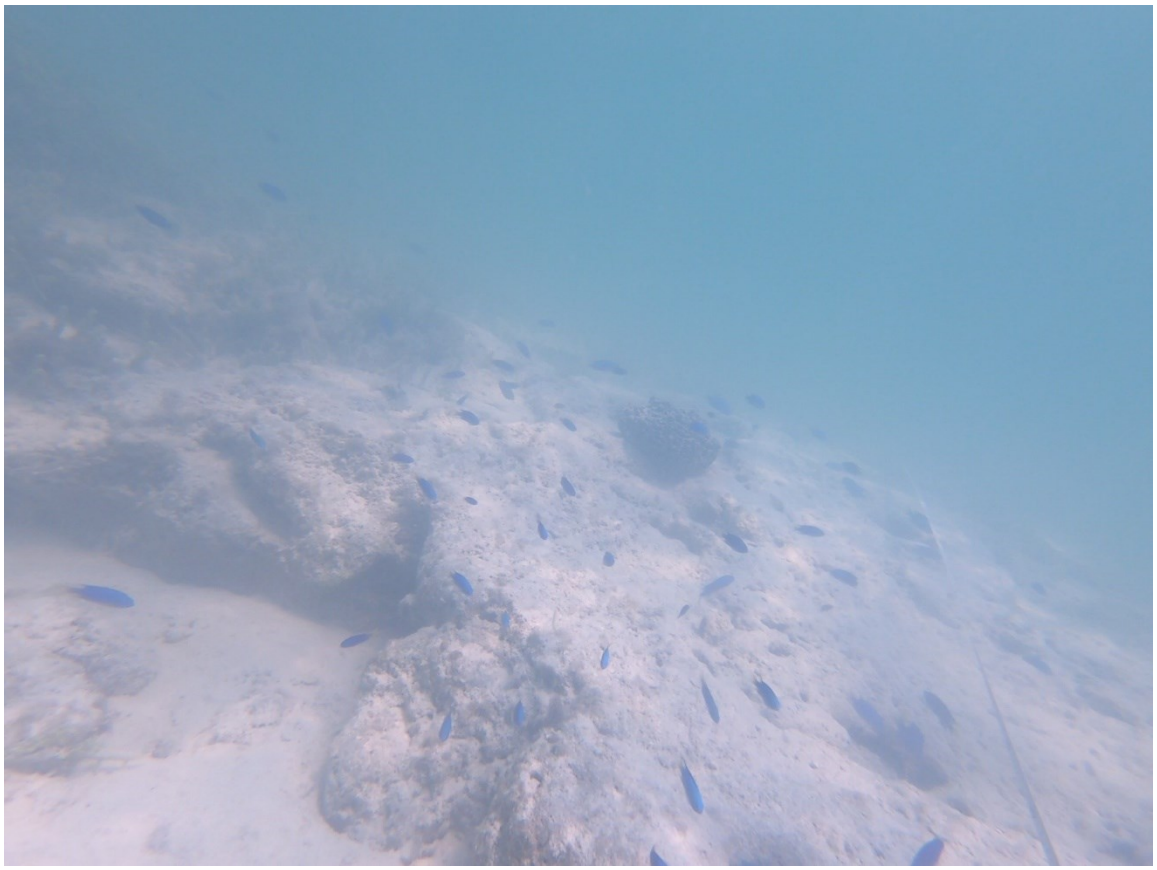


Figure 32. *Underwater image from the inner lagoon on Vaitupu showing the substratum and water turbidity.*

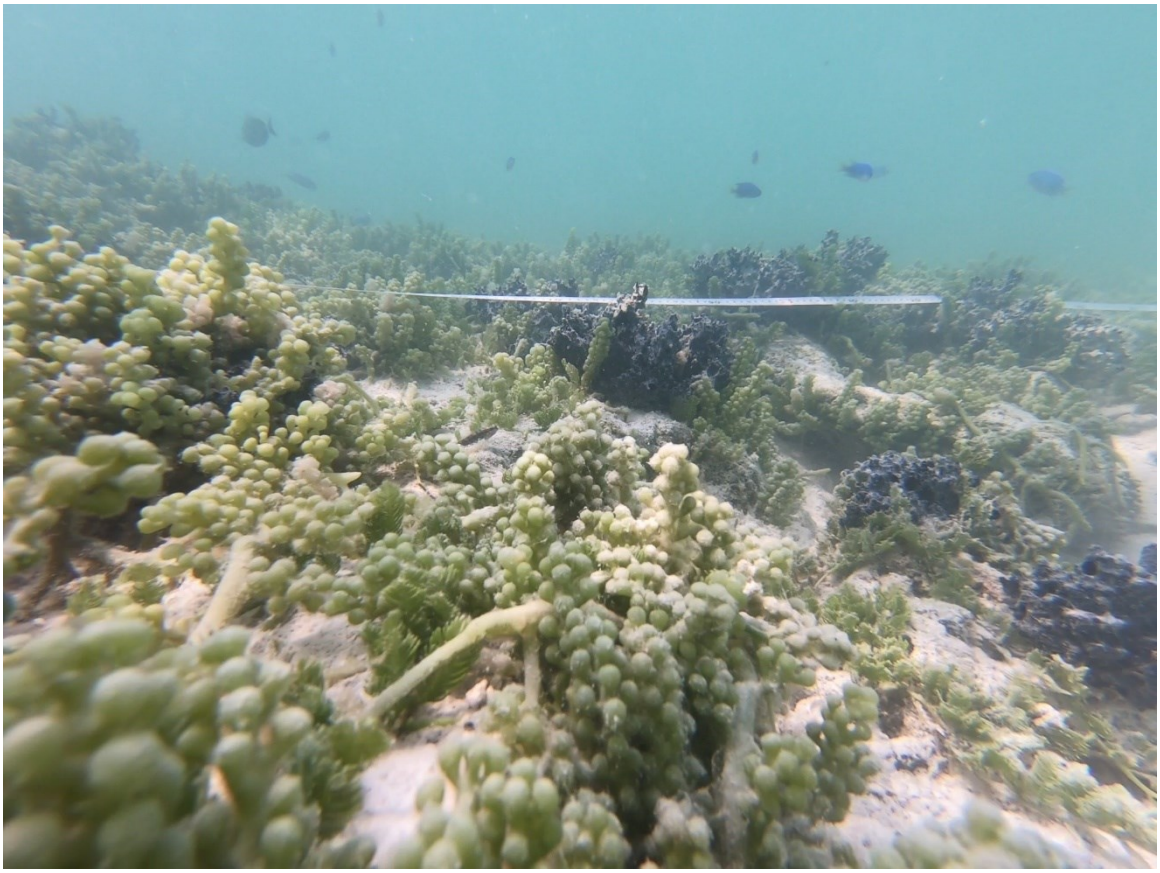


Figure 33. *Jaspis* (purple sponge) and *Caulerpa* spp. growing on the floor of the inner lagoon.

DISCUSSION

The BioRAP of the four islands was carried out during the Covid-19 global pandemic period whereby international travel was restricted in most countries worldwide including Tuvalu. As a result, an experienced team made of 100% local technical people was engaged to carry out the data collection from the four islands. It is also important to note that this being a BioRAP the results presented here are based on only a few days of field survey. The average field days per island was about three days and another three days was spent on travelling as the four islands are separated by a vast distance of open ocean. The results presented therefore might not be an entirely complete picture of the state of the biodiversity however, it does provide important baseline information, which can be verified and monitored in future surveys.

Flora & Vegetation

Earlier botanical surveys in Tuvalu have indicated the dominance of introduced plants in Tuvalu. However, most of the surveys have been concentrated on Funafuti Atoll, which is the administrative center and most populated island in Tuvalu and is dominated by introduced plants. Apart from Funafuti, Nui and Vaitupu, the other islands probably have not been properly botanically surveyed. Since there was no specialist botanist in this survey, it would have been a challenge to record any new species.

The vegetation transects were carried out with the main aim of understanding the vegetation systems on the four atolls/islands. In addition to recording the species identity and diameter at breast height, the height readings were also taken to calculate the basal area and volume of each tree species in the transect. The height readings were based on estimated numbers by the recorders so the factor of human error in this case could affect the volume values that were calculated. Nevertheless, the vegetation survey data serves as baseline information about the composition of the different vegetation systems, which will need to be verified in future surveys. To better understand the vegetation system present on each island, more transects need to be surveyed, with the use of proper equipment.

During the BioRAP, the target was to survey 10 transects in each island, which covers an area of 1000 m^2 or 0.1 ha. This might have been a small area and not representative enough of the vegetation of the whole island system. Future surveys should target coverage of at least 0.5 – 1 ha per island group with transects replicated in the different vegetation systems. The vegetation transects enable ground truthing of the different vegetation systems, which is essential when compiling vegetation maps for each island. The vegetation maps produced for each island or islet should be treated as sketch maps only as there were produced from data collected rapidly and from the freely available google images which are not always up to date. The objective here was not to create accurate maps but to produce vegetation maps that gives a general picture of the dominance status of each vegetation type in an island system.

Birds

The land bird diversity for Tuvalu is low. Only three land species have been recorded, the 'Lupe' (Pacific Pigeon), 'Kaleva' (the Long-tailed Cuckoo), and the Banded Rail. The Long-tailed Cuckoo is an annual visitor, and the Banded Rail is reportedly a recent

arrival, so the 'Lupe' or Pacific Pigeon would probably be seen as the only native land bird of Tuvalu. In this report the estimated density of the 'Lupe' on each of the four islands surveyed, is presented. The density figures are baseline data, which needs to be verified and monitored in future surveys. For Nukulaelae density figures for the sites surveyed were calculated. However, for Funafuti, Niutao and Vaitupu there was enough data to calculate density figures for less disturbed habitats and more disturbed human modified habitats (Table 29). These density figures should serve as baseline data for long-term monitoring of the 'Lupe' population on the four islands.

Table 29. Lupe Density (#/ha) Estimated for Each Island.

	Lupe Density (#/ha)	
Island/Atoll	**Less disturbed sites**	**More disturbed sites**
Funafuti	37	36
Nukulaelae	26	-
Niutao	57	45
Vaitupu	66	25

The shorebirds are known as migrant species. They fly back to the Northern hemisphere around March – April annually and then they return to Southern Hemisphere around September – October. It is most likely that by the time the survey was carried out most of the shorebirds would been on their way back to their feeding grounds in the Northern Hemisphere. Nevertheless, the survey team attempted to carry out point counts at different sites in the four islands to record the diversity and numbers of shorebirds that were present. Shorebirds are an important part of the ecosystem of Tuvalu and this data serves as the baseline for potential long-term monitoring. Preferably, future surveys should be planned to take place between October and March when most of the shorebirds are present.

Similarly, for the seabirds the survey team quantitatively surveyed the population of seabirds on the four islands. The data presented in this report is based on two methods used: the point count of each colony and the AON (adults only nesting) transect count. In the colony count, the recorders carried out estimated counts from single points and the distance to each bird was not measured so the exact area was not known. The two methods are an attempt to produce quantitative baseline data on the diversity and abundance of seabird species in the different seabird colonies in each island. This information still needs to be verified in future or follow up surveys and these sites need to be regularly monitored to paint a realistic picture of the status of these seabird colonies in these four islands.

However, for the AON, nesting seabirds were recorded along a 50 x 2 m transect per colony. The density per 100 m^2 area for nesting seabirds which was then extrapolated to a hectare (density/ha). In future surveys it would be ideal to map land areas inhabited by seabird colonies, which would give an idea of the area. This information would be useful when making population counts. The two methods provide data, which give an idea of the population, diversity and status for each colony. These are attempts carried out in a rapid survey so there is room for human error in the data collected. However, the data presented in this report serves as a baseline for future long-term monitoring.

Reptiles

The reptile fauna present on the four islands surveyed in the Tuvalu group is depauperate. The three commonly observed reptiles are present on most, if not all, of the islands in the Pacific, and are commonly observed in coastal habitats. In particular, the Pygmy Snake-eyed Skink (*Cryptoblepharus eximius*) is a pantropical member of typical beach fauna. It is generally a hardy species and can be found in even the most disturbed beach vegetation. As no nocturnal surveys were conducted, there were no records of common gecko species. The two indicator species, *Emoia adspersal (th*e endangered Micronesian Skink), and *Lepidodactylus tepukapili* (the insular endemic Funafuti Scaly-toed Gecko) were not recorded from Funafuti Atoll during the current surveys. Both the Funafuti Gecko and the Micronesian Skink would be ideal indicator species for monitoring environmental change in primary woodland habitat on Funafuti atoll.

Mammals

Only one species of terrestrial mammal was recorded, the Black/Ship rat (*Rattus rattus*). It is possible that the Pacific rat, Norwegian rat and House mice are also present, but were not detected. These are pests and a threat to terrestrial biodiversity as well as to human health. There is a need to monitor the population regularly and control the population of rats, especially in the protected or reserve areas like the FMCA. Rats are a big threat to the survival of seabird populations as they have been observed preying on the eggs and chicks of seabirds. A regular rat-trapping project needs to be planned and carried out on all conservation areas in Tuvalu to monitor and control the rat population.

Insects (Terrestrial invertebrate fauna)

Terrestrial insects were also surveyed in the four islands. However, the survey was conducted in an opportunistic manner, based on observations only. No standard methodology or technique was used to target a particular group of insects or record quantitative data. As such, this information has not been presented in detail for each of the four islands surveyed.

The insect assemblages were observed to be similar across all the four islands. These included the common insect groups belonging to the orders Lepidoptera (Butterfly and Moth), Formicidae (ants), Araneae (Spiders) and Coleoptera (beetles). Ants were the more diverse group observed with at least four different types recorded from all the island surveyed. The more commonly observed ants were *Anoplolepis gracilipes* (Yellow crazy ants; Figure 34), and *Solenopsis germinate* (Tropical red fire ants).The other two species looked like *Paratrechnina longicornis* and *Nylendaria* sp. however their identification requires expert verification. A recent ant survey on Funafuti, Nukulaelae and Niulakita recorded 18 species with an average of at least 13 species per island group (Vaqalo *et al.* 2014). The two common butterfly species recorded from the four islands surveyed were *Hypolimnas bolina* (Figure 35) and *Junonia villida* (Figure 36). Since there were no night surveys, no moths were observed and recorded.

Terrestrial invertebrates comprise a large group of taxa and could be the most diverse group of the terrestrial fauna of Tuvalu, however due to a lack of technical personnel and proper equipment the group could not be fully investigated. The study and survey of insects in the different islands of Tuvalu should be seen as a priority in any future

biological surveys. The ecological roles of this group of animals is vital in any terrestrial habitat and their roles in small island systems remains understudied.

Figure 34. *Yellow crazy ants (Anoplolepis gracilipes) from Funafuti Atoll.*

Figure 35. *Junonia villida butterfly from Funafuti Atoll.*

Figure 36. *Hypolimnas bolina from Niutao Island.*

Terrestrial Alien Invasive Species

During the BioRAP surveys many introduced terrestrial species were recorded however, four introduced species should be highlighted as species of concern to the conservation of terrestrial biodiversity of Tuvalu. These four species include an insect, a mammal and two plant species which were present on all four islands/atolls surveyed. These four species are *Anolplolepis gracilipes* (Yellow crazy ants), *Rattus rattus* (Ship or Black rat, Figure 37), and the two plants species: *Leucaena leucocephala* (Figure 38) and *Lantana camara* (Figure 39).

All these four species are listed in the '100 of the Worlds' Worst Invasive Alien Species' (2021) and could impact the conservation of vulnerable terrestrial flora and fauna of Tuvalu. The negative impacts brought about by these species could be far worse and more immediate when compared to the effects of climate change and sea level rise if not addressed properly.

Figure 37. *A dead adult male Rattus rattus (Black or Ship rat).*

Figure 38. *Leucaena leucocephala, with seed-pods and flowers.*

Figure 39. *A field covered with Lantana camara.*

Marine Biodiversity & Habitat

The low incidence of coral bleaching and relatively diverse fish and invertebrate fauna on Funafuti Atoll (in comparison to Niutao for instance) is another important distinction. There was no suggestion of reef die back caused by bio-eroding taxa

present in the invertebrate fauna, even with the prevalence of the corallivorous drupes and the high density of the vermetid gastropod (Figure 40). The Horn drupe feeds on the living coral polyp and so can effectively retard coral growth and even cause accelerated bio-erosion, which destabilizes the reef structure (Lam and Shin, 2006).

Figure 40. *Bio-eroding gastropods: Drupella cornus in the lefthand image and vermetid worm, Dendropoma in the image to the right. Source: WiseOceans 2021*

Considering the estimated density of the Horn drupe in the FMCA (Figure 9; Appendix 2.1), this species record needs to be highlighted. Outbreaks of *Drupella cornus* have been linked to terrestrial run-off, overfishing of predators such as the triggerfish, climate change, coral bleaching, coral diseases, and even coral damage caused by divers (Turner, 1994; Lam and Shin, 2006; Shafir and Gur, 2008; Armstrong, 2009). Outbreaks of the drupe have been linked to increased coral mortality and a subsequent reduction in coral cover (Turner, 1994; Shafir and Gur, 2008; Cumming 2009).

In the same way vermetid worm densities could also have an affect on coral mortality and therefore coral cover in the FMCA. Surveys of *Dendropoma* on Moorea Atoll found a negative association between vermetid density and the percent cover of living coral (Shima *et al.* 2010). Where vermetid numbers are high they can reduce reduce skeletal growth of corals by up to 81% and survival by up to 52% (*ibid.*). Long-term monitoring of both species in terms of their abundance and local distribution, would be the best strategy for effectively managing any potential outbreaks. Recent experiments on the species on Ningaloo Reef, Australia, determined the maximum number of *Drupella* that could occur across a range of coral cover without causing too much (Bessey *et al.* 2018). This approach could potentially be used to forecast outbreak densities to assist in management strategies.

Poaching in the FMCA and in the marine reserves on the other islands in the past was an issue reported by the survey team, however this was considered a minor issue as the current level of enforcement of the marine protected area policies was adequate. In particular the community level of enforcement of regulations such as on the types of fishing methods used, was highlighted by the survey team.

There was a certain similarity between Nukulaelae and Funafuti in the biological community, which is probably due to both locations being atolls and sharing similary geomorphology. The low incidence of coral bleaching and relatively diverse fish and invertebrate fauna on Nukulaelae Atoll is similar to Funafuti and may be due to the

physical characteristics of the coral reef platform. Of note for conservation and management would be the presence of the Horn drupe here on Niutao, despite its low abundance.
The high proportion of bleached coral and yet relatively diverse fish fauna on Niutao is similar to Funafuti and may be due to the physical characteristics of the coral reef habitat. If there is a resident Hawksbill turtle population in the waters surrounding Niutao (as suggested by a video taken by the survey team) then this may be linked to the presence of underwater sub-tidal seagrass meadows. The turtle shown in the video (Figure 41) is relatively young and is unlikely a nesting female. The species is Critically Endangered on the IUCN Red List (Short *et al.*, 2010), so it is recommended that further surveys be conducted to confirm if they are foraging nearby.

Figure 41. *A young Hawksbill (Eretmochelys imbricata) captured in Niutao.*

The relatively large abundances of surgeonfish, parrotfish and wrasses at Niutao could be sustained by these hypothetical sub-tidal seagrass meadows, as the substratum records from the BioRAP do not indicate that there is much macroalgal growth within the shallower coral reef flat. Turtlegrass, *Thalassium testudinum*, has been recorded at depths of 30 m below sea level, and so could potentially exist in offshore beds on Niutao. Although the current surveys did not provide evidence for the occurrence of seagrasses on any of the four islands surveyed, there are published records of *Syringodium isoetifolium*, which is a much shallower growing species (Brodie *et al.*, 2020). HIsabayachi and colleagues' (2017) report on their mapping of the changing Tuvalu coastline suggests that the seagrass beds occur offshore and at depth.

Holothurians or as they are commonly known, sea cucumbers, are sand cleaners and functionally are useful members of the biological community on a coral reef. They were not recorded on Funafuti and Nuitao. On Nukulaelae, four distinct taxa were recorded (Appendix 2.1) in relatively low abundances. On Vaitupu, sea cucumbers (grouped together) were recorded in much higher abundances. Species richness and relative abundances of sea cucumber species between sites has been linked to overall reef exposure and the wave energy dynamics (Kerr *et al.*, 1993).

Any perceived differences in species richness and relative abundances of other taxa on leeward and windward transects on Niutao and Vaitupu could also be due to the

protection of the leeward sites. Windward sites on these two islands were not within the bounds of a marine protected area (MPA) and therefore human degradation and fishing pressure at these sites may influence the species richness and relative abundance of other taxa. The lower diversity in coral species on Niutao and Vaitupu (see Tables 13 and 21) may also be a result of past coral bleaching and storm surge from tropical cyclone Pam.

Overall, conservation and management of Tuvalu's marine reserves such as the FMCA, must be doing something right if the species richness and relative abundances of the marine taxa found within the FMCA and on Nukulaelae are anything to go by. The regulations and policies of the FMCA could be used to derive legislation to protect marine taxa and habitats throughout the Tuvaluan archipelago. If possible, a greater proportion of marine area should be placed within the LMMA network, to afford greater protection for species of concern such as the Hawksbill and Humphead parrotfish.

RECOMMENDATIONS

Flora and vegetation

Islands that have a greater human population are more or less dominated by introduced plants and disturbed habitats compared to the islands with fewer human inhabitants. The presence of introduced invasive plant species needs to be monitored and controlled. A management plan or strategy to monitor and control the spread of invasive species needs to be produced. This will be more applicable in terrestrial reserves or protected areas like the FMCA.

The existing less disturbed, more natural vegetation systems like the 'Inland broadleaf woodland', 'Littoral forest and scrub' and 'Mangrove and wetland' existing on each island should ideally be placed under protection in order to preserve their functions and ecosystem services. In addition, there is a need to establish long-term vegetation transects to monitor the vegetation and other terrestrial habitats. Again, the ideal locations for these long term transects should be within protected areas like the FMCA.

It is recommended to use the 50 x 2m Gentry transect for long term monitoring. However how many transects to be placed per islet, where and how to place them and how often the transects are to be surveyed should be further discussed. The only way to understand the effects of environmental change on the natural vegetation of the islands of Tuvalu is through long term monitoring of permanent vegetation transects where data collected using a systematic approach can be quantitatively analysied and compared with other vegetation systems in the Pacific.

Birds

There is still a lack of up to date data and information on the status of land birds, seabirds and shorebirds of Tuvalu. Generating this data requires long-term monitoring using standardized techniques where data collected can be quantitatively analysed to produce information such as population densities. These statistics would enable a better understanding of the status of bird species in Tuvalu. In terms of Land birds we recommend that the 'Lupe' (Pacific pigeon) be monitored using the same technique that was used during this BioRAP. This can be carried out in both disturbed and less disturbed habitats. However, how many replicate survey stations should be surveyed, the time of the year to survey, and how often to survey are issues that need to be discussed prior to the development of a 'Lupe monitoring plan'.

The seabirds for Tuvalu are an important indicator group of the diversity and health of the marine system. Hence, seabirds need to be monitored long-term. One such measure to monitor is the population of each seabird colony. We recommend that the two techniques used in this BioRAP be used in future surveys. We also recommend that long-term monitoring of seabirds is ideal for protected areas only like the FMCA. Again, issues like how many AON transects to survey per colony; how often to survey and when to survey need to be considered in the development of a long-term monitoring plan for seabirds. To enable more precise estimates of species' densities, it is recommended that the area of each seabird colony be mapped during each survey to determine changes to the aerial extent of each seabird colony. We recommend that seabird monitoring should be a matter of priority for the FMCA.

Future surveys in these sites, should build on available baseline data from this BioRAP and the 1998 Watling survey.

Shorebird diversity and population density visiting Tuvalu each year should be monitored annually over a long-term period. It is recommended that this should be done with assistance from Birdlife International in conjunction with other organisations that are monitoring shorebirds population and migration in the Southern hemispehere like New Zealand and Australia.

Reptiles

Reptiles should be treated as a special group for the terrestrial vertebrate fauna of Tuvalu because of the country's only endemic species, the Tuvalu forest gecko, *Lepidodactylus tepukapili.* A monitoring plan/protocol needs to be developed to monitor the population of *Lepidodactylus tepukapili* and other reptiles of Tuvalu. Again, as mentioned earlier, this would be ideal for established reserves like the FMCA. Reptile surveys should target both day and night surveys, to effectively capture nocturnal and diurnal species diversity.

Mammals

The presence of the Ship/Black rat on an island is a threat to the birds, reptiles, and other biodiversity present on that island as well. We recommend that a 'rat trapping and monitoring plan' be established targeting established reserves on Tuvalu like the FMCA where the presence of rats have been confirmed. This is needs to be addressed immediately to enure the long-term conservation of important biodiversity like the land-birds, sea bird colony and the reptile population for the islets within the FMCA for instrance.

Terrestrial invertebrate fauna

Terrestrial invertebrates or insects were not properly surveyed in this BioRAP. It is therefore recommended that a terrestrial invertebrate fauna survey of the four islands in this BioRAP, be placed on a list of target or priority actions stemming from this BioRAP for any terrestrial biological survey in the future. To conduct the survey properly, there is a need to engage appropriate technical experts and employ appropriate survey equipment. The survey should employ day and night surveys, targeting differet groups of insects.

Terrestrial alien invasive species

Populations of terrestrial alien invasive species should be monitored and controlled, especially in conservation or protected areas. A broad invasive species management plan needs to be developed and implemented, to control the spread of terrestrial alien terrestrial species. This is only applicable for isolated protected areas like the islets within the FMCA. Such a protocol or management plan needs to be enforced to ensure the long-term survival of other natural taxa like the seabirds and reptiles.

Marine

Five threatened marine species (Bumphead parrotfish VU, the Humphead wrasse EN, Barramundi cod DD, Hawksbill turtle CR, and Herman sea cucumber VU) were recorded in the BioRAP surveys on the four atolls/islands (Appendix 2.1). In addition, two 'Near Threatened' species were recorded, namely the Black-tip shark and the Chevroned butterfly fish. Finally, three corallivores that were recorded should be placed on a national 'species of concern' list, as global populations of these species are classified as declining on the IUCN Red List. These are the Threadfin, Bluespot and Redfin butterflyfish. Ongoing monitoring in the FMCA and the other marine protected areas in Tuvalu should be used to detail population changes in these 10 species, in order to assist with global conservation efforts.

In addition to these species of conservation interest, we must highlight three invertebrates that have been linked to coral dieback and destabilization of reef structure elsewhere. These are the Long-spined Black Sea Urchin, Horn drupe and Great coral worm. The relatively low densities of the two former species are currently manageable, however the estimated density of the vermetid coral worm in the FMCA, should be of concern. Research on Moorea Atoll in French Polynesia previously demonstrated that vermetids can reduce coral growth and survival by more than 50% (Shima *et al*. 2010). An outbreak of this bioeroder could enhance and/or sustain the effect of coral bleaching resulting from warmer sea surface temperatures. In addition, it is also recommended that long term monitoring of the Horn drupe be maintained within the FMCA and other marine reserves in Tuvalu.

Conclusion

The Tuvalu R2R BioRAP achieved its main aim of surveying the four islands of Funafuti, Nukulaelae, Niutao and Vaitupu and reporting the findings of these surveys. The survey was carried out despite the setbacks brought about by the global Covid-19 pandemic. This incident has prompted the Tuvalu Government to engage experienced local experts to carry out the survey and not to rely on overseas technical expertise. However, certain components of the BioRAP like the terrestrial invertebrate survey were opportunistic rather than systematic due to time constraints, technical expertise and proper survey equipment.

The data collected during the Tuvalu R2R BioRAP and presented in this technical report provides a general assessment of the state of biodiversity (terrestrial and marine) of the four atolls/islands. This data should be treated as baseline, which still needs to be verified and followed up by more surveys in the future to better understand the state of the biodiversity in these islands. Long-term monitoring should ideally apply the same methods used in this BioRAP.

The FMCA is the ideal conservation area to apply long term monitoring as the protected area encompasses marine and terrestrial ecosystems, and is a fair representation of the natural environment of Tuvalu. The FMCA is legally recognised by the Tuvalu Government and long-term protection is guaranteed. However, conservation areas as such need to be regularly surveyed, monitored, and policed to ensure conservation effectiveness. In this report we strongly recommend that a 'long-term monitoring program' be developed and applied for the FMCA and other legally established protected areas in Tuvalu. We believe that only through long-term monitoring will we be able to better understand our biodiversity, our natural heritage and how things like climate change, sea-level rise and alien invasive species are affecting them.

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Appendices

APPENDIX 1.1 Summary of Survey Effort for Funafuti Atoll BioRAP

Transect	Date	Site	Island	X coordinate (°E)	Y coordinate (°S)
Flora & Vegetation Survey					
1	15/04/2021	Fongafale	Funafuti	179°17'37.4"E	08°53'99.3"S
2	15/04/2021	Fongafale	Funafuti	179°17'74.7"E	08°55'39.1"S
3	15/04/2021	Fongafale	Funafuti	179°19'02.9"E	08°47'30.9"S
4	15/04/2021	Fongafale	Funafuti	179°18'48.0"E	08°46'19.3"S
5	13/04/2021	Fuafatu	Funafuti	179°03'80.9"E	08°51'0.16"S
6	13/04/2021	Fuafatu	Funafuti	179°03'74.1"E	08°51'0.50"S
7	13/04/2021	Fuafatu	Funafuti	179°03'75.2"E	08°51'11.0"S
8	13/04/2021	Fualopa	Funafuti	179°06'13.9"E	08°49'07.3"S
9	13/04/2021	Fualopa	Funafuti	179°06'07.1"E	08°49'0.67"S
10	14/04/2021	Funafala	Funafuti	179°01'80.8"E	08°62'26.1"S
11	14/04/2021	Funafala	Funafuti	179°10'09.2"E	08°62'89.9"S
12	14/04/2021	Telelee	Funafuti	179°09'80.5"E	08°63'38.7"S
Land bird survey					
1	13/04/2021	Fualopa	Funafuti	179° 03' 65.9"	08°29' 40.5
2	13/04/2021	Fualopa	Funafuti	179° 03' 70.2"	08°29' 44.4"
3	13/04/2021	Fuafatu	Funafuti	179°02' 33.3"	08°30' 62.4"
4	14/04/2021	Tepuka	Funafuti	179°04' 87.1"	08° 27' 79.7"
5	14/04/2021	Tepuka	Funafuti	179°05' 91.8"	08° 29' 85.6"
6	14/04/2021	Telele	Funafuti	179°05' 95.4"	08° 37' 96.9"
7	14/04/2021	Funafala	Funafuti	179° 05' 71.4"	08°37' 43.5"
8	14/04/2021	Funafala	Funafuti	179° 05' 80.4"	08°37' 60.5"
9	15/04/2021	Fogafale	Funafuti	179° 10' 47.0"	08°34' 39.4"
10	15/04/2021	Fogafale	Funafuti	179°10' 60.9"	08°34' 51.5"
Sea-bird AON transect					
1	13/04/2021	Fualopa	Funafuti	179° 03' 71.2"	08°29' 44.8"
2	13/04/2021	Fuafatu	Funafuti	179° 02' 33.4"	08°30' 62.8"
3	13/04/2021	Teafualiki	Funafuti	179° 01' 68.4"	08°26' 11.7"
4	14/04/2021	Telele	Funafuti	179° 05' 92.4"	08°38' 01.7"
5	14/04/2021	Tepuka	Funafuti	179° 04' 84.4"	08°27' 79.7"
Sea-bird point counts					
1	13/04/2021	Fualopa	Funafuti	179° 03' 70.2"	08°29' 44.4"
2	13/04/2021	Fualopa	Funafuti	179° 03' 65.9"	08°29' 40.5
3	13/04/2021	Teafualiki	Funafuti	179° 03' 65.7"	08°29' 45.0"
4	13/04/2021	Fuafatu	Funafuti	179°02' 35.0"	08°30' 64.0"
5	13/04/2021	Fuafatu	Funafuti	179°02' 33.3"	08°30' 62.4"
6	13/04/2021	Fuafatu	Funafuti	179°02' 31.0"	08°30' 60.2"
7	14/04/2021	Tepuka	Funafuti	179°04' 87.1"	08° 27' 79.7"
8	14/04/2021	Tepuka	Funafuti	179°05' 91.8"	08° 29' 85.6"
9	14/04/2021	Telele	Funafuti	179°05' 95.4"	08° 37' 96.9"
10	14/04/2021	Funafala	Funafuti	179° 05' 91.8"	08° 37' 45.6"
11	14/04/2021	Funafala	Funafuti	179° 05' 71.4"	08°37' 43.5"
Marine Seagrass Transect					
1	15/04/2021	Dump site	Funafuti	179.18214	08. 45654⁰
2	15/04/2021	Kavatoetoe	Funafuti	179. 18539⁰	O8. 53369⁰

Transect	Date	Site	Island	X coordinate (°E)	Y coordinate (°S)
3	15/04/2021	Nanumasa	Funafuti	179. 19833^{0}	08. 51225^{0}
Marine Leeward Transect					
1	13/04/2021	Fualopa	Funafuti	179.06566	8.49228
2	13/04/2021	Fuafatu	Funafuti	179.0439	8.51308
3	14/04/2021	Fuakea	Funafuti	179.06847	8.57295
Marine Windward Transect					
1	13/04/2021	Fualopa	Funafuti	179.0551	8.48761
2	13/04/2021	Fuafatu	Funafuti	179.03691	08. 51465
3	14/04/2021	Fuakea	Funafuti	179.05917	8.57404

APPENDIX 1.2 A Summary Checklist of the Flora of Funafuti Atoll

(Status refers to the 'distribution status' where N = native or indigenous species and I = introduced species. The figures 1, 2, 3, 4, 5 refers to the 'vegetation type codes' where 1 = 'Inland broadleaf woodland forest', 2 = 'Littoral forest and scrub', 3 = 'Mangrove and wetland vegetation', 4 = 'Coconut woodland and agroforest' and 5 = 'Disturbed and human modified vegetation'. An 'x' confirms the presence of the species in that particular vegetation type.)

FERNS								
Tuvalu Name	**Latin Name**	**Family**	**Status**	**1**	**2**	**3**	**4**	**5**
Katafa/Laukatafa	*Asplenium nidus*	Aspleniaceae	N	x	x		x	
Sulufe	*Nephrolepis acutifolia*	Nephrolepidaceae	N	x	x	x		
Sulufe	*Nephrolepis hirsutula*	Nephrolepidaceae	N	x	x	x		x
	Nephrolepis exaltata	Nephrolepidaceae	N	x	x			x
Maile	*Microsorum grossum*	Polypodiaceae	N	x	x		x	
Paotua/Silotau	*Psilotum nudum*	Psilotaceae	N		x			
Laukisikisi/Lautolo	*Pteris tripartita*	Pteridaceae	N	x	x			x
GYMNOSPERMS								
Tuvalu Name	**Latin Name**	**Family**	**Status**	**1**	**2**	**3**	**4**	**5**
Lakau Kilisimasi	*Araucaria columnaris*	Araucariaceae	I					x
Laupama	*Cycas rumphii*	Cycadaceae	I					x
MONOCOTYLEDONS								
Tuvalu Name	**Latin Name**	**Family**	**Status**	**1**	**2**	**3**	**4**	**5**
alovela	*Aloe vera*	Agavaceae	I					x
Launiu	*Dracaena angustifolia*	Agavaceae	I					x
Lauti/Ti	*Cordyline fruticosa*	Agavaceae	I					x
Aniani	*Allium fistulosum*	Alliaceae	I					x
Lili	*Hippeastrum puniceum*	Amaryllidaceae	I					x
Lili	*Hymenicallis pedalis*	Amaryllidaceae	I					x
Susana	*Zephyranthes rosea*	Amaryllidaceae	I		x			x
Talotalo/Tapua	*Crinum asiaticum*	Amaryllidaceae	I		x			x
Talotalo/Tapua	*Crinum augustum*	Amaryllidaceae	I					x
Talotalo/Tapua	*Crinum zeylanicum*	Amaryllidaceae	I					x
Talotalo/Tapua palagi	*Crinum xanthophyllum*	Amaryllidaceae	I					x
Kape/Tamu	*Alocasia macrorrhizos*	Araceae	I	x		x		
Pulaka	*Cyrtosperma chamissonis*	Araceae	I			x		
Taliga kula	*Caladium bicolor*	Araceae	I					x
Talo	*Colocasia esculenta*	Araceae	I			x		
Talo ni tana	*Xanthosoma sagittufolium*	Araceae	I			x		
	Dieffenbachia maculata	Araceae	N					x
Niu	*Cocos nucifera*	Arecaceae	I	x	x	x	x	x
Niu piu	*Pritchardia pacifica*	Arecaceae	I					x
Paama sama	*Chrysalidocarpus lutescens*	Arecaceae	I					x
	Canna generalis	Cannaceae	I					x
	Canna indica	Cannaceae	I					x

	Callisia fragrans	Commelinaceae	N					x
Lakau fai tika	*Mariscus javanicus*	Cyperaceae	I				x	x
Mouku	*Cyperus compressus*	Cyperaceae	I				x	x
Mouku	*Cyperus involucratus*	Cyperaceae	I					x
Mouku	*Kyllinga nemoralis*	Cyperaceae	I					x
Mouku	*Pycreus polystachyos*	Cyperaceae	I					x
Mouku filifou	*Mariscus javanicus*	Cyperaceae	I					x
Mouku milimili taliga	*Fimbristylis cymosa*	Cyperaceae	I		x		x	x
Muta	*Cyperus rotundus*	Cyperaceae	N				x	x
	Fimbristylis dichotoma	Cyperaceae	I					x
	Kyllinga brevifolia	Cyperaceae	I				x	x
Tivoli	*Dioscorea nummularia*	Dioscoreaceae	I					x
Ufi	*Dioscorea alata*	Dioscoreaceae	I					x
	Trimezia martinicensis	Iridaceae	I	x	x			x
Lakau laupiki/Nareau	*Gloria superba*	Liliaceae	I					x
	Asparagus officinalis	Liliaceae	I					x
	Chlorophytum comosum	Liliaceae	I					x
Fuamaoluga/Fuamaulao	*Musa AAA*	Musaceae	I					x
Futi	*Musa sp*	Musaceae	I				x	x
Kefu/Pata	*Musa ABB*	Musaceae	I					x
Misiluki/Tamatama a I lima	*Musa AB*	Musaceae	I				x	x
Vanila	*Vanilla planifolia*	Orchidaceae	N					x
Fala	*Pandanus tectorius 1*	Pandanceae	N		x		x	
Fala vao	*Pandanus tectorius 2*	Pandanceae	I	x		x		
Kaleve/Tolo	*Saccharum officinarum*	Poaceae	I				x	x
Kateketeke	*Cenchurus echinatus*	Poaceae	I				x	x
Mouku	*Chloris barbata*	Poaceae	I				x	x
Mouku	*Cynodon dactylon*	Poaceae	I				x	x
Mouku	*Dactyloctenium aegyptium*	Poaceae	I					x
Mouku	*Eleusine indca*	Poaceae	N					x
Mouku	*Leturus repens*	Poaceae	N		x		x	x
Mouku	*Paspalum vaginatum*	Poaceae	N			x		x
Mouku	*Stenotaphrum micranthum*	Poaceae	N		x			x
Mouku solo	*Thuarea involuta*	Poaceae	I					x
Mouku talatala	*Cenchurus echinatus*	Poaceae	I				x	x
	Axonopus compressus	Poaceae	I					x
	Bothriochloa bladhii	Poaceae	I					x
	Brachiara bladhii	Poaceae	I					x
	Brachiara subquadripara	Poaceae	I					x
	Digitaria ciliaris	Poaceae	I					x
	Digitaria radicosa	Poaceae	I					x
	Sporobolus fertilis	Poaceae	N					x
Vatia	*Tacca leontopetaloides*	Taccaceae	I					x
	Alpinia vittata	Zingiberaceae	I					x

DICOTYLEDONS								
Tuvalu Name	**Latin Name**	**Family**	**Status**	**1**	**2**	**3**	**4**	**5**
Lakau kena	*Pseuderanthemum carruthersii var. carruthersii*	Acanthaceae	I					x
Lakau kena	*P. carruthersii var. reticulatum*	Acanthaceae	I					x
Lakau pula kena	*P. carruthersii var. carruthersii*	Acanthaceae	I					x
Lakau uli	*P. carruthersii var. atropurpureum*	Acanthaceae	I					x
Lautagitagi	*P. carruthersii var. atropurpureum*	Acanthaceae	I					x
Suipi Kula	*P. carruthersii var. atropurpureum*	Acanthaceae	I					x
Tamatama/Lautamatama	*Achyranthes canescens*	Amaranthaceae	I		x			x
	Alternanthera sessilis	Amaranthaceae	I			x		x
	Alternanthera sissoo	Amaranthaceae	N					x
Silalii	*Apium graveolens*	Apiaceae	I					x
Fao	*Ochrosia oppositifolium*	Apocynaceae	I	x	x			
Melia	*Plumeria rubra*	Apocynaceae	I					x
Melia Solomona	*Plumeria obtusa*	Apocynaceae	I					x
Peteli/Peteli Kena	*Catharanthus roseus*	Apocynaceae	I					x
Pua Fiti	*Plumeria rubra*	Apocynaceae	I					x
Pua Fiti Solomona	*Plumeria obtusa*	Apocynaceae	I					x
Lautagitagi	*Polyscias filicifolia*	Araliaceae	I					x
Lautagitagi	*Polyscias fruticosa*	Araliaceae	I					x
Lautagitagi	*Polyscias guifoylei*	Araliaceae	I					x
Lautagitagi	*Polyscias scutellaria*	Araliaceae	N					x
Lautagitagi laukilikili	*Polyscias fruticosa*	Araliaceae	I					
Ateate/Lakau o galiga	*Wollastonia biflora*	Asteraceae	I		x			x
Letisi	*Lactuca sativa*	Asteraceae	I					x
Mili	*Pluchea carolinensis*	Asteraceae	I		x			x
Mili	*Pluchea indica*	Asteraceae	I		x			x
Mouku	*Synedrella nodiflora*	Asteraceae	I		x		x	x
Mouku fai pula	*Cyanthillium cinereum*	Asteraceae	I				x	x
Mouku fai pula	*Tridax procumbens*	Asteraceae	I					x
Saketa laukili	*Mikania micrantha*	Asteraceae	I		x			
	Sphagneticola trilobata	Asteraceae	N		x			x
sinia	*Zinnia elegans*	Asteraceae	I					x
Futu/Kafutu	*Barringtonia asiatica*	Barringtoniaceae	N	x	x			
Nikilailai	*Tecoma stans*	Bignoniaceae	I					x
Kanava	*Cordia subcordata*	Boraginaceae	N	x	x			x
Kanava palagi	*Cordia sebestena*	Boraginaceae	I					x
tausunu	*Tournefortia argentea*	Boraginaceae	I		x			
Kapisi pukupuku	*Brassica oleracea*	Brassicaceae	I					x
Kapisi saina	*Brassica chinensis*	Brassicaceae	I					x
Kapisi saina	*Brassica juncea*	Brassicaceae	I					x

Kapisi saina	*Brassica x hybridus*	Brassicaceae	N					x
Olesi	*Carica papaya*	Caricaceae	N					x
Lakau Kilisimasi/Pulumakau	*Casuarina equisetifolia*	Casuarinaceae	N		x			x
Fetau	*Calophyllum inophyllum*	Clusiaceae	N	x	x			
Kunikuni/Te Kunikuni	*Terminalia catappa*	Combretaceae	N		x			
Talie	*Terminalia samoensis*	Combretaceae	N		x			
Fue/Fur Piniki	*Ipomoea macrantha*	Convolvulaceae	I		x			
Fue	*Ipomoea pes-caprae*	Convolvulaceae	N		x			
Fue	*Ipomoea triloba*	Convolvulaceae	I					x
Fue kena	*Ipomoea macrantha*	Convolvulaceae	I		x			
Kumala	*Ipomoea batatas*	Convolvulaceae	I					x
Kukama	*Cucumis sativa*	Cucurbitaceae	I					x
Meleni	*Citrullus lanatus*	Cucurbitaceae	I					x
Panikeni	*Cucurbita sp*	Cucurbitaceae	I					x
	Lagenaria siceraria	Cucurbitaceae	I					x
	Luffa cylindrica	Cucurbitaceae	N					x
Kalakalapuhi kula/Ogoogo kula	*Acalypha hispida*	Euphorbiaceae	I					x
Kalakalapuki/Ogoogo	*Acalypha grandis*	Euphorbiaceae	I	x	x		x	
Lakau toto	*Pedilanthus titymaloides*	Euphorbiaceae	I					x
Lautagitagi fou	*Codiaeum variegatum*	Euphorbiaceae	I					x
Mouku	*Chamaesyce thymifolia*	Euphorbiaceae	I		x			
Mouku laupukupuku	*Phyllanthus amarus*	Euphorbiaceae	I		x			
Mouku toto	*Chamaesyce atoto*	Euphorbiaceae	I		x			x
Mouku toto	*Chamaesyce hirta*	Euphorbiaceae	I		x			x
Mouku toto	*Chamaesyce hypericifolia*	Euphorbiaceae	I		x			x
Ogoogo kula	*Acalypha wilkesiana*	Euphorbiaceae	I					x
pele	*Cnidoscolus chayamansa*	Euphorbiaceae	I					x
Tapioka	*Manihot esculenta*	Euphorbiaceae	I					x
	Euphorbia cyathephora	Euphorbiaceae	I		x		x	x
Fuatausaga	*Delonix regia*	Fabaceae	I					x
Lakau fai fuaga	*Leucaena leucocephala*	Fabaceae	I	x				x
Mouku matiotio	*Mimosa pudica*	Fabaceae	I		x			x
Piini	*Phaseolus vulgaris*	Fabaceae	N		x		x	x
Piini	*Vigna sesquipadalia*	Fabaceae	N					x
Saketa	*Canavalia cathartica*	Fabaceae	I	x	x			
Saketa	*Vigna marina*	Fabaceae	N		x			
	Senna occidentalis	Fabaceae	N					x
	Sophora tomentosa	Fabaceae	N		x			
Gasu	*Scaevola taccada*	Goodeniaceae	I		x	x		
Nui/Puka	*Hernandia nymphaefolia*	Hernandiaceae	I	x	x			
Mili kai	*Ocimum basilicum*	Lamiaceae	N					x
Mili manogi	*Ocimum tenuiflorum*	Lamiaceae	N		x		x	
Fetai	*Cassytha filiformis*	Lauraceae	I	x	x			

Gie	*Pemphis acidula*	Lythraceae	I			x		
Akata	*Sida fallax*	Malvaceae	I		x		x	x
Akata	*Sida rhombifolia*	Malvaceae	N		x		x	x
Aute/ Aute kula	*Hibiscus rosa-sinesis*	Malvaceae	N					x
Fou	*Hibiscus tiliaceus*	Malvaceae	I		x			
Milo	*Thespesia populnea*	Malvaceae	I	x	x	x		
Pele	*Abelmoschus manihot*	Malvaceae	N					x
Felo palagi	*Ficus carica*	Moraceae	I	x	x		x	x
Felo palagi	*Ficus tinctoria*	Moraceae	I					x
Mei	*Artocarpus altilis*	Moraceae	I	x	x		x	x
Saitiani	*Moringa oleifera*	Moringaceae	N		x			x
Akanita	*Bougainvillea glabra*	Nyctaginaceae	N					x
Kisikisi	*Boerhavia tetrandra*	Nyctaginaceae	I	x				
Pukavai/ Puka	*Pisonia grandis*	Nyctaginaceae	I	x	x			
Lakau pula sega	*Ludwigia octovalvis*	Onagraceae	I					x
Lau kapa	*Oxalis corniculata*	Oxalidaceae	I					x
	Rivina humilis	Phytolacaceae	N	x			x	
	Piper aduncum	Piperaceae	N					x
Katuli	*Portulaca australis*	Portulacaceae	I	x	x		x	x
Katuli	*Portulaca lutea*	Portulacaceae	I	x	x		x	
Katuli	*Portulaca oleracea*	Portulacaceae	N	x	x		x	
Katuli palagi	*Portulaca umbraticola*	Portulacaceae	N					x
Lakau sopu	*Colubrina asiatica*	Rhamnaceae	N					x
Togo	*Rhizophora stylosa*	Rhizophoraceae	N		x	x		
Nonu	*Morinda citrifolia*	Rubiaceae	N	x	x		x	x
Pua/ Pua vao	*Guettarda speciosa*	Rubiaceae	I	x	x	x	x	x
Tiale	*Gardenia taitensis*	Rubiaceae	I		x	x		x
	Spermococe assurgens	Rubiaceae	I					x
Laimi	*Citrus aurantifolia*	Rutaceae	I					x
Paigani	*Solanum melongena*	Solanaceae	I					x
Polo feu/Tili	*Capsicum annuum*	Solanaceae	I					x
Polo feu/ Tili	*Capsicum frutescens*	Solanaceae	N					x
Tomato	*Solanum lycopersicum*	Solanaceae	I					x
Gie	*Suriana maritima*	Surianaceae	I		x			
Tolotolo	*Triumfetta procumbens*	Tiliaceae	N		x		x	
Lakau pula sega	*Turnera ulmifolia*	Turneraceae	N					x
Fou tagata	*Pipturus argenteus*	Urticaceae	I	x	x		x	
Luna	*Laportea ruderalis*	Urticaceae	N	x			x	
Mouku vao	*Pilea microphylla*	Urticaceae	I	x			x	
Inato	*Clerodendrum inerme*	Verbenaceae	I					x
Kaipuaka	*Lantana camara*	Verbenaceae	I				x	x
Lakau pakeke	*Stachytarpheta cayennesis*	Verbenaceae	I					x
Lakau pakeke	*Stachytarpheta jamaicensis*	Verbenaceae	I					x
Valovalo/ Aloalo	*Premna serratifolia*	Verbenaceae	N	x	x		x	x

Appendix 1.3 Funafuti Vegetation Survey Summary

Transect 1 Fongafale 1 (Disturbed inland broadleaf woodland forest)						
Species	Tally	Height (m)	Basal Area (m^2)	Basal Area (%)	Volume (m^3)	Volume (%)
Fala	14	6	1.31	79.52	1.84	57.87
Gasu	14	4	0.03	1.68	0.02	0.70
Leusina*	1	3	0.00	0.16	0.00	0.07
Niu	4	17	0.21	12.98	1.21	38.07
Nonu	2	8	0.03	2.11	0.04	1.11
Pukavai*	1	4	0.05	3.26	0.07	2.12
Valovalo*	1	11	0.00	0.30	0.00	0.07
7	37		1.64	100	3.18	100
Transect 2 Fongafale 2 (Coconut woodland and agroforest vegetation)						
Species	Tally	Height (m)	Basal Area (m^2)	Basal Area (%)	Volume (m^3)	Volume (%)
Fala*	1	7	0.15	39.53	0.12	26.15
Felo*	1	7	0.02	6.33	0.05	10.46
Lime	2	4	0.01	1.84	0.01	1.54
Niu	2	8	0.01	2.57	0.03	5.99
Nonu	4	9	0.05	14.36	0.09	18.37
Lafau/Fou	3	12	0.02	5.69	0.03	6.45
Pua	6	6	0.08	21.34	0.12	24.71
Puka*	1	6	0.03	8.34	0.03	6.34
8	20		0.37	100.00	0.47	100
Transect 3 Fongafale 3 (Coastal littoral forest and scrub)						
Species	Tally	Height (m)	Basal Area (m^2)	Basal Area (%)	Volume (m^3)	Volume (%)
Fala	8	9	0.30	20.79	0.75	13.26
Fao*	1	7	0.02	1.12	0.04	0.71
Fetau*	1	13	0.24	16.97	1.02	18.00
Niu	9	14	0.78	54.17	3.70	65.08
Pua*	1	10	0.10	6.95	0.17	2.95
5	20		1.44	100	5.69	100
Transect 4 Fongafale 4 (Coastal littoral forest and scrub)						
Species	Tally	Height (m)	Basal Area (m^2)	Basal Area (%)	Volume (m^3)	Volume (%)
Fala	7	11	0.39	67.97	0.74	78.18
Gasu	3	5	0.02	3.71	0.02	1.73
Niu	2	11	0.07	12.01	0.12	12.45
Nonu	1	3	0.01	2.10	0.01	0.54
Pua	6	6	0.08	14.21	0.07	7.09
5	19		0.58	100	0.94	100
Transect 5 Fuafatu 1 (Inland Broadleaf Forest and Woodland)						
Species	Tally	Height (m)	Basal Area (m^2)	Basal Area (%)	Volume (m^3)	Volume (%)
Felo	9	5	0.05	4.26	0.06	1.36
Niu*	1	9	0.15	13.47	0.26	6.15
Nonu*	1	5	0.00	0.12	0.00	0.04
Pukavai	5	15	0.94	82.15	3.88	92.44
4	16		1.14	100	4.20	100

Transect 6 Fuafatu 2 (Inland Broadleaf Forest and Woodland)						
Species	**Tally**	**Height(m)**	**Basal Area (m²)**	**Basal Area (%)**	**Volume (m³)**	**Volume (%)**
Felo*	1	5	0.00	0.05	0.00	0.01
Niu	2	9	0.07	4.19	0.08	0.88
Nonu	2	6	0.01	0.49	0.01	0.08
Pukavai	12	15	1.63	95.27	8.72	99.03
4	17		1.71	100	8.81	100
Transect 7 Fuafatu 3 (Inland Broadleaf Forest and Woodland)						
Species	**Tally**	**Height (m)**	**Basal Area (m²)**	**Basal Area (%)**	**Volume (m³)**	**Volume (%)**
Felo*	1	5	0.00	0.19	0.00	0.07
Pukavai	17	9	0.93	99.81	3.45	99.93
2	18		0.93	100	3.46	100
Transect 8 Fualopa 1 (Inland Broadleaf Forest and Woodland)						
Species	**Tally**	**Height (m)**	**Basal Area (m²)**	**Basal Area (%)**	**Volume (m³)**	**Volume (%)**
Fala	2	14	0.06	8.66	0.24	7.72
Dua*	1	16	0.02	2.86	0.08	2.69
Pukavai	15	9	0.61	88.28	2.78	89.54
Talia*	1	5	0.00	0.19	0.00	0.05
4	19		0.70	100	3.11	100
Transect 9 Fualopa 2 (Inland Broadleaf Forest and Woodland)						
Species	**Tally**	**Height (m)**	**Basal Area (m²)**	**Basal Area (%)**	**Volume (m³)**	**Volume (%)**
Felo	2	4	0.08	5.25	0.10	1.52
Niu	2	6	0.28	19.76	0.64	9.86
Nonu*	1	3	0.00	0.06	0.00	0.01
Pukavai	20	10	1.07	74.71	5.76	88.57
Tausunu*	1	4	0.00	0.22	0.00	0.04
5	26		1.43	100	6.50	100
Transect 10 Funafala 1 (Coastal Littoral Forest and Scrub)						
Species	**Tally**	**Height (m)**	**Basal Area (m²)**	**Basal Area (%)**	**Volume (m³)**	**Volume (%)**
Fala	4	8	0.12	**24.59**	0.14	**9.78**
Niu	6	13	0.35	73.27	1.24	88.69
Pua	3	7	0.01	2.14	0.02	1.53
3	13		0.47	100	1.40	100.00
Transect 11 **Funafala 2 (Disturbed/ Human modified)**						
Species	**Tally**	**Height (m)**	**Basal Area (m²)**	**Basal Area (%)**	**Volume (m³)**	**Volume (%)**
Fala	2	10	0.37	50.38	0.68	46.12
Mei	1	9	0.20	27.44	0.09	5.82
Niu	2	14	0.16	22.18	0.71	48.06
3	5		0.74	100.00	1.47	100
Transect 12 Telelee 1 (Coastal Littoral Forest and Scrub)						
Species	**Tally**	**Height (m)**	**Basal Area (m²)**	**Basal Area (%)**	**Volume (m³)**	**Volume (%)**
Niu	6	19	0.86	46.82	4.24	70.31
Pua	9	9	0.40	21.68	0.84	13.96
Pukavai*	1	3	0.03	1.56	0.02	0.40

Pukavaka	1	9	0.55	29.94	0.93	15.33
4	17		1.84	100	6.03	100

APPENDIX 1.4 Summary Calculation for 'Lupe' Density for Funafuti

Point	Veg. Code	Disturb. Status	Site	Species	Dist. (m)	No.	Band	Band area (m^2)	Density (#/band)	Sum Density	Density (#/ha)
1	2	1	Fualopa	Lupe	2	1	1	314	0.0032	**less disturbed sites**	
2	1	1	Fualopa	None	0	0	0		0.0000		
3	1	1	Fuafatu	Lupe	5	1	1	314	0.0032		
3	2	1	Fuafatu	Lupe	25	1	3	1570	0.0006		
4	1	1	Tepuka	Lupe	5	1	1	314	0.0032		
5	2	1	Tepuka	Lupe	2	2	1	314	0.0064		
5	2	1	Tepuka	Lupe	30	3	3	1570	0.0019	0.0185	**36.9427**
6	4	2	Telee	Lupe	20	1	2	314	0.0032	**more disturbed sites**	
7	4	2	Funafala	Lupe	5	2	1	943	0.0021		
8	5	2	Funafala	Moa	0	0	0		0.0000		
	5	2		Take	0	0	0		0.0000		
	5	2		Kaleva	0	0	0		0.0000		
9	5	2	Fongafale	Lupe	15	1	2	314	0.0032		
10	5	2	Fongafale	Lupe	5	2	1	943	0.0064		
10	5	2	Fongafale	Lupe	30	1	2	314	0.0032	0.0180	**36.0889**

APPENDIX 2.1 Abundance and Distribution of the Marine Taxa Recorded During the BioRAP

Taxon	Family	Common name	Scientific Name	Funafuti	Nukulaelae	Niutao	Vaitupu
Fish	Pomacentridae	Lemon Damsel	*Pomacentrus muccensis*	33			
		Princess Damsel	*Pomacentrus vaiuli*	117			
		Other Damsel spp	Unidentifed spp.	12233	1823	3917	3983
	Haemulidae	Grunts/Sweetlips/Margates	Unidentifed spp.	17	5		
	Acanthuridae	Whitecheek surgeonfish	*Acanthurus nigricans*	2133	333	1117	2750
		Convict tang	*Acanthurus triostegus*	67		4650	5083
		Striped surgeon fish	*Acanthurus lineatus*	1400	515	7383	6450
		Striated surgeonfish	*Ctenochaetus striatus*	3967	497		
		Pacific orange-spine unicorn fish	*Naso lituratus*	650	97	10083	2400
		Bluespine unicornfish	*Naso unicornis*	200	58	33	
		Epaulette surgeonfish	*Acanthurus nigricauda*	67	40		
		Brown tang	*Acanthurus nigrofuscus*	33			
		Two toned tang	*Zebrasoma scopas*	17	70		
		Blueline Surgeonfish	*Acanthurus nigroris*			100	33
		Achilles Tang/Surgeon fish	*Acanthurus achilles*	500			
		Marine reef tang	*Ctenochaetus cyanocheilus*			250	1967
		Orange band surgeonfish	*Acanthurus olivaceus*		2		
		Surgeon Fishes/Tang/Unicorn fishes	Unidentifed spp.	1533		967	
	Lutjanidae	One spot snapper	*Lutjanus monostigma*	100			
		Small toothed jobfish	Aphareus furca	100			
		Bluestripe snapper	*Lutjanus kasmira*	33			
		Humpback red snapper	*Lutjanus gibbus*	33			
		Snapper spp	Unidentifed spp.	1050	187	2017	1017
	Lethrinidae	Humpnose big-eye bream	*Monotaxis grandoculis*	433	25	133	
		Yellowlip emperor	*Lethrinus xanthochilus*		2		

	Nemipteridae	White-shouldered whiptail	*Pentapodus bifasciatus*	100			
	Scaridae	Parrotfish spp	Unidentifed spp.	5100	477	767	
		Bumphead parrotfish	*Bolbometopon muricatum* **VU**			1167	1450
	Labridae	Wrasse spp	Unidentifed spp.	3150	565	2383	2217
		Humphead/Napoleon wrasse	*Cheilinus undulates* **EN**	1050	25	433	
	Serranidae	Grouper spp	Unidentifed spp.	3650	25		
		Barramundi cod/ Humpback grouper	*Cromileptes altivelis* **DD**	167			
		Brown-banded rockcod	*Cephalopholis boenak*			67	567
	Balistidae	Pinktail triggerfish	*Melichthys vidua*	200	195	800	933
		Black triggerfish	*Melichthys niger*		167		
		Halfmoon triggerfish	*Rhinecathus chrysopterus*		17		
		Orangestripe triggerfish	*Balistapus undulatus*		12		
		Reef triggerfish	*Rhinecathus rectangulus*		38		
		Lagoon triggerfish	*Rhinecanthus aculeatus*	17	5		
		Redtoothed triggerfish	*Odonus niger*			2233	
		Yellow margin triggerfish	*Pseudobalistes flavomarginatus*	17			
		Blackbelly triggerfish	*Rhinecanthus verrucosus*			33	33
	Carangidae	Bluefin travelly	*Caranx melampygus*	100	7	50	
	Siganidae	Rabbitfish spp	Unidentifed spp.	1000			
		Streamlined spinefoot	*Siganus argenteus*	1067	5	100	
	Kyphosidae	Brassy chub	*Kyphosus vaigiensis*			550	67
	Zanclidae	Moorish Idol	*Zanchus Cornutus*				
	Mullidae	Dash-and-dot goatfish	*Parupeneus barberinus*		5		
		Yellowstripe goatfish	*Mulloidichthys flavolineatus*		78		
		Goldsaddle goatfish	*Parupeneus cyclostomus*		2		
		Manybar goatfish	*Parupeneus multifasciatus*		8		
	Chaetodontidae	Pennant coralfish	*Heniochus acuminatus*			350	100
		Vagabond butterflyfish	*Chaetodon vagabundus*	217		350	33

		Threadfin butterflyfish	*Chaetodon auriga*	183	17		
		Chevroned butterflyfish	*Chaetodon trifascialis* **NT**	50	17		
		Lined butterflyfish	*Chaetodon linoelatus*	33		67	
		Spot-nape butterflyfish	*Chaetodon oxycephalus*			217	100
		Ornate butterflyfish	*Chaetodon ornatissimus*	150			
		Bennett's butterflyfish	*Chaetodon bennetti*			83	
		Dotted butterflyfish	*Chaetodon semeion*	83			
		Bluespot butterflyfish	*Chaetodon plebius*		2	100	33
		Speckled butterflyfish	*Chaetodon citrinellus*	67	7		33
		Forceps butterflyfish	*Forcipiger flavissimus*	33		33	
		Klein's butterflyfish	*Chaetodon kleinii*				50
		Reticulated butterflyfish	*Chaetodon reticulates*	250	3	283	17
		Double-saddled butterflyfish	*Chaetodon ulietensis*	83	3	83	50
		Teardrop butterflyfish	*Chaetodon unimaculatus*			83	
		Dot-and-dash butterflyfish	*Chaetodon pelewensis*	17			
		Redfin butterflyfish	*Chaetodon lunulatus*	267	13		
		Saddled butterflyfish	*Chaetodon ephippium*	83	8	100	
		Racoon butterflyfish	*Chaetodon lunula*	100	3		67
		Fourspot butterflyfish	*Chaetodon quadrimaculatus*	50		217	
		Black butterflyfish	*Chaetodon flavirostris*			33	
		Long-nose butterflyfish	*Forcipiger longirostris*			150	17
		Pyramid butterflyfish	*Hemitaurichthys polyepsis*			50	
Sharks	Carcharhinidae	Black-tip shark	*Carcharhinus limbatus* **NT**	33			
Dolphins	Delphinidae	Pantropical spotted dolphin	*Stenella attenuata*				83
Sea turtles	Cheloniidae	Hawksbill turtle	*Eretmochelys imbricata* **CR**			17	
Echinoderms							
Sea urchins	Diadematidae	Long-spined Black Sea Urchin	*Diadema spp.*	3850	145	1217	283

	Echinometridae	Red pencil urchin	*Heterocentrotus mammillatus*	200			
		Burrowing urchin	*Echinometra mathaei*		140		
Sea dollars	Oreasteridae	Cushion star	*Culcita novaeguineae*	17			
Holothurians	Holothuriidae	Herman sea cucumber	*Stichopus herrmanni* **VU**		2		
		Leopard sea cucumber	*Bohadschia argus*		2		
		Lollyfish	*Holothuria atra*		53		
		Sea cucumber spp	Unidentifed spp.		85		350
Crustaceans	Coenobitidae	Coenobita spp	*Hermit crabs*	200			
	Diogenidae	Anemone hermit crab	*Dardanus pedunculatus*		57		
Molluscs							
Gastropods	Muricidae	**Sea snail**	***Drupella spp***	183			
		Horn drupe	***Drupella cornus***		2		
		Bituberculate rock snail	*Reishia bitubercularis/Thais kieneri*	17			
	Cardiidae	Clam	*Tridacna maxima*	250			
	Strombidae	Lambis/Large sea snail	*Spider conchs*	33			
		Strawberry conch or Tiger conch	*Conomurex luhuanus*		268		
	Vermetidae	**Great coral worm**	***Ceraesignum maximum/ Dendropoma maximum***	2850	13		
	Turbinellidae	Common Pacific Vase	*Vasum turbinellus/ Vasum turbinellum*	17			
	Conidae	Soldier cone	*Conus miles*		3		
		Flag/ Vexillum cone	*Conus vexillum*		2		
	Spondylidae	Imperialis seashells	*Spondylus ducalis*		2		
	Turbinidae	Rough turban	*Turbo setosus*		3		
Bivalves		Bivalve spp	Unidentifed spp.	33			
Cephalopods	Octopodidae	Octopus	Unidentifed spp.				17

[#] Values presented here are the relative densities of each taxa per hectare, extrapolated from the number of individuals recorded per square metre in the UVCs. Species in red font are threatened and the IUCN Red list status is indicated by the letters CR – Critically endangered, EN – Endangered, VU – Vulnerable, NT – Near threatened, DD – Data deficient. Other species in red font are listed on the IUCN Red List with globally declining populations.

APPENDIX 3.1 Summary of Survey Effort for Nukulaelae Atoll BioRAP

Transect	Date	Site	Island	X coordinate (°E)	Y coordinate (°S)
Flora & Vegetation Survey					
1	22/04/2021	Fagaua	Nukulaelae	179°81'01.2 E	9°37'86.2"S
2	22/04/2021	Fagaua	Nukulaelae	179°81'04.6 E	9°37'77.6"S
3	22/04/2021	Fagaua	Nukulaelae	179°80'80.0 E	9°37'11.5"S
4	22/04/2021	Fakai	Nukulaelae	179°86'93.8"E	9°41'92.3"S
5	22/04/2021	Fakai	Nukulaelae	179°86'91.9"E	9°42'03.1"S
6	22/04/2021	Fakai	Nukulaelae	179°86'83.0 E	9°42'14.9"S
7	22/04/2021	Fakai	Nukulaelae	179°86'86.5 E	9°42'20.9"S
8	22/04/2021	Fenualago	Nukulaelae	179°85'82.5 E	9°43'07.1"S
9	22/04/2021	Fenualago	Nukulaelae	179°85'75.1 E	9°43'12.5"S
10	22/04/2021	Fenualago	Nukulaelae	179°85'53.3 E	9°43'16.2"S
11	22/04/2021	Fetuatasi	Nukulaelae	179°86'86.5 E	9°42'20.9"S
Land bird survey					
1	22/04/2021	Nukulaelae	Nukulaelae	179° 51' 76.8"	09° 25'74.9"
2	22/04/2021	Nukulaelae	Nukulaelae	179° 51' 44.7"	09°25' 89.6"
3	22/04/2021	Nukulaelae	Nukulaelae	179⁰ 51'43.6"	09°25' 93.1"
4	22/04/2021	Nukulaelae	Nukulaelae	179⁰ 51' 39.4"	09° 25' 94.8"
5	22/04/2021	Nukulaelae	Nukulaelae	1790 51' 45.0"	09o 25' 95.8"
6	22/04/2021	Nukulaelae	Nukulaelae	179⁰ 52' 03.0"	09° 25' 63.6"
7	22/04/2021	Nukulaelae	Nukulaelae	179⁰ 52' 54.5"	09° 25' 53.5"
8	22/04/2021	Nukulaelae	Nukulaelae	179⁰ 52'06.0"	09° 25' 50.8"
9	23/04/2021	Nukulaelae	Nukulaelae	179⁰ 48' 60.6"	09° 22' 69.3"
10	23/04/2021	Nukulaelae	Nukulaelae	179⁰ 80' 84.6"	09° 37' 45.0"
Sea-bird AON transect					
1	22/04/2021	Fenualago1	Nukulaelae	179o 51' 76.8"	09o 25'74.9"
2	22/04/2021	Fenualago2	Nukulaelae	179o 51' 76.8"	09o 25'74.9"
3	22/04/2021	Fenualago3	Nukulaelae	179o 51' 43.6"	09o 25'43.1"
4	22/04/2021	Fenualago4	Nukulaelae	179o 51' 39.4"	09o 25'94.8"
5	22/04/2021	Fenua 5	Nukulaelae	179o 51' 45.0"	09o 25'95.8"
6	22/04/2021	Fakai 6	Nukulaelae	179o 52'03.0"	09o 25' 63.6"
7	22/04/2021	Fakai 7	Nukulaelae	179o 52'03.0"	09o 25' 63.6"
8	22/04/2021	Fakai 8	Nukulaelae	179o 52'06.0"	09o 25' 50.8"
9	22/04/2021	Fagaua 9	Nukulaelae	179o 80' 84.6"	09o 37' 45.0"
10	22/04/2021	Fagaua 10	Nukulaelae	179o 48' 60.6"	09o 22' 69.3"
Sea-bird point counts					
1	22/04/2021	Fenualago1	Nukulaelae	179° 51' 76.8"	09° 25'74.9"
2	22/04/2021	Fenualago2	Nukulaelae	179° 51' 44.7"	09°25' 89.6"
3	22/04/2021	Fenualago3	Nukulaelae	179⁰ 51'43.6"	09°25' 93.1"
4	22/04/2021	Fenualago4	Nukulaelae	179⁰ 51' 39.4"	09° 25' 94.8"
5	22/04/2021	Fenua 5	Nukulaelae	179⁰ 51' 45.0"	09° 25' 95.8"
6	22/04/2021	Fakai 6	Nukulaelae	179⁰ 52' 03.0"	09° 25' 63.6"
7	22/04/2021	Fakai 7	Nukulaelae	179⁰ 52' 54.5"	09° 25' 53.5"
8	22/04/2021	Fakai 8	Nukulaelae	179⁰ 52'06.0"	09° 25' 50.8"
9	22/04/2021	Fagaua 9	Nukulaelae	179⁰ 80' 84.6"	09° 37' 45.0"
10	22/04/2021	Fagaua 10	Nukulaelae	179⁰ 48' 60.6"	09° 22' 69.3"

Shore-bird Survey Points					
1	23/04/2021	Fagaua Beach	Nukulaelae	179^0 80' 84.6"	09^o 37' 45.0"
2	23/04/2021	Fagaua NE Rocks	Nukulaelae	179^0 82' 20.6"	09^o 35' 30.0"
3	23/04/2021	Fagaua West Beach	Nukulaelae	179^0 48' 60.6"	09^o 22' 69.3"
Marine Leeward Sites					
1	22/04/2021	Fatuomanu	Nukulaelae	179.81227	9.36245
2	22/04/2021	Menigi	Nukulaelae	179. 81 396	09. 37 582
3	22/04/2021	Kaualai	Nukulaelae	179. 82 095	09. 38 091
Marine Windaward Sites					
1	23/04/2021	Fatuomanu	Nukulaelae	179.80399	09.36 245
2	23/04/2021	Menigi	Nukulaelae	179. 80 908	09. 38 251
3	23/04/2021	Kaualai	Nukulaelae	179. 81 587	09. 38 525

APPENDIX 3.2 Checklist of the Flora of Nukulaelae Atoll

(Status here refers to the 'distribution status' where N = native or indigenous species and I = introduced species. The figures 1,2,3,4,5 refers to the 'vegetation type codes' where 1 = 'Inland broadleaf woodland forest', 2 = 'Littoral forest and scrub', 3 = 'Mangrove and wetland vegetation', 4 = 'Coconut woodland and agroforest' and 5 = 'Disturbed and human modified vegetation'. The letter 'x' confirms the presence of the species in that vegetation type.)

FERNS								
Tuvalu Name	**Latin Name**	**Family**	**Status**	**1**	**2**	**3**	**4**	**5**
Katafa/Laukatafa	*Asplenium nidus*	Aspleniaceae	N	x	x		x	
Sulufe	*Nephrolepis acutifolia*	Nephrolepidaceae	N	x	x	x		
Sulufe	*Nephrolepis hirsutula*	Nephrolepidaceae	N	x	x	x		x
Maile	*Microsorum grossum*	Polypodiaceae	N	x	x		x	
Paotua	*Psilotum nudum*	Psilotaceae	N		x			
Silotau	*Pteris tripartita*	Pteridaceae	N	x				
GYMNOSPERMS								
Tuvalu Name	**Latin Name**	**Family**	**Status**	**1**	**2**	**3**	**4**	**5**
Lakau Kilisimasi	*Araucaria columnaris*	Araucariaceae	I					x
MONOCOTYLEDONS								
Tuvalu Name	**Latin Name**	**Family**	**Status**	**1**	**2**	**3**	**4**	**5**
Launiu	Dracaena angustifolia	Agavaceae	I					x
Lauti	Cordyline fruticosa	Agavaceae	I					x
Lili	Hippeastrum puniceum	Amaryllidaceae	I					x
Lili	Hymenicallis pedalis	Amaryllidaceae	I					x
Susana	Zephyranthes rosea	Amaryllidaceae	I		x			x
Talotalo	Crinum asiaticum	Amaryllidaceae	I		x			x
Talotalo	Crinum augustum	Amaryllidaceae	I					x
Talotalo	Crinum zeylanicum	Amaryllidaceae	I					x
Talotalo palagi	Crinum xanthophyllum	Amaryllidaceae	I					x
Kape	Alocasia macrorrhizos	Araceae	I	x		x		

Tuvalu Name	**Latin Name**	**Family**	**Status**	**1**	**2**	**3**	**4**	**5**
Pulaka	Cyrtosperma chamissonis	Araceae	I			x		
Taliga kula	Caladium bicolor	Araceae	I					x
Talo	Colocasia esculenta	Araceae	I			x		
Talo ni tana	Xanthosoma sagittufolium	Araceae	I			x		
Talo palagi	Caladium bicolor	Araceae	I					
Niu	Cocos nucifera	Arecaceae	N	x	x	x	x	x
Fatu piniki	Tradesantia pallida	Commelinaceae	I					x
Mouku tolo	Commelina diffusa	Commelinaceae	I		x			x
Lakau fai tika	Mariscus javanicus	Cyperaceae	I				x	x
Mouku	Cyperus compressus	Cyperaceae	I				x	x
Mouku	Kyllinga nemoralis	Cyperaceae	I					x
Mouku	Pycreus polystachyos	Cyperaceae	I					x
Mouku filifou	Mariscus javanicus	Cyperaceae	N					x
Mouku milimili taliga	Fimbristylis cymosa	Cyperaceae	I		x		x	x
Muta	Cyperus rotundus	Cyperaceae	I				x	x
	Fimbristylis dichotoma	Cyperaceae	I				x	x
Tivoli	Dioscorea nummularia	Dioscoreaceae	I					x
	Trimezia martinicensis	Iridaceae	I	x	x			x
Lakau laupiki/ Nareau	Gloria superba	Liliaceae	I					x
Fuamaoluga/ Fuamaulao	Musa AAA	Musaceae	I					x
Futi	Musa sp	Musaceae	I				x	x
Kefu/Pata	Musa ABB	Musaceae	I					x
Misiluki / Tamatama a I lima	Musa AB	Musaceae	I				x	x
Fala	Pandanus tectorius1	Pandanceae	N		x		x	
Fala vao	Pandanus tectorius2	Pandanceae	N	x		x		

Tuvalu Name	**Latin Name**	**Family**	**Status**	**1**	**2**	**3**	**4**	**5**
Kaleve	Saccharum officinarum	Poaceae	I				x	x
Kateketeke	Cenchurus echinatus	Poaceae	I				x	x
Kofe	Shizostachym glaucifolium	Poaceae	I					x
Mouku	Chloris barbata	Poaceae	I				x	x
Mouku	Cynodon dactylon	Poaceae	I				x	x
Mouku	Dactyloctenium aegyptium	Poaceae	I					x
Mouku	Eleusine indca	Poaceae	I					x
Mouku	Leturus repens	Poaceae	I		x		x	x
Mouku	Paspalum vaginatum	Poaceae	I			x		x
Mouku	Stenotaphrum micranthum	Poaceae	I		x			x
Mouku talatala	Cenchurus echinatus	Poaceae	N				x	x
	Digitaria ciliaris	Poaceae	I					x
	Sporobolus fertilis	Poaceae	I					x
DICOTYLEDONS								
Tuvalu Name	**Latin Name**	**Family**	**Status**	**1**	**2**	**3**	**4**	**5**
Lautagitagi	*Pseuderanthemum carruthersii var. atropurpureum*	Acanthaceae	I					x
Tamatama	*Achyranthes canescens*	Amaranthaceae	I		x			x
	Alternanthera sessilis	Amaranthaceae	I			x	x	x
	Alternanthera sissoo	Amaranthaceae	I					x
	Gomphrena globosa	Amaranthaceae	I					x
Fao	*Ochrosia oppositifolium*	Apocynaceae	N	x	x			
Peteli/ Peteli kena	*Catharanthus roseus*	Apocynaceae	I					x

Tuvalu Name	**Latin Name**	**Family**	**Status**	**1**	**2**	**3**	**4**	**5**
Pua Fiti	*Plumeria rubra*	Apocynaceae	I					x
Pua Fiti Solomona	*Plumeria obtusa*	Apocynaceae	I					x
Lautagitagi	*Polyscias fruticosa*	Araliaceae	I					x
Lautagitagi	*Polyscias guifoylei*	Araliaceae	I					x
Lautagitagi	*Polyscias scutellaria*	Araliaceae	I					x
Ateate	*Wollastonia biflora*	Asteraceae	N		x			x
Mili	*Pluchea carolinensis*	Asteraceae	I		x			x
Mili	*Pluchea indica*	Asteraceae	I		x			x
Mouku	*Synedrella nodiflora*	Asteraceae	I		x		x	x
Mouku fai pula	*Cyanthillium cinereum*	Asteraceae	I				x	x
Saketa laukili	*Mikania micrantha*	Asteraceae	I		x			
	Sphagneticola trilobata	Asteraceae	I		x			x
sinia	*Zinnia elegans*	Asteraceae	I					x
Futu	*Barringtonia asiatica*	Barringtoniaceae	N		x			
Nikilailai	*Tecoma stans*	Bignoniaceae	I					x
Kanava	*Cordia subcordata*	Boraginaceae	N		x			x
Kanava palagi	*Cordia sebestena*	Boraginaceae	I					x
tausunu	*Tournefortia argentea*	Boraginaceae	N		x			
Kapisi pukupuku	*Brassica oleracea*	Brassicaceae	I					x
Kapisi saina	*Brassica chinensis*	Brassicaceae	I					x
Kapisi saina	*Brassica juncea*	Brassicaceae	I					x
Kapisi saina	*Brassica x hybridus*	Brassicaceae	I					x
Olesi	*Carica papaya*	Caricaceae	I					x
Lakau Kilisimasi	*Casuarina equisetifolia*	Casuarinaceae	N					x
Fetau	*Calophyllum inophyllum*	Clusiaceae	N	x	x			
Kunikuni	*Terminalia catappa*	Combretaceae	N		x			
Sagale	*Lumnitzera littorea*	Combretaceae	N			x		

Tuvalu Name	**Latin Name**	**Family**	**Status**	**1**	**2**	**3**	**4**	**5**
Talie	*Terminalia samoensis*	Combretaceae	N		x			
Fue	*Ipomoea macrantha*	Convolvulaceae	N		x			
Fue/ Fue piniki	*Ipomoea pes-caprae*	Convolvulaceae	N		x			x
Kumala	*Ipomoea batatas*	Convolvulaceae	I					x
Kukama	*Cucumis sativa*	Cucurbitaceae	I					x
Meleni	*Citrullus lanatus*	Cucurbitaceae	I					x
Panikeni	*Cucurbita sp*	Cucurbitaceae	I					x
	Lagenaria siceraria	Cucurbitaceae	I					x
	Luffa cylindrica	Cucurbitaceae	I					x
Kalakalapuhi kula	*Acalypha hispida*	Euphorbiaceae	I					x
Kalakalapuki/ Ogoogo	*Acalypha grandis*	Euphorbiaceae	N	x	x		x	
Lakau toto	*Pedilanthus titymaloides*	Euphorbiaceae	I					x
Lautagitagi fou	*Codiaeum variegatum*	Euphorbiaceae	I					x
Mouku	*Chamaesyce thymifolia*	Euphorbiaceae	I		x			
Mouku laupukupuku	*Phyllanythus amarus*	Euphorbiaceae	I		x			
Mouku toto	*Chamaesyce atoto*	Euphorbiaceae	I		x			x
Mouku toto	*Chamaesyce hirta*	Euphorbiaceae	I		x			x
Mouku toto	*Chamaesyce hypericifolia*	Euphorbiaceae	I		x			x
Ogoogo kula	*Acalypha wilkesiana*	Euphorbiaceae	I					x
pele	*Cnidoscolus chayamansa*	Euphorbiaceae	I					x
Tapioka	*Manihot esculenta*	Euphorbiaceae	I					x
	Euphorbia cyathephora	Euphorbiaceae	I		x		x	x
Lakau fai fuaga	*Leucaena leucocephala*	Fabaceae	I	x				x
Mouku matiotio	*Mimosa pudica*	Fabaceae	I		x			x

Tuvalu Name	**Latin Name**	**Family**	**Status**	**1**	**2**	**3**	**4**	**5**
Piini	*Phaseolus vulgaris*	Fabaceae	I		x		x	x
Piini	*Vigna sesquipadalia*	Fabaceae	N					x
Saketa	*Canavalia cathartica*	Fabaceae	N	x	x			
Saketa	*Vigna marina*	Fabaceae	N		x			
	Senna occidentalis	Fabaceae	I					x
	Sophora tomentosa	Fabaceae	N		x			
Gasu	*Scaevola taccada*	Goodeniaceae	N		x	x		
Puka	*Hernandia nymphaefolia*	Hernandiaceae	N	x	x			
Mili kai	*Ocimum basilicum*	Lamiaceae	I					x
Mili manogi	*Ocimum tenuiflorum*	Lamiaceae	I		x		x	
Fetai	*Cassytha filiformis*	Lauraceae	N	x	x			
Gie	*Pemphis acidula*	Lythraceae	N			x		
Akata	*Sida fallax*	Malvaceae	I		x		x	x
Akata	*Sida rhombifolia*	Malvaceae	I		x		x	x
Aute	*Hibiscus rosa-sinesis*	Malvaceae	I					x
Fou	*Hibiscus tiliaceus*	Malvaceae	N		x			
Pele	*Abelmoschus manihot*	Malvaceae	I					x
Felo palagi	*Ficus carica*	Moraceae	I	x	x		x	x
Felo palagi	*Ficus tinctoria*	Moraceae	N					x
Mei	*Artocarpus altilis*	Moraceae	I	x	x		x	x
Akanita	*Bougainvillea glabra*	Nyctaginaceae	I					x
Kisikisi	*Boerhavia tetrandra*	Nyctaginaceae	N	x				
Puka	*Pisonia grandis*	Nyctaginaceae	N	x	x			
Lakau pula sega	*Ludwigia octovalvis*	Onagraceae	I					x
	Rivina humilis	Phytolacaceae	I	x			x	
	Piper aduncum	Piperaceae	I					x
Katuli	*Portulaca australis*	Portulacaceae	N	x	x		x	x
Katuli	*Portulaca lutea*	Portulacaceae	N	x	x		x	

Tuvalu Name	**Latin Name**	**Family**	**Status**	**1**	**2**	**3**	**4**	**5**
Katuli	*Portulaca oleracea*	Portulacaceae	I	x	x		x	
Katuli palagi	*Portulaca umbraticola*	Portulacaceae	I					x
Lakau sopu	*Colubrina asiatica*	Rhamnaceae	N					x
Togo	*Rhizophora stylosa*	Rhizophoraceae	N		x	x		
Nonu	*Morinda citrifolia*	Rubiaceae	N	x	x		x	x
Pua	*Guettarda speciosa*	Rubiaceae	N	x	x	x	x	x
Tiale	*Gardenia taitensis*	Rubiaceae	N		x	x		x
	Spermococe assurgens	Rubiaceae	I					x
Laimi	*Citrus aurantifolia*	Rutaceae	I					x
Paigani	*Solanum melongena*	Solanaceae	I					x
Polo feu	*Capsicum annuum*	Solanaceae	I					x
Polo feu	*Capsicum frutescens*	Solanaceae	I					x
Tomato	*Solanum lycopersicum*	Solanaceae	I					x
lakau manogi	*Waltheria indica*	Sterculiaceae	I				x	
Tolotolo	*Triumfetta procumbens*	Tiliaceae	I		x		x	
Lakau pula sega	*Turnera ulmifolia*	Turneraceae	I					x
Fou tagata	*Pipturus argenteus*	Urticaceae	N	x	x		x	
Luna	*Laportea ruderalis*	Urticaceae	N	x			x	
Mouku vao	*Pilea microphylla*	Urticaceae	I	x			x	
Inato	*Clerodendrum inerme*	Verbenaceae	N					x
Kaipuaka	*Lantana camara*	Verbenaceae	I				x	x
Lakau pakeke	*Stachytarpheta cayennesis*	Verbenaceae	I					x
Lakau pakeke	*Stachytarpheta jamaicensis*	Verbenaceae	I					x
Valovalo	*Premna serratifolia*	Verbenaceae	N	x	x		x	x

APPENDIX 2.3 Nukulaelae Vegetation Survey – Summary

Transect 1 Fagaua 1 (Coastal littoral forest and scrub)						
Species	**Tally**	**Height (m)**	**Basal Area (m^2)**	**Basal Area (%)**	**Volume (m^3)**	**Volume (%)**
Gasu	1	4	0.00	0.67	0.00	0.07
Niu	8	20	0.62	83.60	4.41	96.67
Nonu	1	6	0.03	3.74	0.02	0.51
Pua	3	7	0.09	11.98	0.13	2.75
4	12		0.74	100.00	4.56	100.00
Transect 2 Fagaua2 (Coastal littoral forest and scrub)						
Species	**Tally**	**Height (m)**	**Basal Area (m^2)**	**Basal Area (%)**	**Volume (m^3)**	**Volume (%)**
Mei	1	10	0.06	4.97	0.08	1.49
Niu	8	19	0.67	51.93	4.02	73.78
Nonu	8	6	0.03	2.15	0.04	0.73
Pua	5	9	0.04	2.87	0.06	1.03
Pukavai	4	15	0.49	38.07	1.25	22.97
5	25		1.30	100.00	5.44	100
Transect 3 Fagaua 3 (Disturbed/Human modified)						
Species	**Tally**	**Height (m)**	**Basal Area (m^2)**	**Basal Area (%)**	**Volume (m^3)**	**Volume (%)**
Fetau	1	26	2.41	72.52	6.07	75.14
Puafiti	1	6	0.05	1.38	0.06	0.72
Niu	1	14	0.06	1.86	0.26	3.21
Breadfruit	1	10	0.81	24.24	1.69	20.93
4	4		3.32	100	8.08	100
Transect 4 Fakai 1 (Coastal littoral forest and scrub)						
Species	**Tally**	**Height (m)**	**Basal Area (m^2)**	**Basal Area (%)**	**Volume (m^3)**	**Volume (%)**
Niu	7	16	0.54	43.23	2.54	42.22
Pua	1	3	0.08	6.22	0.05	0.82
Pukavai	9	8	0.63	50.55	3.43	56.96
3	17		1.25	100	6.02	100
Transect 5 Fakai 2 (Inland Broadleaf Forest and Woodland)						
Species	**Tally**	**Height (m)**	**Basal Area (m^2)**	**Basal Area (%)**	**Volume (m^3)**	**Volume (%)**
Fao	31	7	0.24	20.21	0.92	20.44
Niu	2	29	0.11	9.30	1.11	24.84
Pua	1	17	0.83	69.45	2.44	54.49
Puka	4	4	0.01	1.04	0.01	0.23
4	38		1.20	100	4.48	100
Transect 6 Fakai 3 (Coastal littoral forest and scrub)						
Species	**Tally**	**Height (m)**	**Basal Area (m^2)**	**Basal Area (%)**	**Volume (m^3)**	**Volume (%)**
Fao	1	x10	0.01	1.42	0.02	0.62
Niu	6	12	0.31	40.83	1.17	31.71
Nonu	2	7	0.05	6.96	0.07	1.82
Pukavai	5	9	0.39	50.80	2.43	65.85

4	14		0.77	100	3.69	100
Transect 7 Fakai 4 (Inland Broadleaf Forest and Woodland)						
Species	**Tally**	**Height (m)**	**Basal Area (m^2)**	**Basal Area (%)**	**Volume (m^3)**	**Volume (%)**
Niu	4	15	0.22	6.81	1.04	6.45
Pukavai	15	12	2.98	93.19	15.05	93.55
2	19		3.19	100	16.09	100
Transect 8 Fenualago 1 (Coastal littoral forest and scrub)						
Species	**Tally**	**Height (m)**	**Basal Area (m^2)**	**Basal Area (%)**	**Volume (m^3)**	**Volume (%)**
Fala	10	11	0.35	50.16	0.58	41.03
Gie	1	12	0.17	24.43	0.36	25.59
Niu	2	13	0.12	16.34	0.39	27.37
Pua	3	10	0.06	9.07	0.08	6.01
4	16		0.70	100	1.41	100
Transect 9 Fenualgo 2 (Inland Broadleaf Forest and Woodland)						
Species	**Tally**	**Height (m)**	**Basal Area (m^2)**	**Basal Area (%)**	**Volume (m^3)**	**Volume (%)**
Fala	2	18	0.05	5.09	0.07	1.74
Niu	6	22	0.33	36.96	2.23	52.94
Puka	4	17	0.52	57.95	1.91	45.33
3	12		0.89	100	4.22	100
Transect 10 Fenualago 3 (Coastal Littoral Forest and Scrub)						
Species	**Tally**	**Height (m)**	**Basal Area (m^2)**	**Basal Area (%)**	**Volume (m^3)**	**Volume (%)**
Niu	9	24	0.52	**69.97**	4.21	**89.20**
Ogoogo	1	x4	0.00	0.09	0.00	0.01
Pukavai	7	9	0.22	29.94	0.51	10.79
3	17		0.74	100	4.71	100.00
Transect 11 Fetuatasi 1 (Coastal Littoral Forest and Scrub)						
Species	**Tally**	**Height (m)**	**Basal Area (m^2)**	**Basal Area (%)**	**Volume (m^3)**	**Volume (%)**
Fala	1	21	0.10	16.84	0.20	11.54
Niu	5	14	0.31	54.64	1.23	70.03
Pua	2	12	0.03	4.92	0.07	3.97
Pukavai	3	9	0.09	15.97	0.18	10.28
Tausunu	1	9	0.04	7.62	0.07	4.18
5	12		0.57	100.00	1.75	100

APPENDIX 3.4 'Lupe' density calculation for Nukulaelae Atoll

Lupe density estimate for Nukulaelae Atoll											
Point	**Veg. Code**	**Disturb. Status**	**Site**	**Species**	**Dist. (m)**	**No.**	**Band**	**Band value (m^2)**	**Density (#/band)**	**Sum Density**	**Density (#/ha)**
NKL 1	2	1	NKL	Lupe	15	1	2	943	0.0011		
NKL 2	1	1	NKL			0	0	0	0.0000		
NKL 3	1	1	NKL			0	0	0	0.0000		
NKL 4	2	1	NKL	Lupe	10	1	1	314	0.0032		
		1	NKL	Lupe	25	1	3	1570	0.0006		
NKL 5	2	1	NKL			0	0	0	0.0000		
NKL 6	2	1	NKL	Lupe	15	2	2	943	0.0021		
NKL 7	1	1	NKL	Lupe	10	2	1	314	0.0064		
		1	NKL	Lupe	30	1	3	1570	0.0006		
NKL 8	2	1	NKL	Lupe	5	2	1	314	0.0064		
		1	NKL	Lupe	20	2	2	943	0.0021		
NKL 9	4	2	NKL	Lupe	10	1	1	314	0.0032		
NKL 10	4	2	NKL	Moa	15	0	2	943	0.0000	**0.0257**	**25.6844**

APPENDIX 4.1 Summary of survey effort for Niutao BioRAP

Transect	Date	Site	Island	X coordinate (°E)	Y coordinate (°S)
Flora & Vegetation Survey					
1	29/04/2021	Niutao	Niutao	177°33'73.6"E	06°11'17.0"S
2	29/04/2021	Niutao	Niutao	177°34'07.0" E	06°11'41.4" S
3	29/04/2021	Niutao	Niutao	177°34'12.3" E	06°11'27.9 "S
4	29/04/2021	Niutao	Niutao	177°34'64.2"E	06°11'23.0"S
5	29/04/2021	Niutao	Niutao	177°34'64.2"E	06°11'07.7" S
6	29/04/2021	Niutao	Niutao	177°34'83.3" E	06°11'12.1" S
7	29/04/2021	Niutao	Niutao	177°34'94.1" E	06°11'04.7" S
8	29/04/2021	Niutao	Niutao	177°34'36.0" E	06°11'53.0" S
9	30/04/2021	Niutao	Niutao	177°34'37.3" E	06°10'58.0" S
10	30/04/2021	Niutao	Niutao	177°34'09.0" E	06°10'60.9" S
11	30/04/2021	Niutao	Niutao	177°33'87.6" E	06°10'53.0" S
12	30/04/2021	Niutao	Niutao	177°33'42.0" E	06°10'74.1" S
Land bird survey					
1	28/04/2021	Niutao	Niutao	177° 34' 10.2"	06°10' 67.9"
2	28/04/2021	Niutao	Niutao	177° 34' 52.6"	06°10'59.3"
3	28/04/2021	Niutao	Niutao	177° 34' 27.7"	06°11'25.2"
4	29/04/2021	Niutao	Niutao	177° 34' 15.5"	06°10'80.6"
5	29/04/2021	Niutao	Niutao	177° 34' 81.1"	06°10'71.6"
6	29/04/2021	Niutao	Niutao	177° 33' 80.3"	06°11'32.9"
7	29/04/2021	Niutao	Niutao	177° 34' 80.2"	06°11'31.7"
8	30/04/2021	Niutao	Niutao	177° 35' 23.6"	06°10' 81.1"
9	30/04/2021	Niutao	Niutao	177° 35' 06.6"	06°10' 32.2"
10	30/04/2021	Niutao	Niutao	177° 35' 06.6"	06°10' 32.2"
11	30/04/2021	Niutao	Niutao	177° 33' 69.6"	06°10' 34.1"
Sea-bird AON transect					
1	29/04/2021	Niutao	Niutao	177o 34' 15.4	06o 10' 80.6"
2	29/04/2021	Niutao	Niutao	177o 34' 12.8	06o 10' 96.2"
3	29/04/2021	Talo	Niutao	177o 34' 27.7	06o 10' 25.2"
4	29/04/2021	Talipoiaki	Niutao	177o 34' 81.1	06o 10' 71.6"
5	28/04/2021	Tefuti	Niutao	177o 34' 10.2	06o 10' 67.9"
6	28/04/2021	Agaia 1	Niutao	177o 34' 52.6	06o 10' 59.8"
7	30/04/2021	Agaia 2	Niutao	177o 34' 58.4	06o 10' 51.8"
8	30/04/2021	Niutao	Niutao	177o 34'68.3"	06o 10' 63.2"
9	28/04/2021	Tamana	Niutao	177o 35' 06.6"	06o 10' 52.2"
10	30/04/2021	Tulufala	Niutao	177o 35' 23.6"	06o 10' 81.1"
11	29/04/2021	Matagi	Niutao	177o 33' 80.3	06o 11' 32.9 "
12	30/04/2021	Pukapuka	Niutao	177o 34' 80.2"	06o 11' 31.7
13	30/04/2021	Maumatagi	Niutao	177o 33' 69.6"	06o 10' 34.1"
Sea-bird point counts					
1	28/04/2021	Tefuti 5	Niutao	177o 34 ' 10.2"	06o10' 67.9"
2	28/04/2021	Agaia 1	Niutao	177o 34' 52.6"	06o10' 59.8"
3	29/04/2021	Matagi 11	Niutao	177o 33' 80.3"	06o11' 32.9"

4	29/04/2021	Talo 3	Niutao	177o 34' 27.7"	06o11' 25.2"
5	29/04/2021	Samatua 2	Niutao	177o 34' 12.8"	06o10' 96.2"
6	29/04/2021	T1	Niutao	177o 34' 15.5"	06o10' 80.6"
7	29/04/2021	Talipoiaki4	Niutao	177o 34' 81.1"	06o10' 71.6"
8	30/04/2021	Pukapuka 12	Niutao	177o 34' 80.2	06o11' 31.7"
9	30/04/2021	Teulufala10	Niutao	177o 35' 23.6"	06o10' 81.2"
10	30/04/2021	Tamana 9	Niutao	177o 35' 06.6"	06o10' 52.2"
11	30/04/2021	T8		177o 34' 68.3"	06o10' 63.2"
12	30/04/2021	Agaia2		177o 33' 69.6"	06o10' 51.8"
13	30/04/2021	Maumatagi		177o 34' 58.4"	06o10' 34.1"
Shore-bird Survey Points					
1	29/04/2021	NW Agaia Beach	Niutao	177° 34'39.2"	06°10' 41.9"
2	29/04/2021	NE Tamana Beach	Niutao	177° 35' 09.7"	06° 10' 33.2"
3	29/04/2021	East Tegie Rock	Niutao	177° 35' 31.3"	06°11' 03.6"
4	29/04/2021	SE Sagasaga	Niutao	177° 34' 22.1"	06° 11' 41.7"
5	29/04/2021	S Beach	Niutao	177°33' 47.0"	06° 11' 09.2"
Marine Leeward Sites					
1	29/04/2021	Niutao	Niutao	177 20.092	06 06.790
2	29/04/2021	Niutao	Niutao	177 19. 873	06 06. 586
3	29/04/2021	Niutao	Niutao	177 19. 798	06 06. 187
Marine Windaward Sites					
4	30/04/2021	Niutao	Niutao	177 19. 920	06 06. 928
5	30/04/2021	Niutao	Niutao	177 20. 716	06 06. 110
6	30/04/2021	Niutao	Niutao	177 19. 920	06 06. 124

APPENDIX 4.2 A summary checklist of the flora of Niutao Island (Status here refers to the 'distribution status' where N = native or indigenous species and I = introduced species. The figures 1,2,3,4,5 refers to the 'vegetation type codes' where 1 = 'Inland broadleaf woodland forest', 2 = 'Littoral forest and scrub', 3 = 'Mangrove and wetland vegetation', 4 = 'Coconut woodland and agroforest' and 5 = 'Disturbed and human modified vegetation'. The letter 'x' confirms the presence of the species in that vegetation type.)

FERNS								
Tuvalu Name	**Latin Name**	**Family**	**Status**	**1**	**2**	**3**	**4**	**5**
Katafa/ Laukatafa	*Asplenium nidus*	Aspleniaceae	N	x	x		x	
Sulufe	*Nephrolepis acutifolia*	Nephrolepidaceae	N	x	x	x		
Sulufe	*Nephrolepis hirsutula*	Nephrolepidaceae	N	x	x	x		x
Maile	*Microsorum grossum*	Polypodiaceae	N	x	x		x	
Paotua	*Psilotum nudum*	Psilotaceae	N		x			
Silotau	*Pteris tripartita*	Pteridaceae	N	x				
GYMNOSPERMS								
Tuvalu Name	**Latin Name**	**Family**	**Status**	**1**	**2**	**3**	**4**	**5**
Lakau Kilisimasi	*Araucaria columnaris*	Araucariaceae	I					x
MONOCOTYLEDONS								
Tuvalu Name	**Latin Name**	**Family**	**Status**	**1**	**2**	**3**	**4**	**5**
Launiu	*Dracaena angustifolia*	Agavaceae	I					x
Lauti	*Cordyline fruticosa*	Agavaceae	I					x
Lili	*Hippeastrum puniceum*	Amaryllidaceae	I					x
Lili	*Hymenicallis pedalis*	Amaryllidaceae	I					x
Susana	*Zephyranthes rosea*	Amaryllidaceae	I		x			x
Talotalo	*Crinum asiaticum*	Amaryllidaceae	I		x			x
Talotalo	*Crinum augustum*	Amaryllidaceae	I					x
Talotalo	*Crinum zeylanicum*	Amaryllidaceae	I					x
Talotalo palagi	*Crinum xanthophyllum*	Amaryllidaceae	I					x
Kape	*Alocasia macrorrhizos*	Araceae	I	x		x		
Pulaka	*Cyrtosperma chamissonis*	Araceae	I			x		
Taliga kula	*Caladium bicolor*	Araceae	I					x
Talo	*Colocasia esculenta*	Araceae	I			x		
Talo ni tana	*Xanthosoma sagittufolium*	Araceae	I			x		
Niu	*Cocos nucifera*	Arecaceae	N	x	x	x	x	x
Lakau fai tika/ mouku Filifou	*Mariscus javanicus*	Cyperaceae	N				x	x
Mouku	*Cyperus compressus*	Cyperaceae	I				x	x
Mouku	*Kyllinga nemoralis*	Cyperaceae	I					x
Mouku	*Pycreus polystachyos*	Cyperaceae	I					x
Mouku milimili taliga	*Fimbristylis cymosa*	Cyperaceae	I		x		x	x
Muta	*Cyperus rotundus*	Cyperaceae	I				x	x
	Fimbristylis dichotoma	Cyperaceae	I					x
Tivoli	*Dioscorea nummularia*	Dioscoreaceae	I					x
	Trimezia martinicensis	Iridaceae	I	x	x			x

Lakau laupiki/ Nareau	*Gloria superba*	Liliaceae	I					x
Fuamaoluga/ Fuamaulalo	*Musa AAA*	Musaceae	I					x
Futi	*Musa sp*	Musaceae	I				x	x
Kefu/ Pata	*Musa ABB*	Musaceae	I					x
Misiluki / Tamatama ai lima	*Musa AB*	Musaceae	I				x	x
Fala	*Pandanus tectorius1*	Pandanceae	N		x		x	
Fala vao	*Pandanus tectorius2*	Pandanceae	N	x		x		
Kaleve	*Saccharum officinarum*	Poaceae	I				x	x
Kateketeke	*Cenchurus echinatus*	Poaceae	I				x	x
Kofe	*Shizostachym glaucifolium*	Poaceae	I					x
Mouku	*Chloris barbata*	Poaceae	I				x	x
Mouku	*Cynodon dactylon*	Poaceae	I				x	x
Mouku	*Dactyloctenium aegyptium*	Poaceae	I					x
Mouku	*Eleusine indca*	Poaceae	I					x
Mouku	*Leturus repens*	Poaceae	N		x		x	x
Mouku	*Paspalum vaginatum*	Poaceae	N			x		x
Mouku	*Stenotaphrum micranthum*	Poaceae	N		x			x
Mouku talatala	*Cenchurus echinatus*	Poaceae	I				x	x
	Digitaria ciliaris	Poaceae	I					x
	Sporobolus fertilis	Poaceae	I					x
DICOTYLEDONS								
Tuvalu Name	**Latin Name**	**Family**	**Status**	**1**	**2**	**3**	**4**	**5**
Lautagitagi	*Pseuderanthemum carruthersii var. atropurpureum*	Acanthaceae	I					x
Tamatama	*Achyranthes canescens*	Amaranthaceae	I		x			x
	Alternanthera sessilis	Amaranthaceae	I			x		x
	Alternanthera sissoo	Amaranthaceae	I					x
Fao	*Ochrosia oppositifolium*	Apocynaceae	N	x	x			
Peteli/ Pateli kena	*Catharanthus roseus*	Apocynaceae	I					x
Pua Fiti	*Plumeria rubra*	Apocynaceae	I					x
Pua Fiti Solomona	*Plumeria obtusa*	Apocynaceae	I					x
Lautagitagi	*Polyscias fruticosa*	Araliaceae	I					x
Lautagitagi	*Polyscias guifoylei*	Araliaceae	I					x
Lautagitagi	*Polyscias scutellaria*	Araliaceae	I					x
Ateate	*Wollastonia biflora*	Asteraceae	N		x			x
Mili	*Pluchea carolinensis*	Asteraceae	I		x			x
Mili	*Pluchea indica*	Asteraceae	I		x			x
Mouku	*Synedrella nodiflora*	Asteraceae	I		x		x	x
Mouku fai pula	*Cyanthillium cinereum*	Asteraceae	I				x	x
Saketa laukili	*Mikania micrantha*	Asteraceae	I		x			
	Sphagneticola trilobata	Asteraceae	I		x			x
Futu	*Barringtonia asiatica*	Barringtoniaceae	N		x			
Nikilailai	*Tecoma stans*	Bignoniaceae	I					x
Kanava	*Cordia subcordata*	Boraginaceae	N		x			x

Kanava palagi	*Cordia sebestena*	Boraginaceae	I					x
tausunu	*Tournefortia argentea*	Boraginaceae	N		x			
Kapisi pukupuku	*Brassica oleracea*	Brassicaceae	I					x
Kapisi saina	*Brassica chinensis*	Brassicaceae	I					x
Kapisi saina	*Brassica juncea*	Brassicaceae	I					x
Kapisi saina	*Brassica x hybridus*	Brassicaceae	I					x
Olesi	*Carica papaya*	Caricaceae	I					x
Lakau Kilisimasi	*Casuarina equisetifolia*	Casuarinaceae	N					x
Fetau	*Calophyllum inophyllum*	Clusiaceae	N	x	x			
Kunikuni	*Terminalia catappa*	Combretaceae	N		x			
Sagale	*Lumnitzera littorea*	Combretaceae	N			x		
Talie	*Terminalia samoensis*	Combretaceae	N		x			
Fue	*Ipomoea macrantha*	Convolvulaceae	N		x			
Fue/ Fue piniki	*Ipomoea pes-caprae*	Convolvulaceae	N		x			
Kumala	*Ipomoea batatas*	Convolvulaceae	I					x
Kukama	*Cucumis sativa*	Cucurbitaceae	I					x
Meleni	*Citrullus lanatus*	Cucurbitaceae	I					x
Panikeni	*Cucurbita sp*	Cucurbitaceae	I					x
	Lagenaria siceraria	Cucurbitaceae	I					x
	Luffa cylindrica	Cucurbitaceae	I					x
Kalakalapuhi kula	*Acalypha hispida*	Euphorbiaceae	I					x
Kalakalapuki/ Ogoogo	*Acalypha grandis*	Euphorbiaceae	N	x	x		x	
Lakau toto	*Pedilanthus titymaloides*	Euphorbiaceae	I					x
Lautagitagi fou	*Codiaeum variegatum*	Euphorbiaceae	I					x
Mouku	*Chamaesyce thymifolia*	Euphorbiaceae	I		x			
Mouku laupukupuku	*Phyllanythus amarus*	Euphorbiaceae	I		x			
Mouku toto	*Chamaesyce atoto*	Euphorbiaceae	I		x			x
Mouku toto	*Chamaesyce hirta*	Euphorbiaceae	I		x			x
Mouku toto	*Chamaesyce hypericifolia*	Euphorbiaceae	I		x			x
Ogoogo kula	*Acalypha wilkesiana*	Euphorbiaceae	I					x
pele	*Cnidoscolus chayamansa*	Euphorbiaceae	I					x
Tapioka	*Manihot esculenta*	Euphorbiaceae	I					x
	Euphorbia cyathephora	Euphorbiaceae	I		x		x	x
Lakau fai fuaga	*Leucaena leucocephala*	Fabaceae	I	x				x
Mouku matiotio	*Mimosa pudica*	Fabaceae	I		x			x
Piini	*Phaseolus vulgaris*	Fabaceae	I		x		x	x
Piini	*Vigna sesquipadalia*	Fabaceae	N					x
Saketa	*Canavalia cathartica*	Fabaceae	N	x	x			
Saketa	*Vigna marina*	Fabaceae	N		x			
	Senna occidentalis	Fabaceae	I					x
	Sophora tomentosa	Fabaceae	N		x			
Gasu	*Scaevola taccada*	Goodeniaceae	N		x	x		
Puka	*Hernandia nymphaefolia*	Hernandiaceae	N	x	x			
Mili kai	*Ocimum basilicum*	Lamiaceae	I					x
Mili manogi	*Ocimum tenuiflorum*	Lamiaceae	I		x		x	
Fetai	*Cassytha filiformis*	Lauraceae	N	x	x			

Gie	*Pemphis acidula*	Lythraceae	N			x		
Akata	*Sida fallax*	Malvaceae	I		x		x	x
Akata	*Sida rhombifolia*	Malvaceae	I		x		x	x
Aute	*Hibiscus rosa-sinesis*	Malvaceae	I					x
Fou	*Hibiscus tiliaceus*	Malvaceae	N		x			
Pele	*Abelmoschus manihot*	Malvaceae	I					x
Felo palagi	*Ficus carica*	Moraceae	I	x	x		x	x
Felo palagi	*Ficus tinctoria*	Moraceae	N					x
Mei	*Artocarpus altilis*	Moraceae	I	x	x		x	x
Akanita	*Bougainvillea glabra*	Nyctaginaceae	I					x
Kisikisi	*Boerhavia tetrandra*	Nyctaginaceae	N	x				
Puka	*Pisonia grandis*	Nyctaginaceae	N	x	x			
Lakau pula sega	*Ludwigia octovalvis*	Onagraceae	I					x
	Rivina humilis	Phytolacaceae	I	x			x	
	Piper aduncum	Piperaceae	I					x
Katuli	*Portulaca australis*	Portulacaceae	N	x	x		x	x
Katuli	*Portulaca lutea*	Portulacaceae	N	x	x		x	
Katuli	*Portulaca oleracea*	Portulacaceae	I	x	x		x	
Katuli palagi	*Portulaca umbraticola*	Portulacaceae	I					x
Lakau sopu	*Colubrina asiatica*	Rhamnaceae	N					x
Togo	*Rhizophora stylosa*	Rhizophoraceae	N		x	x		
Nonu	*Morinda citrifolia*	Rubiaceae	N	x	x		x	x
Pua	*Guettarda speciosa*	Rubiaceae	N	x	x	x	x	x
Tiale	*Gardenia taitensis*	Rubiaceae	N		x	x		x
	Spermococe assurgens	Rubiaceae	I					x
Laimi	*Citrus aurantifolia*	Rutaceae	I					x
Paigani	*Solanum melongena*	Solanaceae	I					x
Polo feu	*Capsicum annuum*	Solanaceae	I					x
Polo feu	*Capsicum frutescens*	Solanaceae	I					x
Tomato	*Solanum lycopersicum*	Solanaceae	I					x
Tolotolo	*Triumfetta procumbens*	Tiliaceae	I		x		x	
Lakau pula sega	*Turnera ulmifolia*	Turneraceae	I					x
Fou tagata	*Pipturus argenteus*	Urticaceae	N	x	x		x	
Luna	*Laportea ruderalis*	Urticaceae	N	x			x	
Mouku vao	*Pilea microphylla*	Urticaceae	I	x			x	
Inato	*Clerodendrum inerme*	Verbenaceae	N					x
Kaipuaka	*Lantana camara*	Verbenaceae	I				x	x
Lakau pakeke	*Stachytarpheta cayennesis*	Verbenaceae	I					x
Lakau pakeke	*Stachytarpheta jamaicensis*	Verbenaceae	I					x
Valovalo	*Premna serratifolia*	Verbenaceae	N	x	x		x	x

APPENDIX 4.3 Summary of the vegetation survey on Niutao Island

Transect 1 (Coconut woodland & agroforest)						
Species	**Tally**	**Height (m)**	**Basal Area (m^2)**	**Basal Area (%)**	**Volume (m^3)**	**Volume (%)**
Futi	1	3	0.01	1.19	2.10	0.16
Niu	5	18	0.35	48.53	0.00	72.12
Nonu	2	5	0.00	0.49	0.01	0.10
Lafau/Fou	3	7	0.01	1.36	0.06	0.43
Olesi	3	6	0.03	3.49	0.66	2.10
Pukavaka	2	15	0.28	37.93	0.07	22.75
Valovalo	12	7	0.05	7.01	2.91	2.34
7	28		0.73	100.00	2.91	100.00
Transect 2 (Coastal littoral forest and scrub)						
Species	**Tally**	**Height (m)**	**Basal Area (m^2)**	**Basal Area (%)**	**Volume (m^3)**	**Volume (%)**
Kanava	1	x14	0.03	5.12	0.06	1.65
Niu	8	18	0.61	89.40	3.44	97.37
Pua	1	x8.4	0.02	3.30	0.02	0.64
Valovalo	2	4	0.01	2.17	0.01	0.35
4	12		0.68	100.00	3.54	100
Transect 3 (Coastal littoral forest and scrub)						
Species	**Tally**	**Height (m)**	**Basal Area (m^2)**	**Basal Area (%)**	**Volume (m^3)**	**Volume (%)**
Falavao	15	13	0.50	64.10	1.17	65.34
Felo	2	12	0.08	10.40	0.22	12.46
Nonu	1	4	0.00	0.23	0.00	0.06
Pua	3	10	0.20	25.28	0.40	22.14
4	21		0.78	100	1.79	100
Transect 4 (Coastal littoral forest and scrub)						
Species	**Tally**	**Height (m)**	**Basal Area (m^2)**	**Basal Area (%)**	**Volume (m^3)**	**Volume (%)**
Felo	2	8	0.04	5.26	0.05	2.15
Lafau/Fou	5	6	0.03	3.96	0.04	1.63
Niu	8	16	0.58	80.60	2.21	90.84
Nonu	3	6	0.00	0.50	0.01	0.21
Pua	2	16	0.07	9.68	0.13	5.85
5	20		0.72	100	2.43	100
Transect 5 (Coastal littoral forest and scrub)						
Species	**Tally**	**Height (m)**	**Basal Area (m^2)**	**Basal Area (%)**	**Volume (m^3)**	**Volume (%)**
Fala	1	20	0.04	3.30	0.12	1.82
Lafau/Fou	4	11	0.01	0.52	0.01	0.17
Niu	10	21	0.90	83.00	6.22	94.32
Nonu	1	13	0.01	0.90	0.02	0.31
Pua	2	5	0.13	12.28	0.22	3.38
5	18		1.08	100	6.60	100
Transect 6 (Coastal littoral forest and scrub)						
Species	**Tally**	**Height (m)**	**Basal Area (m^2)**	**Basal Area (%)**	**Volume (m^3)**	**Volume (%)**

Felo	7	12	0.26	36.30	0.63	17.44
Niu	4	23.5	0.30	41.80	2.45	67.36
Pua	3	12.5	0.16	21.90	0.55	15.20
3	14		0.72	100	3.63	100
Transect 7 (Coastal littoral forest and scrub)						
Species	**Tally**	**Height (m)**	**Basal Area (m^2)**	**Basal Area (%)**	**Volume (m^3)**	**Volume (%)**
Fala	2	11	0.059	10.245	0.11103248	5.3282334
Niu	5	17	0.350	60.289	1.82135207	87.403151
Lafau/Fou	10	6	0.040	6.824	0.02590457	1.24311
Pua	5	8.16	0.13	22.64	0.13	6.03
4	22		0.58	100	2.08	100
Transect 8 (Coastal littoral forest and scrub)						
Species	**Tally**	**Height (m)**	**Basal Area (m^2)**	**Basal Area (%)**	**Volume (m^3)**	**Volume (%)**
Fala	5	11.4	0.14	9.48	0.31	7.27
Felo	1	x5.5	0.00	0.22	0.00	0.08
Fetau	2	15.75	0.13	8.89	0.74	17.17
Niu	7	18.28571429	0.48	33.27	2.68	61.98
Pua	4	8.125	0.69	48.14	0.58	13.50
5	19		1.44	100	4.32	100
Transect 9 (Inland Broadleaf Forest and Woodland)						
Species	**Tally**	**Height (m)**	**Basal Area (m^2)**	**Basal Area (%)**	**Volume (m^3)**	**Volume (%)**
Fala	5	8	0.12	9.60	0.20	6.59
Fetau	3	17	0.44	35.30	1.39	44.95
Niu	4	10	0.17	13.53	0.27	8.83
Nonu	1	6	0.00	0.11	0.00	0.05
Pua	7	8	0.51	41.46	1.22	39.57
5	20		1.24	100	3.09	100
Transect 10 (Inland Broadleaf Forest and Woodland)						
Species	**Tally**	**Height (m)**	**Basal Area (m^2)**	**Basal Area (%)**	**Volume (m^3)**	**Volume (%)**
Felo	1	20	0.04	0.93	0.38	4.14
Fetau	2	28	3.86	91.63	6.89	75.68
Niu	3	24	0.21	4.95	1.63	17.94
Nonu	1	6	0.01	0.13	0.00	0.05
Pua	7	9	0.10	2.36	0.20	2.20
5	14		4.21	100	9.10	100.00
Transect 11 (Mangrove & wetland)						
Species	**Tally**	**Height (m)**	**Basal Area (m^2)**	**Basal Area (%)**	**Volume (m^3)**	**Volume (%)**
Mangrove	5	8	0.33	36.38	0.35	23.50
Sagale	2	10	0.18	20.25	0.39	26.07
Kanava	3	9	0.30	33.48	0.62	41.67
Valovalo	2	9	0.09	9.89	0.13	8.75
4	12		0.91	100.00	1.48	100
Transect 12 (Coconut woodland & agroforest)						
Species	**Tally**	**Height (m)**	**Basal Area (m^2)**	**Basal Area (%)**	**Volume (m^3)**	**Volume (%)**

Breadfruit	2	8	0.09	8.53	0.13	3.40
Felo	1	3	0.00	0.03	0.00	0.01
Mei	2	7	0.06	6.37	0.07	1.77
Niu	7	19	0.54	52.87	3.16	83.31
Olesi	3	5	0.02	1.75	0.03	0.75
Pawpaw	1	5	0.06	5.67	0.10	2.55
Pukavai	1	8	0.00	0.31	0.01	0.18
Valovalo	4	4	0.25	24.47	0.31	8.04
8	21		1.01	100.00	3.80	100

APPENDIX 4.4 Summary of the calculated 'Lupe' density for Niutao Island

Lupe density estimate for Nukulaelae Atoll											
Point	**Veg. Code**	**Disturb. Status**	**Site**	**Species**	**Dist. (m)**	**No.**	**Band**	**Band value (m^2)**	**Density (#/band)**	**Sum Density**	**Density (#/ha)**
N5	1	1	Niutao	Lupe	5	1	1	314	0.003185	**less disturbed sites**	
N5	1	1	Niutao	Lupe	15	2	2	943	0.002121		
N5	1	1	Niutao	Lupe	20	1	2	943	0.00106		
N5	1	1	Niutao	Lupe	30	1	3	1570	0.000637		
N6	1	1	Niutao	Lupe	3	1	1	314	0.003185		
N6	1	1	Niutao	Lupe	10	1	1	314	0.003185		
N6	1	1	Niutao	Lupe	35	2	4	2200	0.000909		
N3	1	1	Niutao	Lupe	5	1	1	314	0.003185		
N3	1	1	Niutao	Lupe	20	2	2	943	0.002121		
N1	1	1	Niutao	Lupe	10	1	1	314	0.003185		
N1	1	1	Niutao	Lupe	25	2	3	1570	0.001274		
N11	2	1	Niutao	Lupe	5	1	1	314	0.003185		
N11	2	1	Niutao	Lupe	20	1	2	943	0.00106	0.02829	**56.58174**
N4	4	2	Niutao	Lupe	10	1	1	314	0.003185	**more disturbed sites**	
N4	4	2	Niutao	Lupe	20	1	2	943	0.00106		
N12	4	2	Niutao	Lupe	20	1	2	943	0.00106		
	4	2	Niutao	Lupe	5	1	1	314	0.003185		
N10	4	2	Niutao	Lupe	7	2	1	314	0.006369		
N10	4	2	Niutao	Lupe	20	1	2	943	0.00106		
N9	4	2	Niutao	Lupe	15	1	2	943	0.00106		
	4	2	Niutao	Lu[e	30	1	3	1570	0.000637		
N7	4	2	Niutao	Lupe	5	1	1	314	0.003185		
	4	2	Niutao	Lupe	20	2	2	943	0.002121		
N13	5	2	Niutao	Lupe	5	3	1	1570	0.001911		
	5	2	Niutao	Lupe	15	2	2	943	0.002121	0.02695	**44.92483**

APPENDIX 5.1 Summary of survey effort for Vaitupu BioRAP

Transect	Date	Site	Island	X coordinate (°E)	Y coordinate (°S)
Flora & Vegetation Survey					
1	04/05/2021	Vaitupu	Vaitupu	178°66'60.6" E	07°46'60.2" S
2	04/05/2021	Vaitupu	Vaitupu	178°66'39.7" E	07°46'39.5" S
3	04/05/2021	Vaitupu	Vaitupu	178°66'71.9" E	07°45'98.3" S
4	04/05/2021	Vaitupu	Vaitupu	178°67'02.7" E	07°46'18.2" S
5	04/05/2021	Vaitupu	Vaitupu	178°67'26.1" E	07°46'59.4" S
6	04/05/2021	Vaitupu	Vaitupu	07°46'74.9" S	07°46'74.9" S
7	04/05/2021	Vaitupu	Vaitupu	178°67'37.7" E	07°47'22.2" S
8	04/05/2021	Vaitupu	Vaitupu	178°67'47.4" E	07°47'55.4" S
9	04/05/2021	Vaitupu	Vaitupu	178°68'09.5" E	07°49'39.1" S
10	04/05/2021	Vaitupu	Vaitupu	178°68'40.1" E	07°49'54.0" S
11	05/05/2021	Vaitupu	Vaitupu	178°68'97.4" E	07°49'44.0" S
12	05/05/2021	Vaitupu	Vaitupu	178°69'28.6" E	07°48'94.8" S
13	05/05/2021	Vaitupu	Vaitupu	178°69'21.8" E	07°48'11.6" S
14	05/05/2021	Vaitupu	Vaitupu	178°68'84.0" E	07°48'60.3" S
Land bird survey					
1	03/05/2021	V3	Vaitupu	178° 38' 98.9"	07° 27' 97.4"
2	03/05/2021	V1	Vaitupu	178° 39' 84.6"	07° 27' 86.5"
3	03/05/2021	V5	Vaitupu	178° 40' 21.0"	07° 27' 94.6"
4	03/05/2021	V6	Vaitupu	178° 40' 30.6"	07° 28' 09.4"
5	03/05/2021	V8	Vaitupu	178° 40' 34.3"	07° 28' 09.4"
6	03/05/2021	V9	Vaitupu	178° 40' 67.2"	07° 28' 49.8"
7	03/05/2021	V7	Vaitupu	178° 40' 70.9"	07° 28' 29.7"
8	03/05/2021	V4	Vaitupu	178° 40' 14.1"	07° 27' 71.7"
9	03/05/2021	V2	Vaitupu	178° 40' 05.6"	07° 27' 61.2"
10	04/05/2021	V11	Vaitupu	178° 41' 62.8"	07° 28' 83.8"

11	04/05/2021	V14	Vaitupu	178° 41' 12.9"	07° 29' 87.9"
12	04/05/2021	V13	Vaitupu	178° 41' 45.0"	07° 29' 78.2"
13	04/05/2021	V10	Vaitupu	178° 41' 17.1"	07° 28' 98.4"
14	04/05/2021	V12	Vaitupu	178° 41' 62.3"	07° 29' 00.0"
Sea-bird AON transect					
1	03/05/2021	Punatau 1	Vaitupu	178o 39' 98.9'	07o 27' 97.4"
2	03/05/2021	Motu Letika	Vaitupu	178o 40' 05.5'	07o 27' 61.2"
3	03/05/2021	Punatau 3	Vaitupu	178o 39' 98.9	07o 27' 97.4"
4	03/05/2021	Teakega	Vaitupu	178o 40'19.1'	07o 27' 71.7"
5	03/05/2021	Fongamanu	Vaitupu	178o 40' 21.0'	07o 27' 94.6"
6	03/05/2021	Olokalaga	Vaitupu	178o 40' 21.0'	07o 27' 94.6"
7	03/05/2021	Olosau	Vaitupu	178o 40'70.9 '	07o 28' 29.7"
8	03/05/2021	Taaga	Vaitupu	178o 40' 34.3'	07o 28' 17.5"
9	03/05/2021	Soala	Vaitupu	178o 40' 67.2 '	07o 28' 49.6"
10	04/05/2021	Elisefou	Vaitupu	178o 41' 17.1'	07o 28'98.4"
11	04/05/2021	Motu Masana	Vaitupu	178o 41' 62.8'	07o 28' 83.6"
12	04/05/2021	Togo	Vaitupu	178o 41' 62.3'	07o 29'00.0"
13	04/05/2021	Dumpsite	Vaitupu	178o 41' 45.0'	07o 29' 75.2"
14	04/05/2021	Patamo	Vaitupu	178o 41' 12.8'	07o 29' 87.9"
Sea-bird point counts					
1	03/05/2021	Punatau 3	Vaitupu	178o 39' 98.9"	07o27' 97.4"
2	03/05/2021	Punatau 1	Vaitupu	178o 39' 84.6"	07o27' 86.5"
3	03/05/2021	Poogamanu 5	Vaitupu	178o 48' 21.0"	07o27' 94.6"
4	03/05/2021	Olokalaga 6	Vaitupu	178o 40' 30.6"	07o28' 09.4"
5	03/05/2021	Taaga 8	Vaitupu	178o 40' 34.3"	07o28' 17.5"
6	03/05/2021	Soala 9	Vaitupu	178o 40' 67.2"	07o28' 49.8"
7	03/05/2021	Olosau 7	Vaitupu	178o 40' 70.9"	07o28' 29.7"
8	03/05/2021	Teakega 4	Vaitupu	178o 40'19.1"	07o27' 71.7"
9	03/05/2021	Motu Letika	Vaitupu	178o 40' 05.5"	07o28' 83.8"

10	03/05/2021	Motu Masana	Vaitupu	178o 41' 62.8"	07o28' 83.8"
11	04/05/2021	Patamo 14	Vaitupu	178o 41' 12.9"	07o29' 87.9"
12	04/05/2021	Dumpsite 13	Vaitupu	178o 41' 45.0"	07o29' 78.2"
13	04/05/2021	Elisefou 10	Vaitupu	178o 41' 17.1"	07o28' 98.4"
14	04/05/2021	Togo 12	Vaitupu	178o 41' 62.3"	07o29' 00.00"
Shore-bird Survey Points					
1	04/05/2021	NE Rocks Motu Olepa	Vaitupu	178o 41'68.7"	07o 29' 00."
2	04/05/2021	SW Beach Rock Te Felo	Vaitupu	178o 40'68.7"	07o 29'39.7"
3	05/05/2021	SW Rocks Wharf Site	Vaitupu	178o 40' 53.4"	07o 29'05.9"
4	05/05/2021	SE Motufoua Beach	Vaitupu	178o 41'69.5'"	07o 29'44.7"
Marine Leeward Sites					
1	03/05/2021	Vaitupu	Vaitupu	178 40' 31.3"	07 29' 20.2"
2	03/05/2021	Vaitupu	Vaitupu	178 40' 33.7"	07 29' 25.8"
3	03/05/2021	Vaitupu	Vaitupu	178 40' 35.1"	07 29' 32.6"
Marine Windaward Sites					
4	04/05/2021	Vaitupu	Vaitupu	178 41' 43.9"	07 29' 37.7"
5	04/05/2021	Vaitupu	Vaitupu	178 41' 53.3"	07 29' 25.0"
6	04/05/2021	Vaitupu	Vaitupu	178 41' 38.7"	07 29' 43.0"
Marine Central Lagoon					
1	05/05/2021	Central lagoon	Vaitupu	178 41' 03.1"	07 28' 59.8"

APPENDIX 5.2 Checklist of the Flora of Vaitupu Atoll

(Status here refers to the 'distribution status' where N = native or indigenous species and I = introduced species. The figures 1,2,3,4,5 refers to the 'vegetation type codes' where 1 = 'Inland broadleaf woodland forest', 2 = 'Littoral forest and scrub', 3 = 'Mangrove and wetland vegetation', 4 = 'Coconut woodland and agroforest' and 5 = 'Disturbed and human modified vegetation'. The letter 'x' confirms the presence of the species in that vegetation type.)

FERNS								
Tuvalu Name	**Latin Name**	**Family**	**Status**	**1**	**2**	**3**	**4**	**5**
Katafa/Laukatafa	*Asplenium nidus*	Aspleniaceae	N	x	x		x	
Sulufe	*Nephrolepis acutifolia*	Nephrolepidaceae	N	x	x	x		
Sulufe	*Nephrolepis hirsutula*	Nephrolepidaceae	N	x	x	x		x
	Nephrolepis exaltata	Nephrolepidaceae	N	x	x			x
Maile	*Microsorum grossum*	Polypodiaceae	N	x	x		x	
Paotua	*Psilotum nudum*	Psilotaceae	N		x			
Silotau	*Pteris tripartita*	Pteridaceae	N	x				
GYMNOSPERMS								
Tuvalu Name	**Latin Name**	**Tuvalu Name**	**Status**	**1**	**2**	**3**	**4**	**5**
Lakau Kilisimasi	*Araucaria columnaris*	Araucariaceae	I					x
Laupama	*Cycas rumphii*	Cycadaceae	I					x
MONOCOTYLEDONS								
Tuvalu Name	**Latin Name**	**Family**	**Status**	**1**	**2**	**3**	**4**	**5**
Launiu	Dracaena angustifolia	Agavaceae	I					x
Lauti/ Ti	Cordyline fruticosa	Agavaceae	I					x
Aniani	Allium fistulosum	Alliaceae	I					x
Lili	Hippeastrum puniceum	Amaryllidaceae	I					x
Lili	Hymenicallis pedalis	Amaryllidaceae	I					x
Susana	Zephyranthes rosea	Amaryllidaceae	I		x			x
Talotalo/Tapua	Crinum asiaticum	Amaryllidaceae	I		x			x

Talotalo/Tapua	Crinum augustum	Amaryllidaceae	I					x
Talotalo/Tapua	Crinum zeylanicum	Amaryllidaceae	I					x
Talotalo/Tapua palagi	Crinum xanthophyllum	Amaryllidaceae	I					x
Kape	Alocasia macrorrhizos	Araceae	I	x		x		
Pulaka	Cyrtosperma chamissonis	Araceae	I			x		
Taliga kula	Caladium bicolor	Araceae	I					x
Talo	Colocasia esculenta	Araceae	I			x		
Talo ni tana	Xanthosoma sagittufolium	Araceae	I			x		
Tamu	Alocasia macrorrhizos	Araceae	I		x	x		x
Niu	Cocos nucifera	Arecaceae	I	x	x	x	x	x
Niu piu	Pritchardia pacifica	Arecaceae	I					x
Painapolo	Ananas comosus	Bromeliaceae	I					x
Lakau fai tika/Mouku filifou	Mariscus javanicus	Cyperaceae	I				x	x
Mouku	Cyperus compressus	Cyperaceae	I				x	x
Mouku	Kyllinga nemoralis	Cyperaceae	I					x
Mouku	Pycreus polystachyos	Cyperaceae	I					x
Mouku milimili taliga	Fimbristylis cymosa	Cyperaceae	I		x		x	x
Muta	Cyperus rotundus	Cyperaceae	I				x	x
	Fimbristylis dichotoma	Cyperaceae	I					x
	Kyllinga brevifolia	Cyperaceae	I				x	x
Tivoli	Dioscorea nummularia	Dioscoreaceae	I					x
Ufi	Dioscorea alata	Dioscoreaceae	I					x
	Trimezia martinicensis	Iridaceae	I	x	x			x
Lakau laupiki	Gloria superba	Liliaceae	I					x

Nareau	Gloria superba	Liliaceae	I					x
Fuamaoluga/Fuamaulalo	Musa AAA	Musaceae	I					x
Futi	Musa sp	Musaceae	I				x	x
Kefu/Pata	Musa ABB	Musaceae	I					x
Misiluki/ Tamatama ai lima	Musa AB	Musaceae	I				x	x
Vanila	Vanilla planifolia	Orchidaceae	I					x
Fala	Pandanus tectorius1	Pandanceae	N		x		x	
Fala vao	Pandanus tectorius2	Pandanceae	N	x		x		
Kaleve/Tolo	Saccharum officinarum	Poaceae	I				x	x
Kateketeke	Cenchurus echinatus	Poaceae	I				x	x
Mouku	Chloris barbata	Poaceae	I				x	x
Mouku	Cynodon dactylon	Poaceae	I				x	x
Mouku	Dactyloctenium aegyptium	Poaceae	I					x
Mouku	Eleusine indca	Poaceae	I					x
Mouku	Leturus repens	Poaceae	N		x		x	x
Mouku	Paspalum vaginatum	Poaceae	N			x		x
Mouku	Stenotaphrum micranthum	Poaceae	I		x			x
Mouku solo	Thuarea involuta	Poaceae	N					x
Mouku talatala	Cenchurus echinatus	Poaceae	I				x	x
	Axonopus compressus	Poaceae	I					x
	Digitaria ciliaris	Poaceae	I					x
	Digitaria radicosa	Poaceae	I					x
	Sporobolus fertilis	Poaceae	I					x
DICOTYLEDONS								

Tuvalu Name	**Latin Name**	**Family**	**Status**	**1**	2	3	**4**	**5**
Lakau kena	*Pseuderanthemum carruthersii var. carruthersii*	Acanthaceae	I					x
Lakau kena	*P. carruthersii var. reticulatum*	Acanthaceae	I					x
Lakau pula kena	*P. carruthersii var. carruthersii*	Acanthaceae	I					x
Lakau uli	*P. carruthersii var. atropurpureum*	Acanthaceae	I					x
Lautagitagi	*P. carruthersii var. atropurpureum*	Acanthaceae	I					x
Tamatama	*Achyranthes canescens*	Amaranthaceae	I		x			x
	Alternanthera sessilis	Amaranthaceae	I			x		x
	Alternanthera sissoo	Amaranthaceae	I					x
Fao	*Ochrosia oppositifolium*	Apocynaceae	N	x	x			
Melia	*Plumeria rubra*	Apocynaceae	I					x
Melia Solomona	*Plumeria obtusa*	Apocynaceae	I					x
Peteli	*Catharanthus roseus*	Apocynaceae	I					x
Peteli Kena	*Catharanthus roseus*	Apocynaceae	I					x
Pua Fiti	*Plumeria rubra*	Apocynaceae	I					x
Pua Fiti Solomona	*Plumeria obtusa*	Apocynaceae	I					x
Lautagitagi	*Polyscias fruticosa*	Araliaceae	I					x
Lautagitagi	*Polyscias guifoylei*	Araliaceae	I					x
Lautagitagi	*Polyscias scutellaria*	Araliaceae	I					x
Ateate/ Lakau o galiga	*Wollastonia biflora*	Asteraceae	N		x			x
Letisi	*Lactuca sativa*	Asteraceae	I					x

Mili	*Pluchea carolinensis*	Asteraceae	I		x			x
Mili	*Pluchea indica*	Asteraceae	I		x			x
Mouku	*Synedrella nodiflora*	Asteraceae	I		x		x	x
Mouku fai pula	*Cyanthillium cinereum*	Asteraceae	I				x	x
Mouku fai pula	*Tridax procumbens*	Asteraceae	I					x
Saketa laukili	*Mikania micrantha*	Asteraceae	I		x			
	Sphagneticola trilobata	Asteraceae	I		x			x
sinia	*Zinnia elegans*	Asteraceae	I					x
Futu	*Barringtonia asiatica*	Barringtoniaceae	N		x			
Nikilailai	*Tecoma stans*	Bignoniaceae	I					x
Kanava	*Cordia subcordata*	Boraginaceae	N		x			x
Kanava palagi	*Cordia sebestena*	Boraginaceae	I					x
tausunu	*Tournefortia argentea*	Boraginaceae	N		x			
Kapisi pukupuku	*Brassica oleracea*	Brassicaceae	I					x
Kapisi saina	*Brassica chinensis*	Brassicaceae	I					x
Kapisi saina	*Brassica juncea*	Brassicaceae	I					x
Kapisi saina	*Brassica x hybridus*	Brassicaceae	I					x
Olesi	*Carica papaya*	Caricaceae	I					x
Lakau Kilisimasi	*Casuarina equisetifolia*	Casuarinaceae	N					x
Fetau	*Calophyllum inophyllum*	Clusiaceae	N	x	x			
Kunikuni/ Te Kunikuni	*Terminalia catappa*	Combretaceae	N		x			
Talie	*Terminalia samoensis*	Combretaceae	N		x			
Fue	*Ipomoea macrantha*	Convolvulaceae	N		x			
Fue/ Fur pinink	*Ipomoea pes-caprae*	Convolvulaceae	N		x			
Kumala	*Ipomoea batatas*	Convolvulaceae	I					x

Kukama	*Cucumis sativa*	Cucurbitaceae	I					x
Meleni	*Citrullus lanatus*	Cucurbitaceae	I					x
Panikeni	*Cucurbita sp*	Cucurbitaceae	I					x
	Lagenaria siceraria	Cucurbitaceae	I					x
	Luffa cylindrica	Cucurbitaceae	I					x
Kalakalapuhi kula/ Ogoogo kula	*Acalypha hispida*	Euphorbiaceae	I					x
Kalakalapuki/ Ogoogo	*Acalypha grandis*	Euphorbiaceae	N	x	x		x	
Lautagitagi fou	*Codiaeum variegatum*	Euphorbiaceae	I					x
Mouku	*Chamaesyce thymifolia*	Euphorbiaceae	I		x			
Mouku laupukupuku	*Phyllanythus amarus*	Euphorbiaceae	I		x			
Mouku toto	*Chamaesyce atoto*	Euphorbiaceae	I		x			x
Mouku toto	*Chamaesyce hirta*	Euphorbiaceae	I		x			x
Mouku toto	*Chamaesyce hypericifolia*	Euphorbiaceae	I		x			x
Ogoogo kula	*Acalypha wilkesiana*	Euphorbiaceae	I					x
pele	*Cnidoscolus chayamansa*	Euphorbiaceae	I					x
Tapioka	*Manihot esculenta*	Euphorbiaceae	I					x
	Euphorbia cyathephora	Euphorbiaceae	I		x		x	x
Lakau fai fuaga	*Leucaena leucocephala*	Fabaceae	I	x				x
Mouku matiotio	*Mimosa pudica*	Fabaceae	I		x			x
Piini	*Phaseolus vulgaris*	Fabaceae	I		x		x	x
Piini	*Vigna sesquipadalia*	Fabaceae	N					x
Saketa	*Canavalia cathartica*	Fabaceae	N	x	x			

Saketa	*Vigna marina*	Fabaceae	N		x			
	Senna occidentalis	Fabaceae	I					x
	Sophora tomentosa	Fabaceae	N		x			
Gasu	*Scaevola taccada*	Goodeniaceae	N		x	x		
Nui/ Puka	*Hernandia nymphaefolia*	Hernandiaceae	N	x	x			
Mili kai	*Ocimum basilicum*	Lamiaceae	I					x
Mili manogi	*Ocimum tenuiflorum*	Lamiaceae	I		x		x	
Fetai	*Cassytha filiformis*	Lauraceae	N	x	x			
Gie	*Pemphis acidula*	Lythraceae	N			x		
Akata	*Sida fallax*	Malvaceae	I		x		x	x
Akata	*Sida rhombifolia*	Malvaceae	I		x		x	x
Aute/ Aute kula	*Hibiscus rosa-sinesis*	Malvaceae	I					x
Fou	*Hibiscus tiliaceus*	Malvaceae	N		x			
Milo	*Thespesia populnea*	Malvaceae	N	x	x	x		
Pele	*Abelmoschus manihot*	Malvaceae	I					x
Felo palagi	*Ficus carica*	Moraceae	I	x	x		x	x
Felo palagi	*Ficus tinctoria*	Moraceae	N					x
Mei	*Artocarpus altilis*	Moraceae	I	x	x		x	x
Akanita	*Bougainvillea glabra*	Nyctaginaceae	I					x
Kisikisi	*Boerhavia tetrandra*	Nyctaginaceae	N	x				
Puka/ Pukavai	*Pisonia grandis*	Nyctaginaceae	N	x	x			
Lakau pula sega	*Ludeigia octovalvis*	Onagraceae	I					x
	Rivina humilis	Phytolacaceae	I	x			x	
	Piper aduncum	Piperaceae	I					x
Katuli	*Portulaca australis*	Portulacaceae	N	x	x		x	x
Katuli	*Portulaca lutea*	Portulacaceae	N	x	x		x	
Katuli	*Portulaca oleracea*	Portulacaceae	I	x	x		x	

Katuli palagi	*Portulaca umbraticola*	Portulacaceae	I					x
	Portulaca grandilfora	Portulacaceae	I					
Lakau sopu	*Colubrina asiatica*	Rhamnaceae	N					x
Togo	*Rhizophora stylosa*	Rhizophoraceae	N		x	x		
Nonu	*Morinda citrifolia*	Rubiaceae	N	x	x		x	x
Pua/ Pua vao	*Guettarda speciosa*	Rubiaceae	N	x	x	x	x	x
Tiale	*Gardenia taitensis*	Rubiaceae	N		x	x		x
	Spermococe assurgens	Rubiaceae	I					x
Laimi	*Citrus aurantifolia*	Rutaceae	I					x
Paigani	*Solanum melongena*	Solanaceae	I					x
Polo feu/ Tili	*Capsicum annuum*	Solanaceae	I					x
Polo feu/ Tili	*Capsicum frutescens*	Solanaceae	I					x
Tomato	*Solanum lycopersicum*	Solanaceae	I					x
Tolotolo	*Triumfetta procumbens*	Tiliaceae	I		x		x	
Lakau pula sega	*Turnera ulmifolia*	Turneraceae	I					x
Fou tagata	*Pipturus argenteus*	Urticaceae	N	x	x		x	
Luna	*Laportea ruderalis*	Urticaceae	I	x			x	
Mouku vao	*Pilea microphylla*	Urticaceae	I	x			x	
Aloalo	*Premna serratifolia*	Verbenaceae	N	x	x		x	x
Inato	*Clerodendrum inerme*	Verbenaceae	N					x
Kaipuaka	*Lantana camara*	Verbenaceae	I				x	x
Lakau pakeke	*Stachytarpheta cayennesis*	Verbenaceae	I					x

Lakau pakeke	*Stachytarpheta jamaicensis*	Verbenaceae	I					x
Valovalo	*Premna serratifolia*	Verbenaceae	N	x	x		x	x

APPENDIX 5.3 Summary of the Vegetation Survey of Vaitupu Atoll

Transect 1 (Coconut woodland & agroforest)						
Species	Tally	Height (m)	Basal Area (m^2)	Basal Area (%)	Volume (m^3)	Volume (%)
Kanava	1	16	0.92	22.33	0.58	5.71
Niu	3	19	0.15	3.52	1.18	11.62
Nonu	2	6	0.02	0.45	0.02	0.15
Pua	2	7	0.00	0.05	0.00	0.03
Pukavai	8	7	0.06	1.38	0.13	1.30
Pukavaka	9	14	2.97	72.14	8.23	81.12
Valovalo	1	8	0.01	0.13	0.01	0.07
7	26		4.12	100.00	10.15	100.00
Transect 2 (Coastal littoral forest and scrub)						
Species	Tally	Height (m)	Basal Area (m^2)	Basal Area (%)	Volume (m^3)	Volume (%)
Niu	8	22	0.59	32.74	3.90	57.69
Nonu	8	7	0.03	1.41	0.04	0.59
Pua	3	8	0.01	0.59	0.03	0.49
Pukavai	6	7	0.08	4.40	0.08	1.12
Pukavuka	7	14	1.11	60.87	2.71	40.12
5	32		1.82	100.00	6.76	100
Transect 3 (Coastal littoral forest abd scrub)						
Species	Tally	Height (m)	Basal Area (m^2)	Basal Area (%)	Volume (m^3)	Volume (%)
Niu	10	18	0.75	56.13	4.10	87.52
Pukavai	17	6	0.53	39.65	0.47	9.96
Valovalo	1	9	0.06	4.22	0.12	2.52
3	28		1.33	100	4.68	100
Transect 4 (Coastal littoral forest and scrub)						
Species	Tally	Height (m)	Basal Area (m^2)	Basal Area (%)	Volume (m^3)	Volume (%)
Fala	2	13	0.04	2.89	0.12	2.46
Felo	1	9	0.03	2.00	0.05	0.97
Fetau	1	7	0.00	0.11	0.00	0.03
Niu	9	18	0.64	44.48	3.08	62.22
Nonu	5	4	0.00	0.21	0.00	0.05
Ogogo	1	3	0.00	0.01	0.00	0.00
Pua	5	8	0.12	8.02	0.27	5.44
Pukavai	2	24	0.61	42.29	1.42	28.82
8	26		1.43	100	4.94	100
Transect 5 (Inland Broadleaf Forest and Woodland)						
Species	Tally	Height (m)	Basal Area (m^2)	Basal Area (%)	Volume (m^3)	Volume (%)
Felo	3	8	0.01	0.37	0.02	0.13
Niu	8	18	0.66	16.80	4.13	30.10
Nonu	6	5	0.03	0.78	0.03	0.21
Ogogo	1	3	0.00	0.01	0.00	0.00
Pua	3	11	0.02	0.48	0.07	0.49
Pukavai	5	9	3.23	81.57	9.47	69.06
6	26		3.95	100	13.72	100

Transect 6 (Coconut woodland and agroforest)						
Species	Tally	Height (m)	Basal Area (m^2)	Basal Area (%)	Volume (m^3)	Volume (%)
Felo	1	9	0.01	0.81	0.01	0.17
Gasu	2	2.5	0.00	0.33	0.00	0.05
Niu	6	22	0.68	81.58	4.59	94.73
Nonu	4	8	0.05	6.13	0.07	1.39
Pua	10	9	0.08	10.22	0.17	3.55
Pukavai	1	3	0.00	0.08	0.00	0.01
Tausuni	1	5	0.01	0.86	0.00	0.09
7	25		0.83	100	4.84	100
Transect 7 (Inland Broadleaf Forest and Woodland)						
Species	Tally	Height (m)	Basal Area (m^2)	Basal Area (%)	Volume (m^3)	Volume (%)
Niu	2	14	0.277	11.122	1.80	23.27
Nonu	2	3	0.002	0.080	0.00	0.01
Laufau/Fou	2	5	0.020	0.787	0.02	0.21
Pukavai	11	5	0.091	3.666	0.10	1.26
Pukavaka	7	19	2.10	84.34	5.82	75.25
5	24		2.49	100	7.73	100
Transect 8 (Coastal littoral forest and scrub)						
Species	Tally	Height (m)	Basal Area (m^2)	Basal Area (%)	Volume (m^3)	Volume (%)
Felo	2	8	0.01	0.26	0.01	0.08
Niu	4	20	0.32	16.72	2.41	28.86
Nonu	13	7.692307692	0.13	6.82	0.24	2.84
Pukavuka	4	19.75	1.48	76.20	5.69	68.23
4	23		1.94	100	8.34	100
Transect 9 (Coconut woodland & agroforest)						
Species	Tally	Height (m)	Basal Area (m^2)	Basal Area (%)	Volume (m^3)	Volume (%)
Fetau	2	23	2.41	52.24	3.68	36.73
Mei	2	24	1.79	38.82	4.20	41.87
Niu	3	23	0.26	5.61	2.01	20.01
Nonu	2	5	0.04	0.82	0.03	0.33
Pukavaka	3	8	0.02	0.54	0.03	0.30
Valovalo	3	8	0.09	1.98	0.08	0.76
6	15		4.61	100	10.03	100
Transect 10 (Inland Broadleaf Forest and Woodland)						
Species	Tally	Height (m)	Basal Area (m^2)	Basal Area (%)	Volume (m^3)	Volume (%)
Fala	1	12	0.03	1.30	0.08	0.74
Niu	9	19	0.70	26.89	4.50	39.32
Nonu	2	7	0.01	0.52	0.02	0.14
Pua	2	7	0.00	0.13	0.00	0.03
Pukavai	3	17	1.84	71.05	6.84	59.75
Pukavaka	2	5	0.00	0.11	0.00	0.02
6	19		2.58	100	11.45	100.00
Transect 11 (Inland Broadleaf Forest and Woodland)						

Species	Tally	Height (m)	Basal Area (m^2)	Basal Area (%)	Volume (m^3)	Volume (%)
Felo	2	4	0.00	0.03	0.00	0.02
Niu	5	15	0.34	5.90	1.26	17.59
Pukavai	2	13	1.99	35.00	1.67	23.28
Pukavaka	17	11	3.36	59.08	4.25	59.11
4	26		5.69	100.00	7.19	100
Transect 12 (Coconut woodland & agroforest)						
Species	**Tally**	**Height (m)**	**Basal Area (m^2)**	**Basal Area (%)**	**Volume (m^3)**	**Volume (%)**
Mei	3	15	3.31	90.30	7.28	79.06
Niu	4	18	0.36	9.70	1.93	20.94
2	7		3.66	100.00	9.20	100
Transect 13 (Coastal littoral forest and scrub)						
Species	**Tally**	**Height (m)**	**Basal Area (m^2)**	**Basal Area (%)**	**Volume (m^3)**	**Volume (%)**
Fala	1	12	0.02	0.85	0.06	0.65
Fetau	1	20	0.12	4.12	0.39	4.18
Niu	8	19	0.59	20.92	3.58	38.18
Nonu	5	3	0.00	0.11	0.00	0.02
Pua	1	9	0.00	0.00	0.00	0.00
Pukavuka	7	16	2.10	73.98	5.34	56.97
Valovalo	1	3	0.00	0.02	0.00	0.00
7	24		2.83	100.00	9.38	100
Transect 14 (Coastal littoral forest and scrub)						
Species	**Tally**	**Height (m)**	**Basal Area (m^2)**	**Basal Area (%)**	**Volume (m^3)**	**Volume (%)**
Gasu	2	4	0.01	1.22	0.01	0.66
Gie	12	6	0.26	40.15	0.25	24.48
Niu	6	9	0.38	57.68	0.76	73.34
Pua	1	8	0.01	0.95	0.02	1.52
4	21		0.66	100.00	1.03	100

APPENDIX 5.4 Summary of the 'Lupe' Density Calculation for Vaitupu Island

Point	Veg. Code	Disturb. Status	Site	Species	Dist. (m)	No.	Band	Band value (m^2)	Density (#/band)	Sum Density	Density (#/ha)
V3	1	1	Vaitupu	Lupe	10	1	1	314	0.003185	**less disturbed sites**	
V3	1	1	Vaitupu	Lupe	25	2	3	1570	0.001274		
V1	2	1	Vaitupu	Lupe	20	1	2	943	0.00106		
V5	1	1	Vaitupu	Lupe	10	5	1	314	0.015924		
1	1	1	Vaitupu	Lupe	25	1	3	1570	0.000637		
V6	1	1	Vaitupu	Lupe	5	1	1	314	0.003185		
V6	1	1	Vaitupu	Lupe	30	2	3	1570	0.001274		
V8	2	1	Vaitupu	Lupe	10	2	1	314	0.006369		
V9	1	1	Vaitupu	Lupe	15	1	2	943	0.00106		
V7	1	1	Vaitupu	Lupe	20	1	2	943	0.00106		
V4	2	1	Vaitupu	Lupe	10	7	1	314	0.022293		
V4	2	1	Vaitupu	Lupe	35	1	4	2200	0.000455		
V14	2	1	Vaitupu	Lupe	10	1	1	314	0.003185		
V10	3	1	Vaitupu	Lupe	20	5	2	943	0.005302	**0.06626**	**66.262949**
V2	4	2	Vaitupu	Lupe	10	1	1	314	0.003185	**more disturbed sites**	
V11	4	2	Vaitupu	Lupe	15	1	2	943	0.00106		
V12	4	2	Vaitupu	Lupe	10	1	1	314	0.003185	**0.00743**	**24.76624**