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Biological and Socio-Economical Baseline Report for the Establishment of the Greater Delaikoro Protected Area, Vanua Levu, Fiji Islands

2014 Rapid Biodiversity Assessment, Socioeconomic Study and Archaeological Survey of the Greater Delaikoro Area

Ministry of Fisheries & Forests "Our Forest, Our Ocean, Our Future"

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A biodiversity assessment, socioeconomic study and archaeological survey of the Greater Delaikoro Area, Vanua Levu.

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A report compiled by the Institute of Applied Science, University of the South Pacific for FAO/GEF-PAS Forest and Protected Area Management, FPAM, Project

June 2014, Suva, Fiji Islands

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Executive Summary

This report is a compilation of the findings of a biodiversity, socio-economic and archaeological survey carried out in a proposed protected area in Vanua Levu, Fiji. The area under consideration for protection is the Greater Delaikoro Area, an upland region spanning the main mountain range of Vanua Levu, encompassing Mt Delaikoro, Mt Sorolevu and the Waisali Reserve. This work was carried out under the Forestry and Protected Area Management Project, a component of the GEF-PAS program.

Flora and vegetation ecology

A total of 641 vascular plant taxa and 117 bryophyte taxa were recorded. Range extensions were documented for all the bryophytes and 90 species of the vascular plants. Ten taxa were recorded that have botanical significant due to their rarity or protection status. A notable find was a rare moss, *Bescherelli cryphaeiodes*, in the cloud forest of Mt Delaikoro, hitherto known only from a single location in Viti Levu. Lowland and dry forest areas and associated riparian vegetation were the most heavily impacted by agricultural activity and invasive species. In the upland and cloud forest areas, despite some evidence of recent and historical logging, tree species diversity and density were higher than in the lowland forests.

Terrestrial Insects

A total of eighteen families of beetles (Coleoptera) were recorded within the study area, as well as a high abundance of ants (Formicidae), and a diverse macro-moth fauna. These taxa provide critical ecosystem services in forest systems such as soil processing, decomposition, herbivory, pollination and seed dispersal. Insects of conservation value recorded during the survey were *Hypolimnas inopinata, Cotylosoma dipneusticum, Phasmatonea inermis, Hypena rubrescens* and *Luxiaria sesquilinea.*

Avifauna

A total of 27 species of land birds and three species of bats were recorded from 46 point count stations located in different sub-habitat types within both lowland, upland and cloud forest. All of the 27 bird species recorded were native, 24 of them endemic to Fiji.

Herpetofauna

Eight species of herpetofauna were recorded during the survey, of which four were endemic to Fiji, three others native and one was an invasive introduced species. The Vanua Levu endemic skink, *Emoia mokosariniveikau,* was not encountered. Further surveys will very likely reveal the existence of additional herpetofaunal species.

Freshwater Fishes

A total of eighteen species of fish from six families were recorded in the tributaries of the Delaikoro range. A notable find was the goby *Lentipes kaaea,* this being the first record of it on the island of Vanua Levu. Two gobies endemic to Vanua Levu, *Redigobius leveri* and *Redigobius lekutu*, and two as yet undescribed gobies from the genus *Stiphodon* were also documented. Water quality was well within habitable range in terms of dissolved oxygen, conductivity, temperature and turbidity across all sampling stations. The introduced tilapia (*Oreochromis* spp.) was recorded in mid and lower reach sites and may account for the low abundance and diversity of native stream fishes.

Freshwater macroinvertebrates

A total of 70 freshwater macroinvertebrate taxa were identified from the 11,395 specimens collected. Of these 70 taxa, a total of 37 were endemic or native to Fiji. A total of twelve macroinvertebrate taxa were selected as potential bioindicators. The high number of endemic and native taxa recorded, as well as the high abundance of a large number of species is

indicative of a healthy stream system. A major finding during the survey was a new record of prawn species for Fiji, *Macrobrachium spinosum.*

Invasives

There were 21 invasive plant species and thirteen invasive animal species recorded throughout the survey area. Invasive plants were readily observed in all areas surveyed, most abundantly in disturbed habitats such as roads, tracks, waterways, agricultural areas and near human habitation. The invasive animals recorded included birds, mammals and amphibians. The mammalian invasives were generally domesticated animals, such as pigs, cats and dogs which have become feral, as well as several species of invasive rodents.

Archaeology

The Greater Delaikoro Area is rich in historical and cultural material remains many of which were documented for the first time as part of this survey. Eleven sites were documented including house mounds, burial grounds (including skeletal remains), and fortification ditches.

Socioeconomic Survey

A socioeconomic assessment of eight villages was carried out using household surveys, key informant interviews and focus group discussions. It was evident from this survey that the forests of the Greater Delaikoro Area play a major role in the attainment of sustainable livelihoods in these communities. The average household monthly income is $719, with the main income sources being reported as the sale of yaqona. Subsistence agriculture was also important to these communities, with 91% of households stated that they eat food grown by household members every day. The forested areas are also a major food source for communities, in terms of hunting, fishing and gathering of wild foods. The survey also reported community views on

resource utilisation and management, with 85% of respondents in support of creating a protected area.

Recommendations

Overall the survey findings support a recommendation for protection of the area. Ongoing community awareness programs are recommended to discuss the value of and the mechanisms for protecting the area. Demarcating and managing the protected area should take into account ecological connectivity of habitats and the threats posed by agriculture and invasive species. Further flora and fauna survey work is required for a more comprehensive report on the biodiversity of the area, and a community needs assessment and oral history documentation are also recommended.

Introduction

The Pacific Alliance for Sustainability (PAS) is a program of the Global Environment Facility (GEF). The overall objective of the GEF-PAS is to increase the efficiency and effectiveness of GEF support to Pacific Island countries, thereby enhancing achievement of both global environmental and national sustainable development goals.

One of the projects funded by GEF-PAS is the Forestry and Protected Area Management Project, which is being implemented in Fiji, Niue, Vanuatu and Samoa. This project aims to enhance the sustainable livelihoods of local communities living in and around protected areas, as well as strengthen biodiversity conservation and reduce forest and land degradation.

In Fiji, one of the forest areas being considered for protection is the Greater Delaikoro Area, an upland region spanning the main mountain range of Vanua Levu, encompassing Mt Delaikoro, Mt Sorolevu and the Waisali Forest Reserve.

In September-October 2013 a team from the South Pacific Regional Herbarium at the Institute of Applied Sciences (IAS) and from the Forestry Department carried out surveys in the Greater Delaikoro Area to produce a baseline assessment of the biodiversity. This biodiversity survey comprised the following taxonomic groups: plants, insects, avifauna, freshwater fishes and macroinvertebrates and herpetofauna. Invasive flora and fauna were also documented.

As part of this baseline survey, parataxonomic training was also carried out to build capacity amongst community members who were recruited as field guides and assistants. Technical personnel from the Forestry Department and research students from USP were also given training to upscale their taxonomic skills.

Additionally, a team from the Environment Unit of IAS carried out a study of the socioeconomic status of communities living in and around the proposed protected area. Cultural landmarks located within the forest were documented by an archaeological team from the Fiji Museum. This report is a compilation of the findings of the biodiversity, socio-economic and archaeology surveys.

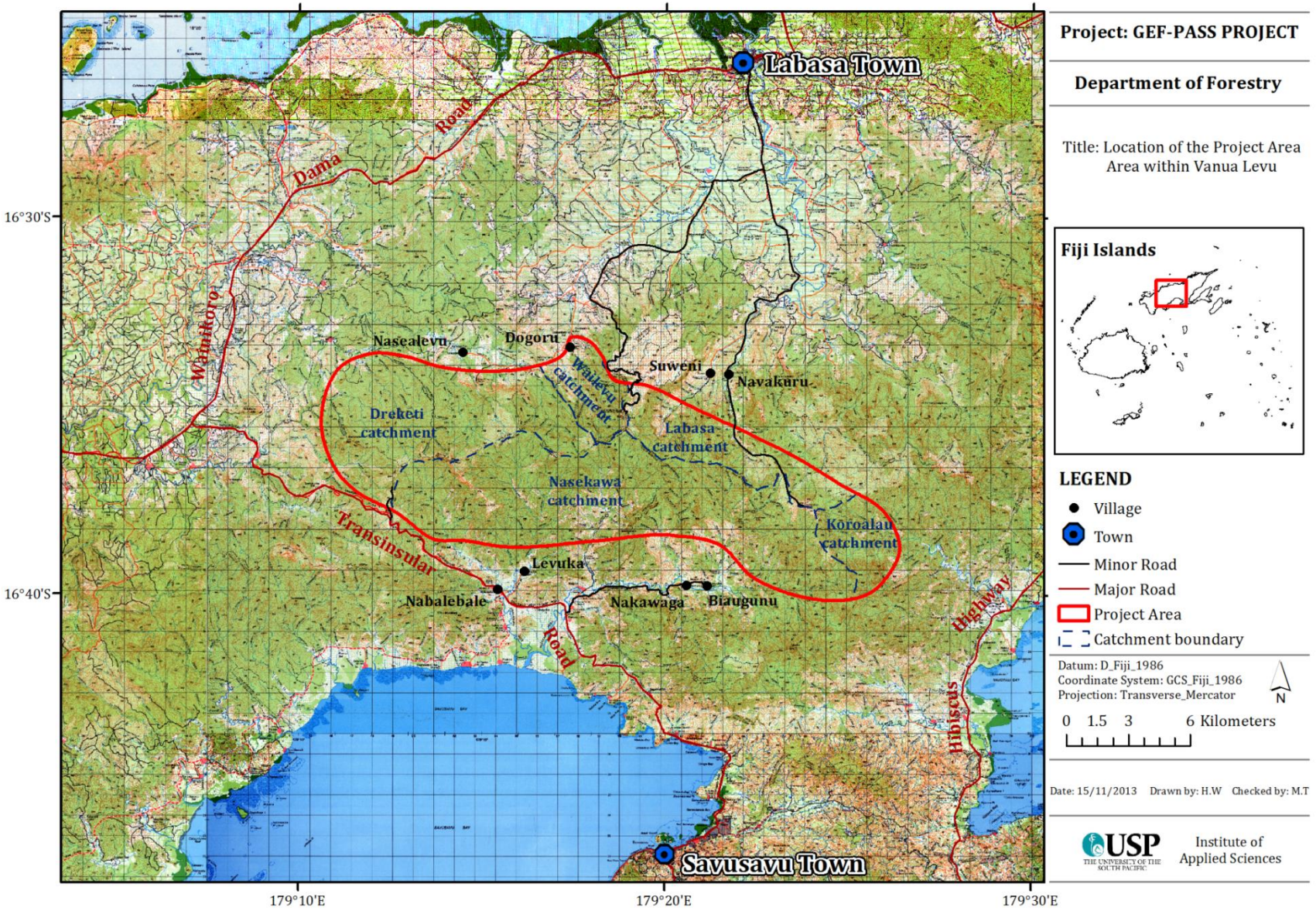

Figure 1: Location of the proposed protected Greater Delaikoro Area in Vanua Levu

1 Flora and Vegetation Ecology

Marika Tuiwawa, Art Whistler, Senilolia H. Tuiwawa, Mereia Katafono and Hans Wendt

1.1 Introduction

This report documents the results of a survey of vascular and non-vascular plants of the Greater Delaikoro Area. The objectives of this survey were:

- to document the range of vegetation types and botanical communities within the study area,
- to identify the presence (or potential presence) of species or ecosystems of national or international significance,
- to assess the susceptibility of plant communities to the potential impacts associated with human activities, such as agriculture, hydro-electricity and habitation development.

1.2 Methods

1.2.1 Reconnaissance

Prior to the fieldwork an initial assessment of the study area was made using satellite imagery and 1:50,000 topographic maps. It was noted that forested areas near villages closest to the area of interest (Mt. Sorolevu, Mt. Delaikoro and the ridge running from Waisali to Mt. Delaikoro) were degraded secondary forest. Areas closer to the mountain tops appeared to have more intact forest vegetation types, such as montane or cloud forest.

A five-day reconnaissance trip was carried out in August 2013 to finalise key biodiversity areas in central Vanua Levu that would form the basis for the proposed protected area. Local stakeholders were formally approached to solicit their support for the survey and eventual protection of the area. Some of the villages included during the consultation were Doguru, Suweni, Navakuru, Waisali and Biaugunu.

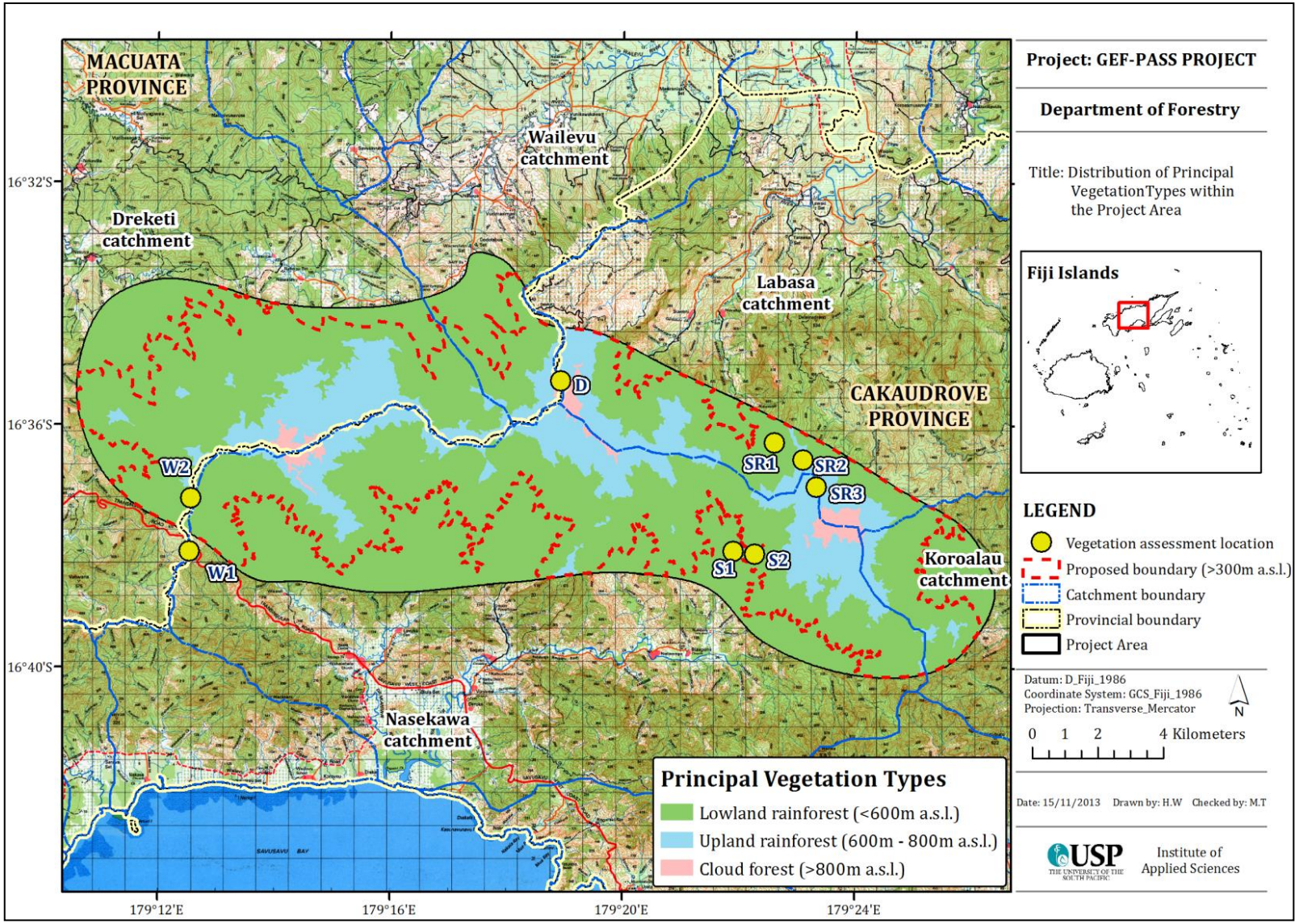

Figure 2: The distribution of principal vegetation types within the project area, and the four main sites for the flora survey: Waisali (W), Mt Delaikoro (D), Mt Sorolevu (SR) and Savusa (S).

1.2.2 Floral diversity

The biodiversity assessment was carried out in September 2013. The survey involved the documentation of vascular and non-vascular plants, with an emphasis on the presence of rare and threatened endemic species. All the plant species encountered within the belt transects set up to quantitatively assess plant density, distribution and diversity within the forest types were documented, as well as those observed whilst trekking through the study area.The four main sites for the flora survey were Mt Delaikoro, Mt Sorolevu, Waisali and Savusa.

Specimens were deposited at the South Pacific Regional Herbarium (SPRH). Verification of specimen identification was carried out with reference to herbarium vouchers and published floras and checklists, notably Smith (1979; 1981; 1985; 1988; 1991) for the spermatophytes, and Brownlie (1977) and Brownsey and Perrie (2011) for the pteridophytes.

1.2.3 Vegetation ecology

Habitat characterisation

Habitat characterisation for forested areas relied on a number of sources of information:

- plot data to determine vegetation community structure
- principal vegetation types (Mueller-Dombois and Fosberg, 1998)
- 1:50,000 topographic map indicating terrain features

The non-forested areas included open country (rivers, open riparian areas, roads, villages and settlements) and agricultural land (subsistence plantations, commercial farms, pastures and fallow land). These non-forested areas were not assessed in detail but were briefly described and highlighted in the vegetation map (Figure 2). The assessment of the vegetation was focused more on forested area then on non-forested areas.

For the habitat-typing process the most prominent topographical feature of the forested area was used:

- Slope - forested area found on slopes with a gradient ranging from 10 to 85 degrees.
- Ridge top - forested area found on top of or along a ridge or mountain range. The width of such ridges could range from a few centimetres up to 20 m.
- Flat - forested areas with a gradient ranging from 0 to 10 degrees. These areas also included raised river flats and flood plains.

Vegetation community structure

Quantitative assessment of the communities in different forest types was carried out using 10 m x 10 m plots along a 100 m transect, a methodology used previously in other sites in Fiji (Mueller-Dombois and Fosberg, 1998; Tuiwawa, 1999).

Plots were used to:

- assess the presence and absence of focal species,
- characterise associated vegetation communities with each principal vegetation type,
- confirm boundaries between biological communities encountered.

Within each plot, every tree with a diameter at breast height (dbh) greater or equal to 5 cm was measured, identified and recorded. The bole height, crown height and crown width were estimated for each tree enumerated. Ground cover vegetation was described, canopy cover estimated and the epiphytic flora recorded.

1.3 Results and discussion

1.3.1 Overall floral diversity

A total of 758 taxa were recorded for the four sites surveyed, of which there were 641 taxa of vascular plants (Appendix 1) and 117 taxa of non-vascular plants or bryophytes (Appendix 2). The vascular plants comprised 139 families, 390 genera

and 594 species. 101 taxa could not be determined to species level. The dominant families were Rubiaceae (58 species), Orchidaceae (43 species) and Euphorbiaceae (28 species) whilst the most species-rich genera were *Psychotria* (16 species) in the Rubiaceae family, *Ficus* (12 species) in the Moraceae family and *Syzygium* (11 species) in the Myrtaceae family. In total, there were 539 angiosperms (435 dicots and 104 monocots), 92 ferns and fern allies and ten gymnosperm taxa. Altogether 539 native species were recorded during the survey, of which 224 are endemic to Fiji. A total of 94 introduced species or exotics were recorded, of which eight were recognized invasive species.

The preliminary checklist of the bryophytes comprised 68 mosses and 49 liverworts identified to the family and genus level. The largest families of mosses were Calymperaceae (14 species), Dicranaceae (12 species) and Hypnaceae (7 species). The largest liverwort families were Lejeuneaceae (24 species) and Lepidoziaceae (6 species). A notable find was the rare moss, *Bescherelli cryphaeiodes,* in the cloud forest of Mt Delaikoro, previously known only from Mt Voma in Namosi, Viti Levu.

1.3.2 New flora records

There were 207 taxa listed as new records of the areas surveyed. These comprised 90 species of vascular plants whose documented distributions did not include the four sites surveyed, as well as the 68 species of moss and 49 species of liverworts collected. Bryophyte work is in its infancy in Fiji, hence the high number of new records yielded by this initial collection (Konrat *pers. comm.*).

1.3.3 Focal species

There were a total of ten taxa considered important due to their rarity, botanical significance and current distribution. Many of these appear on the IUCN Red List and are protected under the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) and Fiji's Endangered and Protected Species (EPS) Act.

1. *Agathis macrophylla* (Lindl.) Mast.—was recorded in most of the study area at 400–500 m. This indigenous tree podocarp found in the lowland and upland areas surveyed is currently listed as endangered on the IUCN Red list (Farjon, 2013). It is locally known as dakua makadre and is under threat from logging.
2. *Balaka macrocarpa* Burret—an endemic palm in the family Arecaceae, sighted in the vicinity of Mt. Sorolevu and Savusa area between 200–500 m. It is classified on the IUCN Red List as critically endangered (Fuller, 1998) and is protected under the EPS. It is locally referred to as niuniu and is a relatively uncommon species.
3. *Astronidium inflatum* (A.C.Sm.) A. C. Sm—an endemic trees species in the Melastomaceae family. It is classified as critically endangered on the IUCN Red List (World Conservation Monitoring Centre, 1998a) and is protected under the Fiji Endangered and Protected Species (EPS) Act. .
4. *Cynometra falcata* A. Gray—an endemic species in the Leguminosae family. Saplings were observed mostly in the understory of the lowland rainforest on Mt. Sorolevu. It is classified as being critically endangered on the IUCN Red List (World Conservation Monitoring Centre, 1998b). Logging activities pose a major threat to its occurrence.
5. *Spiraeanthemum graeffei* Seem.—an endemic tree species in the Cunnoniaceae family. It is listed as an endangered species on the IUCN Red List (World Conservation Monitoring Centre, 1998c) and is protected under the EPS. Its biggest threat is from logging.
6. *Storckiella vitiensis* Seem.—an endemic species in the Leguminosae family. It is categorised as a vulnerable species on the IUCN Red list (World Conservation Monitoring Centre, 1998d) and is protected under the Fiji EPS Act. Major threats are unsustainable logging activities.
7. *Weinmannia exigua* A.C.Sm.—an endemic tree species in the Cunnoniaceae family. It is listed as critically endangered on the IUCN Red List (World

Conservation Monitoring Centre, 1998e) and has protection under the EPS. Logging activities pose a major threat to its occurrence.

8. *Weinmannia vitiensis* Seem.—an endemic tree species in the Cunnoniaceae family. It is listed as a vulnerable species on the IUCN Red list (World Conservation Monitoring Centre, 1998f) and is protected under the Fiji EPS Act. Logging activities pose a major threat to its occurrence.
9. *Metroxylon vitiense* (H.Wendl.) H.Wendl.ex Hook.f.—very few trees were observed along the river embankments in the lower Waivuvu River catchment. The palm is endemic to Fiji and is locally common on south east Viti Levu and Vanua Levu. The palm is locally referred to as soga. Unfortunately the palm is highly threatened both for the use of the palm heart for food and leaves for thatching in the tourism industry. Its habitat (swamp) is targeted for land reclamation both for agricultural development and human habitation.
10. *Bescherelli cryphaeiodes* (Mull.Hal.) M. Fleisch.—an uncommon moss collected on tree branches near the road in the cloud forest of Mt. Delaikoro at about 1110 m. The only other known collection has been from Mt. Voma (Namosi Province, Viti Levu) at 700 m in 2007-2008.

1.3.4 Vegetation ecology

Of the nine principal vegetation types recorded for Fiji, five were encountered in the study area: lowland rainforest, upland rainforest, cloud forest, dry forest and talasiga grassland. The dry forest referred to here is a mesic forest. Representative areas of lowland and cloud forest vegetation types were quantitatively assessed, whilst the other vegetation types were qualitatively described.

The detailed results of the quantitative assessment of plots in these different vegetation types are given in Appendix 3. In total, 50 plots along seven transects were analysed, 36 in lowland forest and fourteen in cloud forest. Within each of these vegetation types the plots were distributed over a variety of forest habitats based on the most prominent physical features i.e. ridge flat, slope or riparian flat.

1.3.5 Lowland rainforest

Lowland rainforest in Fiji is typically found on the windward side of the large islands, from sea level to 650 m, with an annual rainfall of over 2000 mm. In the proposed Greater Delaikoro Area the lowland rainforest is found at elevations of 300 m and above, including the upper catchments of the Labasa, Tabia, Qawa, Dreketi, Koroalau, Nasekau and Qaloyago rivers. Overall, the forest in this principal vegetation type is best described as primary forest. The majority of the tree species recorded from the lowland forest plots were either endemic or indigenous. A few were species associated with human habitation, and some of these were also observed outside the plots. Stocking of good quality timber tree species was high and so was the size of merchantable tree species.

Two different lowland forest types were observed and quantified using seventeen plots in three transects:

Ridge-top forest type

The nine plots used to assess this forest type contained an average of nineteen trees (range: 14–24) and an average of thirteen species (range: 10–16) per plot. The most common species was *Myristica* spp. (kaudamu), which was present in 50% of the plots assessed. The largest trees measured were *Degeneria vitiensis* (vavaloa) with a dbh of 82 cm, followed by *Myristica* spp. with a dbh of 81 cm and *Endospermum macrophyllum* (kauvula) with a dbh of 80 cm. The average tree dbh was 19 cm (range 5–82 cm). Overall, the dominant species for this forest type was *Syzygium* spp. with 38% relative dominance which together with *Myristica* spp. makes up two thirds (66%) of the total tree biomass in the plots.

Slope forest type

A total of 26 plots along four transects were assessed in lowland slope forest at Navakuro, Nukubolu and Savusa. At Navakuro the most common tree species recorded were *Macaranga* spp. (gadoa), *Cyathea* spp. (balabala) and *Gironniera*

celtidifolia (sisisi). The largest trees were *Alphitonia* spp. (doi), *Dysoxylum richii* (tarawau kei rakaka) and *Endospermum macrophyllum* with average dbh of 11 cm (range: 5–55 cm). These more common trees are usually associated with secondary forest and the larger trees are fast growing trees.

At Nukubolu and Savusa, the 21 plots assessed had an average of nineteen trees (range: 7–29) per plot, and an average of eleven species (range: 5–17). *Syzygium* spp. (yasiyasi) *and Gironniera celtidifolia* occurred in more than 30% of the plots assessed, and were the most common species. The average dbh was 15 cm (range: 5–73 cm). The largest trees documented in the plots were *Calophyllum vitiense* (damanu) with a dbh of 73 cm, followed by *Retrophyllum vitiense* (dakua salusalu) with a dbh of 68 cm and *Heritiera ornithocephala* (rogi or rosarosa) with a dbh of 65cm and Myristica spp. with 62 cm. There was no single dominant species as the tree sizes were evenly distributed amongst all species, but the combined biomass (as reflected in the dbh) of *Syzygium* spp. and *Myristica* spp. gave a relative dominance of 54%.

1.3.6 Cloud forest

In the Greater Delaikoro Area, cloud forest is restricted to mountain tops and ridges above 850 m and is almost always shrouded in clouds. Precipitation is high and temperatures are lower than the lowland areas. Trees in the cloud forest tend to be stunted and heavily covered with bryophytes. Cloud forest vegetation was assessed in eleven plots at Mt. Delaikoro and four plots at Mt Sorolevu.

An average of 22 trees per plot (range: 13–39) with an average number of thirteeen species per plot (range: 10–17) was recorded for the area. The most common species were *Syzygium* spp. and *Cyathea* spp. occurring in thirteen of the fifteen plots assessed. The average dbh was 7 cm (range 5–22 cm) and the average bole height was 3 m (range: 1–6 m). The largest tree, with a dbh of 22 cm, was *Elaeocarpus* spp. (kabi). Other large trees included *Syzygium* spp., *Agathis macrophylla* (dakua makadre), *Neuburgia* spp. (bo), *Litsea* spp. (lidi) and *Saurauia rubicunda* (mimila). The overall dominant species was *Syzygium* spp. with a relative dominance of 49%.

Other species observed outside the plots that are typical of cloud forest vegetation included *Metrosideros* spp. (vuga), *Polyscias corticata* (danidani), *P. joskei*, *Trimmenia weinmanniifolia*, *Physokentia thurstonii* (niuniu), *Clinostigma exorrhizum* (niuniu) and *Pandanus vitiensis* (vadra).

Three other principal vegetation types, the upland forest, the dry forest and the talasiga vegetation types were not quantitatively assessed due to time and logistical constraints. A summary of observations made of these vegetation types is given below.

1.3.7 Upland forest

Segments of upland forest were observed along the dirt road to the top of Mt. Delaikoro and along the track (unused logging road) to Mt. Sorolevu from Navakuro village at elevations around 700m. At Delaikoro some of this forest type has been planted with mahogany. Some of the more common tree species observed in these upland forests included *Physokentia thurstonii*, *Plerandra* spp. (sole), *Elaeocarpus* spp., *Calophyllum* spp., *Agathis macrophylla, Dacrydium nidulum* (yaka), *Retrophyllum vitiense* and *Dacrycarpus imbricatus* (amunu).

1.3.8 Dry forest

Most of the native dry forest vegetation type on the leeward side of the Greater Delaikoro Area has been almost completely destroyed by a combination of grazing, agriculture activities and fire. Remnants of this forest type may be observed north-east of Mt. Delaikoro on the upper tributaries of the Labasa and Wailevu rivers.

1.3.9 Talasiga grassland

The grassland is restricted to the slopes and ridge tops and is mostly made up of *Pennisetum polystachyon* (mission grass), *Sporobolus* spp. (wire grass), *Dicranopteris* spp., (qato or bracken ferns), *Pteridium esculentum, Miscanthus floridulus* (gasau or reed), *Dodonaea viscosa* (usi), *Casuarina equisetifolia* (nokonoko) and many other smaller weedy plants. The general lack of tree cover is characteristic of such a

landscape. The grassland is regularly set on fire to allow for regrowth of grass for use as fodder for cattle and horses. Most of the lower elevation vegetation encountered en route to Mt. Delaikoro is made up of this vegetation type and a typical plant associated with this on Vanua Levu is *Cycas seemannii* (logologo).

1.3.10 Woody shrubland habitat type

This vegetation was observed growing between the grassland and the forest edge and is also referred to as savannah grassland. The area was dominated by secondary pioneer plant species like *Commersonia bartramia* (sama), *Parasponia andersonii* (drou), *Tarenna sambucina* (vakaceredavui), *Trema orientalis*, *Dillenia biflora* (kuluva), *Decaspermum vitiense* (nuqanuqa) and larger patches of *Schizostachyyum glaucifolium* (bitu wai) and *Miscanthus floridulus*. Also present here are exotic species like *Albizia saman* (raintree, vaivai), *Spathodea campanulata* (African tulip), *Aleurites moluccana* (lauci), *Merremia peltata* and *Piper aduncum* (onalulu). This habitat is where active agricultural activities are occurring both at the subsistence level and on a semi-commercial scale. Gardens or plantations of *Piper methysticum* (yaqona), *Musa nana* (banana) and *Colocasia esculenta* (taro) are common and so are patches of abandoned (fallow) gardens. Such activity expands the grassland habitat types into forested areas and as noticed from the survey will continue to do so especially with increasing pressure from subsistence farming and a growing population.

1.3.11 River bank/riparian habitat type

The vegetation along the creeks and river systems adjacent to the grassland was dominated by introduced and native fruit trees. Also found here were important trees species that have cultural uses, such as *Inocarpus fagifer* (ivi, chestnut), *Pometia pinnata* (dawa), several species of *Citrus* spp., *Artocarpus altilis* (uto, breadfruit), *Cocos nucifera* (niu), *Codiaeum variegatum* (sacasaca), *Syzygium malaccense* (kavika) and *Terminalia catappa* (tavola). Other culturally important trees include *Aleurites moluccana*, *Bischofia javanica* (koka), *Cananga odorata* (makosoi), *Cordyline fruticosa* (qai) and *Euodia hortensis* (uci).

Intact riparian systems were observed further upstream along creeks and streams. Here large indigenous tree species such as *Sterculia vitiensis* (waciwaci), *Neonauclea fosteri* (vacea), *Citronella vitiensis* (nuqa) and *Calophyllum* cf. *neo-ebudicum* (damanu dilo) were observed to be the dominant trees forming, in most cases, a closed canopy over the streams. Bryophytes on rock surfaces and over lower branches of trees were plentiful, and ground cover species of terrestrial ferns, *Selaginella* spp. and herbaceous urticales were common.

1.4 Conclusion

The key findings obtained demonstrate that the surveyed areas on Vanua Levu have high botanical prospects for both future work and research. With the unexpected high number of floristic datasets, new range extensions, scientifically important plants but more importantly the high list of indeterminants attained, a follow up or continued work with longer period in the centres and surrounding vicinities of the areas must be considered and adopted before making any conclusive statements.

The new range extension of 207 species shows the lack of detailed floristic work on Vanua Levu especially in botanical hot spots such as the Greater Delaikoro Area.

High altitude (> 600 m) forest systems to the south-east of Mt. Sorolevu and Waisali should be revisited and more time spent botanizing because some species known only from their type localities were not assessed during this trip due to time constraints and adverse weather conditions.

Seasonality was also indicated as an important factor to consider for future surveys, to ensure that flowering and fruiting collections can aid in the full identification of specimens to the lowest possible taxonomic level.

2 Terrestrial Insects

Hilda Waqa-Sakiti

2.1 Introduction

The first recorded entomological surveys conducted on Vanua Levu were in 1938 by E. C. Zimmerman from the Bishop Museum, Hawaii. In 2005 and 2006, the National Science Foundation (NSF) funded the Fiji Arthropod Survey which included the island of Vanua Levu (Evenhuis and Bickel, 2005). In 2006 and 2008, Van Gossum and colleagues also visited the island of Vanua Levu focusing on the species diversity of the Fijian Zygoptera (Van Gossum *et al.*, 2006; Van Gossum *et al.*, 2008) In 2009, the Darwin Initiative funded a project titled *Insect Inventories in Fiji*, focusing on entomological surveys and included selected sites within Vanua Levu.

In September 2013, a baseline survey was carried out with the primary aim of determining the general diversity of insects within the areas of Delaikoro, Sorolevu and Waisali forest. The survey targeted a diversity of habitats (slopes, flats, ridges and riparian areas) and vegetation types (lowland and upland systems within primary, secondary and native forests). A variety of collection techniques (light traps, leaf litter sampling, active and opportunistic surveys) were employed. The general diversity of insects and those species of higher conservation value (i.e. focal species) were sampled as an indicator of the status or health of the forest within the Greater Delaikoro Area.

2.2 Methodology

2.2.1 Site selection and habitat considerations

A number of key habitat types were surveyed (Figure 4) to maximise the chance of encountering individuals of focal species as well as to adequately sample the diversity of insects. The location of each survey site is provided in Appendix 5.

- Lowland forest areas: targeted specifically to find Fiji's rare endemic butterflies *Papilio schmeltzi* and *Hypolimnas inopinata*.
- Upland forest areas: leaf litter sampling and light traps on slopes mainly targeted the general diversity of insects within this specific habitat. Active and opportunistic searches for the endemic phasmids (stick insects or mimimata) were also conducted.
- Ridges: leaf litter sampling and light traps on ridges targeted the general diversity of insects found within this specific habitat. A high diversity of insects (and in particular the focal order Coleoptera and the macromoths) is indicative of intact forest systems.
- Riparian surveys in all vegetation types: These surveys specifically targeted butterflies (namely Fiji's rare endemic butterfly, *H. inopinata)* and damselflies (namely those of the endemic genus *Nesobasis*). These often fly out to open areas on a fine day in search for sunlight and food, and usually aggregate along the streams in forested areas. Their presence, abundance and richness are excellent indicators of forest and stream systems in good health.

2.2.2 Nocturnal surveys

Nocturnal surveys were conducted using ultra violet (UV) light traps at the four sites (Figure 3). These were set up and left to run for 12 hour periods from 6pm-6am (roughly dusk till dawn).

Figure 3: UV light traps for nocturnal insects (Photo: Apaitia Liga)

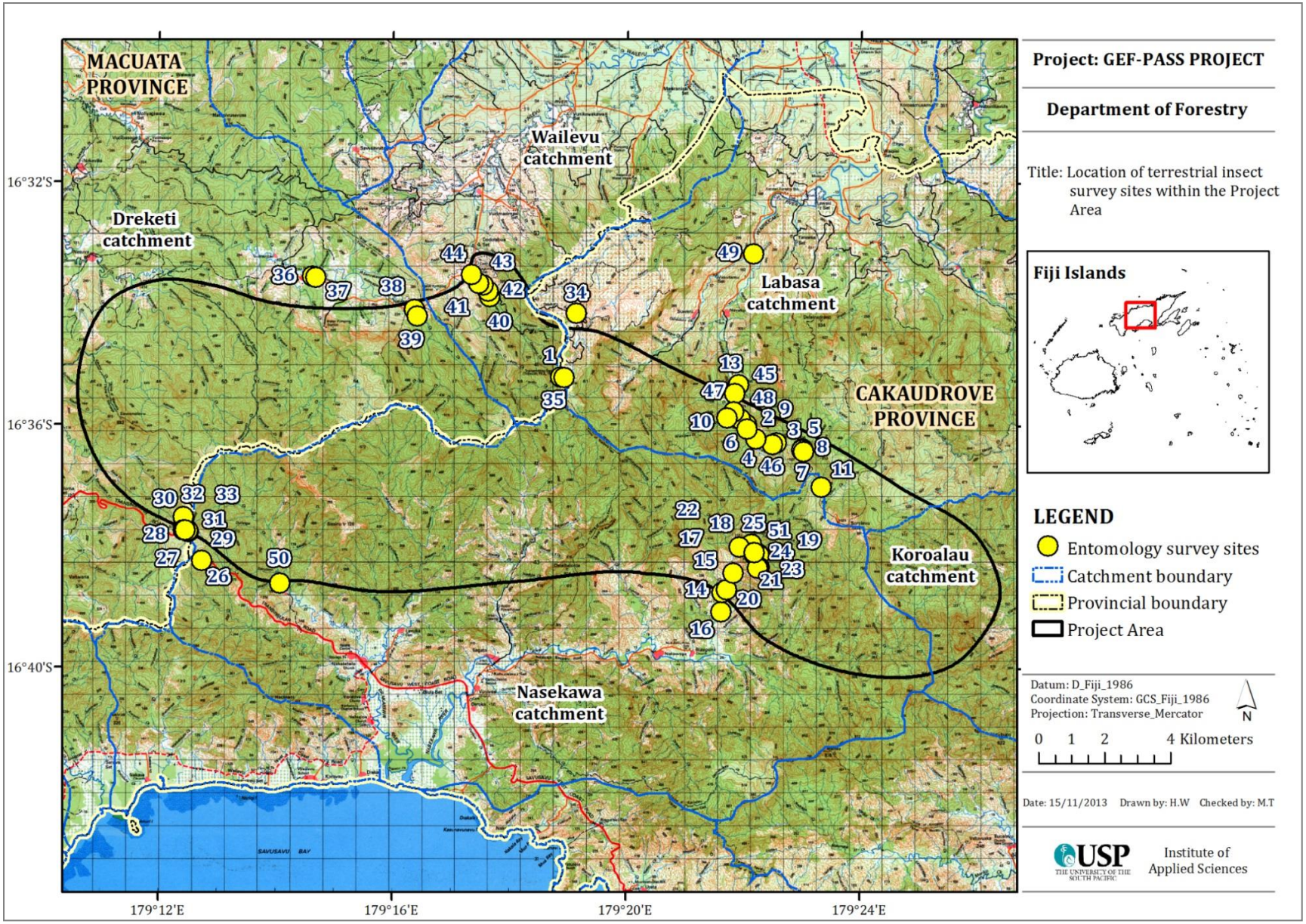

Figure 4: Terrestrial insect survey sites within the project area

To effectively sample moths, manual collections were conducted for the first two hours after dusk. A bucket trap was set up and operated in the center of a 2 m x 2 m white sheet which was spread on the ground at the collection site. Moths that flew towards the light and onto the white sheet were collected in killing jars charged with ethyl acetate.

Beetles and other nocturnal insects were passively sampled overnight on each sampling occasion. Insect specimens were sorted to Order and then to Family level. Specimens are currently being curated, catalogued and stored at the South Pacific Regional Herbarium, USP.

2.2.3 Leaf litter surveys

Leaf litter surveys were conducted targeting different habitat types (i.e. river flats, slopes and ridges) in the lowland and upland vegetation types. Quadrats of $1m^2$ were laid at 10 m intervals along a 50 m transect. Leaf litter from each quadrat was sieved through 12 mm mesh sieves and transferred into Winkler bags (Figure 5). The Winkler bags were hung out for at least 48 hours to allow drying of the leaf litter. Insect specimens were stored in ethanol for further sorting and identification.

Figure 5: Winkler bags filled with leaf litter (Photo: Apaitia Liga)

2.2.4 Opportunistic encounters- Lepidoptera (butterflies) and Odonates (damselflies)

Butterflies and damselflies were opportunistically collected within open grassland and riparian areas along creeks and streams using handheld nets. Voucher specimens were taken for identification.

2.2.5 Identification and curation

Identification of specimens was carried out with the aid of available taxonomic references for each of the main groups; butterflies and moths (Waterhouse, 1920; Robinson, 1975; Prasad and Waqa-Sakiti, 2007), dragonflies and damselflies (Donnelly, 1990; Van Gossum *et al.*, 2006) and beetles (Lawrence and Britton, 1994).

2.3 Results and discussion

2.3.1 Insect Diversity

The results of the insect survey at each site are provided in Appendix 4. A total of eighteen Coleopteran (beetle) families were sampled from within the entire study area. The most abundant taxa sampled included the beetle families Curculionidae (weevils) and Staphylinidae (rove beetles) and from the Order Hymenoptera, Family Formicidae (ants). Rare beetle families Lampyridae (lightning bug) and Passalidae (bess beetles) were also encountered in the surveys. The diversity of the target taxa Coleoptera and the family Formicidae are a good indication that ecosystem services such as soil processing, decomposition, herbivory, pollination and seed dispersal within the study areas are still intact.

A total of 522 moth individuals belonging to seven families, 36 genera and 40 species were collected. Of the collected macromoth species, 50% are endemic to Fiji. The rate of endemism of macromoth species collected at each of the four sites ranged from 25% to 67%.

The site with the highest diversity in terms of macromoth species was the lowland rainforest of Delaikoro (<600 m), having a total of 24 macromoth species belonging to

six families. Mt. Sorolevu was the least diverse site with a total of twelve species from three families (Table 1)

Table 1: Summary of the moth data collected from the four nocturnal survey sites.

Site	Abundance of moths caught/site	Number of macro-moth families/site	Number of macromoth species/site	Rate of endemism
Upland Forest (Delaikoro)	103	4	12	25%
Lowland forest (Delaikoro)	167	6	24	45.8%
Waisali Forest Reserve	183	5	18	66.67%
Sorolevu - Savusa	69	3	12	58.33%

A detailed checklist of the moths collected during this survey is provided in Appendix 4. There are two new records of macromoths for Vanua Levu and these include *Luxiaria sesquilinea* and *Hypena rubrescens*, both from the Noctuidae family. The latter, *Hypena rubrescens* is a new species, recently described by Clayton (2010) who only has records of its collection from Viti Levu.

Other endemic, uncommon or rare forest macromoths species include *Gnathothlibus fijiensis* (Sphingidae), *Calliteara nandarivatu* (Lymantriidae), *Sasunaga tomaniiviensis* (Noctuidae), and *Tholocoleus astrifer* (Noctuidae).

2.3.2 Focal Species

Order Lepidoptera

Hypolimnas inopinata (Figure 6) is a rare butterfly, endemic to the Fiji islands. It is a montane species and lives in rainforests. It is often found in or near pristine mountain areas, usually in semi-open areas along streams leading up to the

mountains. Its presence and abundance has also proven to be a very good indicator of the pristine nature of the rainforest system.

Hypolimnas inopinata has so far been only recorded on Viti Levu, its extant populations are in the forests of Navai and Nasoqo (Ra Province), Waisoi, Wainavadu and Saliadrau (Namosi Province), Naikorokoro (Rewa Province) and Emalu (Navosa Province). The sighting of *H. inopinata* on two occasions along the Waicacuru stream, Sorolevu (Figure 4, survey points 48 and 49) is the first record for Vanua Levu. This habitat consists of primary lowland forest and is an ideal habitat for *H. inopinata*.

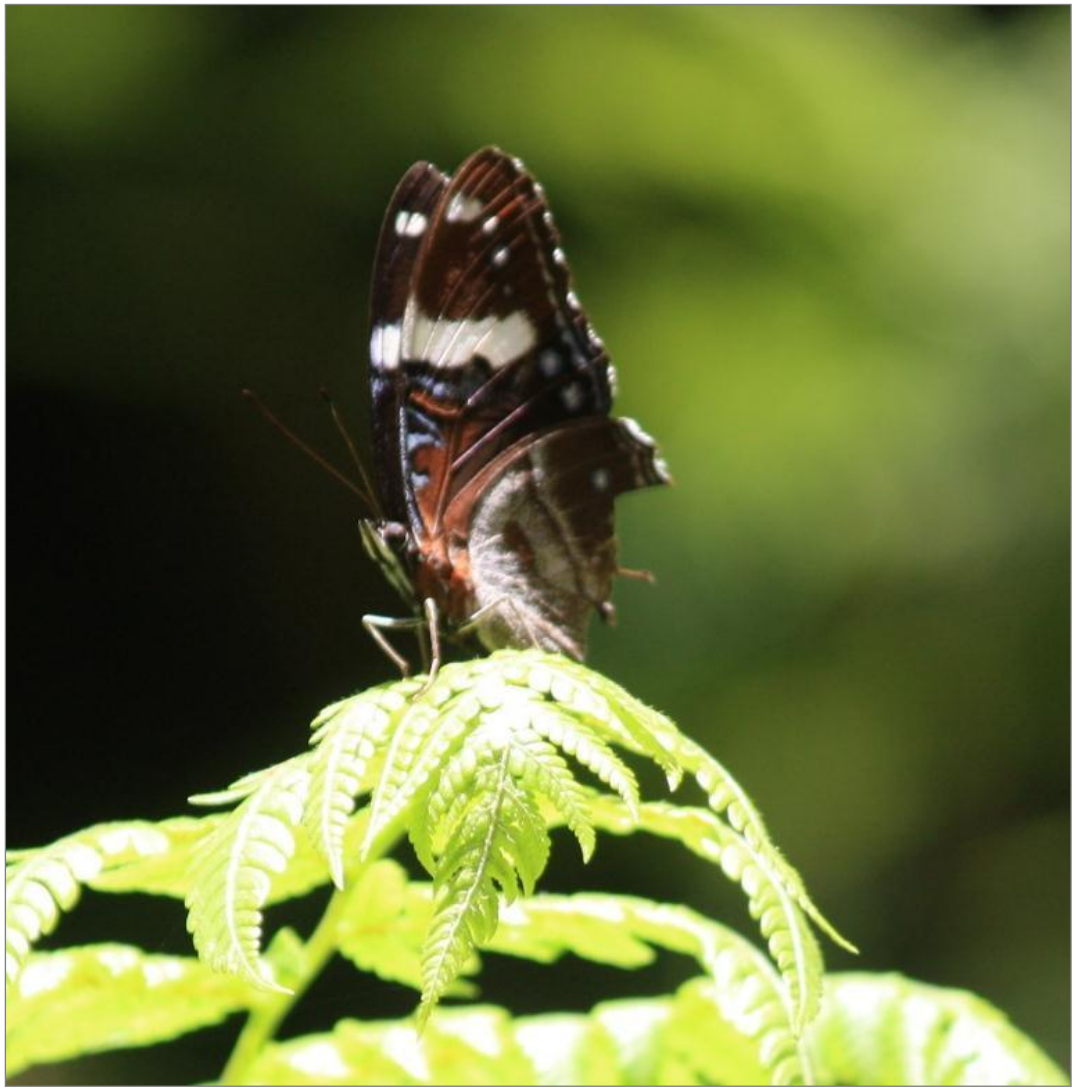

Figure 6: *Hypolimnas inopinata* (Photo: Apaitia Liga)

Hypena rubrescens (Figure 7) is an endemic species, described in 2010. It has been previously recorded only from Viti Levu (Savura and Namosi). This is the first record for Vanua Levu, found within the lowland forests of Delaikoro (Figure 4, site 34)

Figure 7: *Hypena rubrescens*, Noctuidae (Photo: SPRH)

Luxiaria sesquilinea (Figure 8) is a rare and endemic moth, usually restricted to primary forests. It has been previously recorded on Viti Levu (Serua, Suva, Naqali, Nausori highlands, Nadarivatu, Vunidawa, and Namosi) and Levuka (Ovalau). This is the first record for Vanua Levu found within the Waisali native forest reserve (Figure 4, site 26).

Figure 8: *Luxiaria sesquilinea* Noctuidae (Photo: SPRH)

Order Phasmida

Cotylosoma dipneusticum (Fig 6) is a rare endemic stick insect, previously recorded only from Taveuni and Viti Levu (Nakorotubu range, Emalu forests and Savura Forest Reserve). Two specimens of this species were sampled each from intact upland forests within Sorolevu perched on *Balaka seemannii* and another within Waisali Forest Reserve on the bark of *Timonious affinis* (dogo ni vanua) (Figure 4, sites 8 and 29).

Figure 9: *Cotylosoma dipneusticum*, a rare endemic stick insect

Phasmatonea inermis is another rare and endemic stick insect, previously recorded only on Viti Levu (Nakorotubu Range). It was first recorded in 1908, the type specimens are currently housed in the Vienna Museum and the locality data on the specimens only mention SW Pacific, Fiji with no specific locality data. This will be a first record for Vanua Levu from within the primary upland Sorolevu forests (Figure 4, site 11). From previous observations, these two species of stick insects have been known to be closely associated with intact forest systems.

2.4 Discussion and recommendations

The survey collections yielded a good diversity of insects, suggesting that the ecosystem services provided by the abundant and diverse Coleoptera (beetles, 18 families), Formicidae (ants) and macromoths (7 families, 40 species) are well represented, and that the forests systems remain intact.

The primary lowland forest of Sorolevu harbours three of the five focal species recorded from this survey i.e. *H. inopinata*, *C. dipneusticum* and *P. inermis*. These three focal species have proven to be excellent indicators of the good status and health of the forest system which suggests the same for Sorolevu. Waisali Forest Reserve was also interesting in that it recorded the greatest diversity of macromoths of the three sites (i.e. 18 species) with a high endemism rate of 66.67% followed by Sorolevu with twelve species and an endemism rate of 58. 33%.

2.5 Recommendations

- Increased sampling efforts is required for the Delaikoro lowland and upland sites to ascertain the true status of the forest health and more comparable to the Sorolevu and Waisali sites.
- Further surveys need to focus on *H. inopinata* to locate other populations on Vanua Levu. It will also be interesting to conduct a study on the population genetics of this species to ascertain the status of the Vanua Levu population(s).

3 Avifauna

Alivereti Naikatini and Senivalati Vido

3.1 Introduction

Fiji's bats play an essential role as seed dispersing agents, major pollinators, and insect control agents in the rainforest and other terrestrial ecosystems (Palmeirim *et al.*, 2007). Bats are the only native terrestrial mammals of Fiji and six species occur in Fiji, four of which are native and two endemic (Flannery, 1995; Palmeirim *et al.*, 2007). Four bat species are listed as threatened (Palmeirim *et al.*, 2007). Bats are poorly studied in Fiji in terms of ecological research and there is little public awareness of their role and importance.

Like bats, birds are also very important indicators of the forest health. They are also seed dispersers, pollinators and insect control agents. There are 68 species of land birds found in Fiji, eleven of which are introduced species. Native and endemic species are expected to be found in greatest numbers in a pristine forest system.

The Greater Delaikoro Area has been a focus area for bird and bat surveys in Vanua Levu in the past. A notable survey was carried out in 1974 in the Delainacau Mountains (South West of Mt Delaikoro) where the only known record of *Trichocichla rufa clunei* was taken. This sub-species of the Endangered Long-legged Warbler is endemic to Vanua Levu, and the area is now designated an Important Bird Area for Fiji. No further sighting has been recorded since 1974.

Other recent bird surveys carried out in the Greater Delaikoro Area were by Birdlife Fiji while carrying out the IBA (Important Bird Area) project for Fiji in from 2000 to 2005, and by PhD student Michael Andersen who collected bird samples in the Waisali Reserve in 2008. Previous bat surveys in the area have been conducted by Ruth Utzurrum's team from American Samoa, studying the status of *Pteropus samoensis* in 2001 and also by Jorge Palmeirin in 2003-2004 while reviewing the status

of the bats of Fiji. A recent detailed bat study was conducted in the Waisali Forest Area from 2009 to 2011 by PhD student Annette Scanlon.

The main objectives of this survey were to:

- provide a checklist of all avifauna species (birds and bats) present in the Greater Delaikoro Area,
- highlight species that are of conservation importance (focal species),
- provide preliminary abundances of species present.

3.2 Methodology

The survey methods used in the survey were:

- Point count method (for both bats and birds)
- Mist netting in open high areas for bats at night and birds in the early mornings
- Bat detector surveys in the evenings
- Opportunistic surveys
- Interviews with local communities

The point count method was the most commonly used method to survey for the bats and birds. It was only carried out in the morning and afternoons when birds are more active. Counts in a point were restricted within a 50 m radius for a period of five minutes according to an established methodology for a rapid survey (Naikatini, 2009). Stations were not randomly located, due to the rugged terrain of the area, but were placed along tracks and accessible areas. To maximise the size of the area covered, points were placed at least 200-400 m apart. This was also done to minimise the likelihood of double counts. Each morning or afternoon session would last two to four hours depending on the weather.

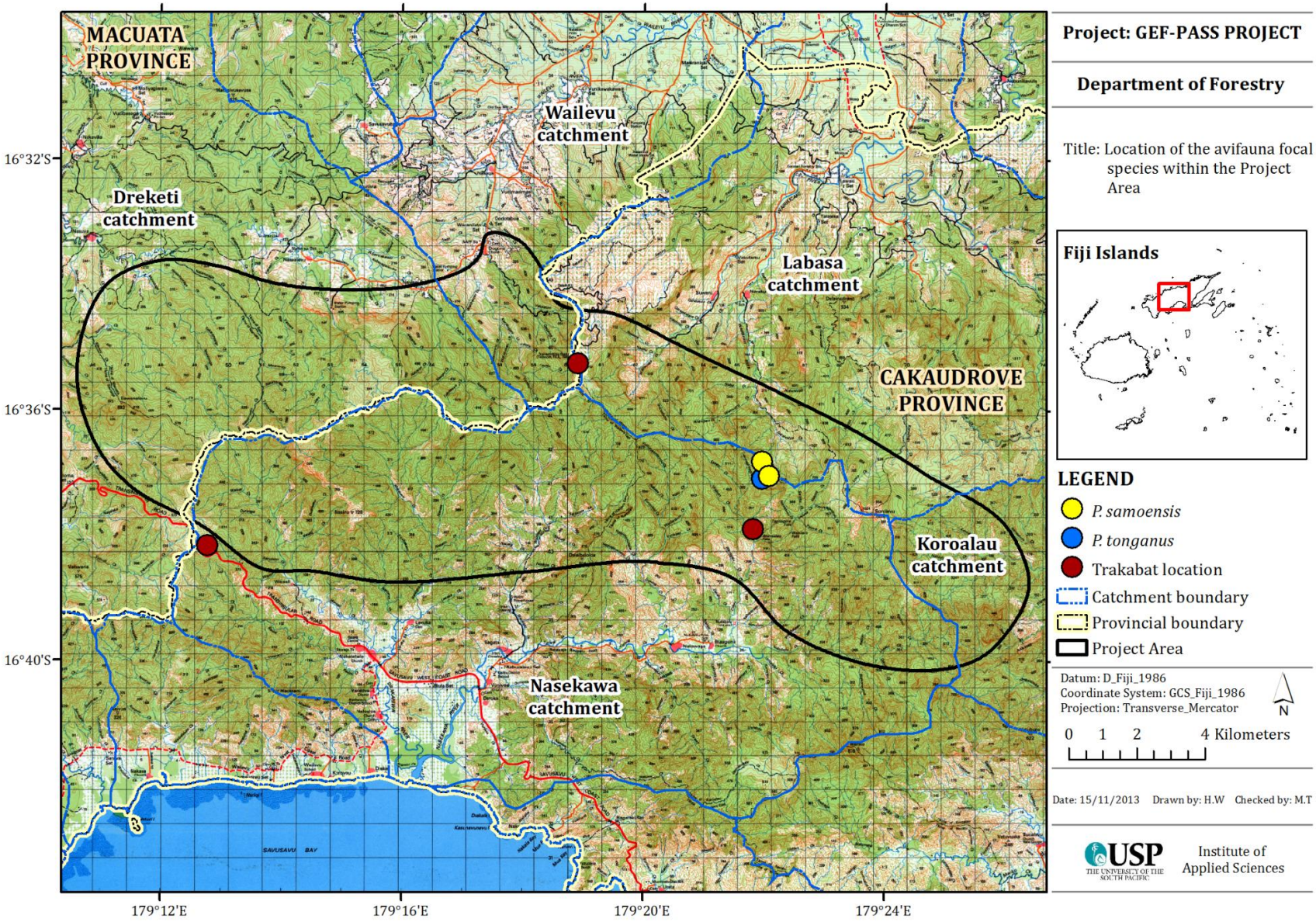

Figure 10: The location of the focal bat species, *Pteropus samoensis* and *P. tonganus*, in the study area

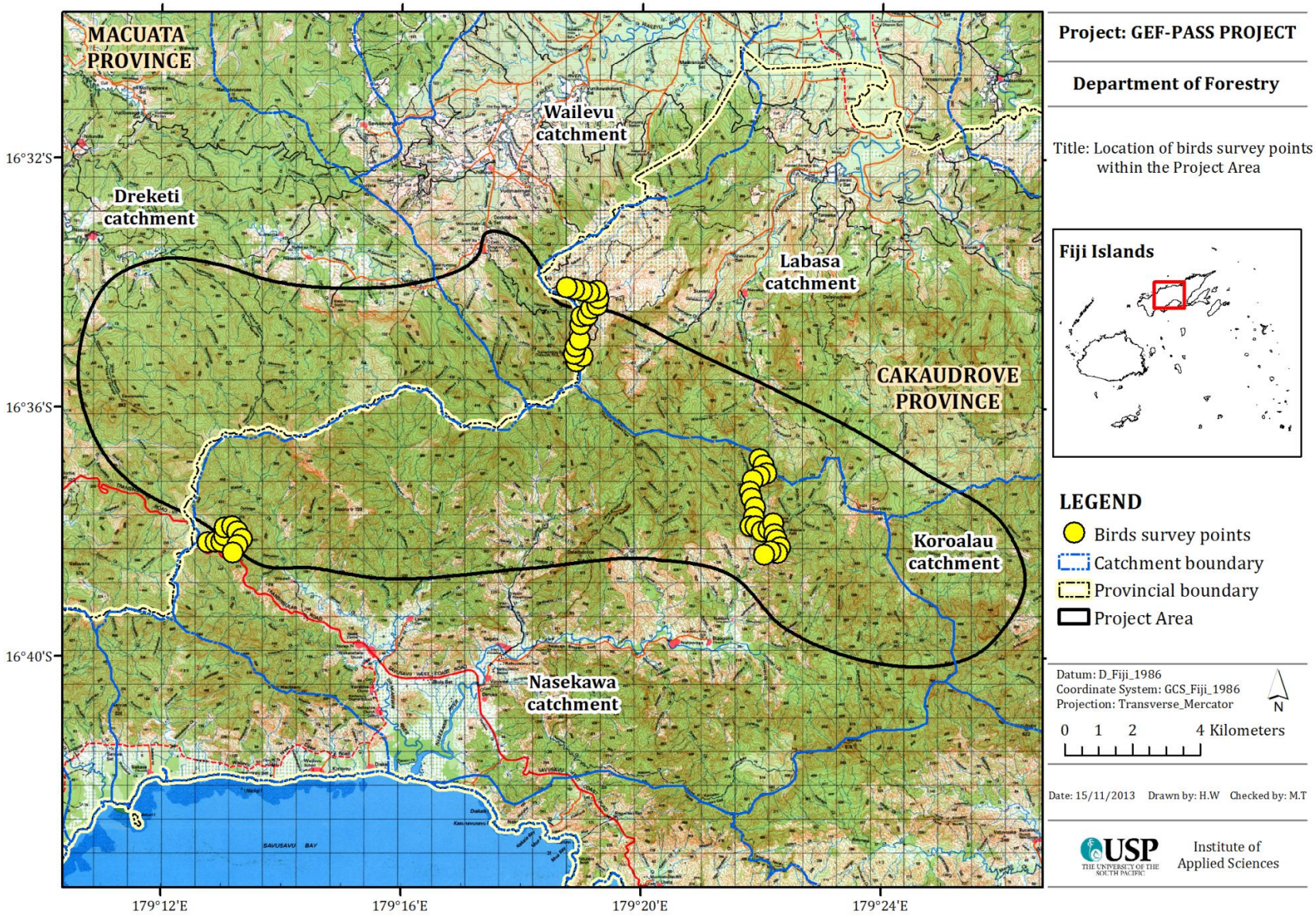

Figure 11: Location of bird survey points within the study area

All birds detected within the 50 m radius area were recorded and GPS locations noted. The total number of points, birds and species recorded were tabulated and analysed to give the relative abundance or density of each species. Surveys of fruit bats were done opportunistically during the project. A TrakaBat was used in evenings depending on places where we camped to track for presence of micro-bats overnight. The TrakaBat was prepared and set up in the early evening around 7pm and then retrieved in the morning and the data downloaded onto a computer to determine if any passing bats were detected overnight.

Opportunistic surveys were also conducted whilst travelling from one point station to another, or whilst travelling within the area from one base camp to another. Interviews with the local guides were carried out on some evenings. Local guides knew the area well, including where the main bat roosts are located, and the species of birds they may have encountered in the area previously.

3.3 Results and discussion

In total approximately 230 minutes were spent actively conducting bat and bird surveys, and over 36 hectares were covered using the point count method. A total of 46 point stations were surveyed during the ten days of survey. These point stations (Figure 11) were located in different sub-habitat types found with the main vegetation systems; lowland rainforest (<600 m), and upland-cloud rainforest (600-800 m).

A total of 27 species of land birds and three species of bats were recorded in the study site, and these are listed in Appendix 6. Identifications were verified using a published field guide (Watling, 2001). A table of the location and habitat of each station and a summary of the species diversity and bird abundance is provided in Appendix 7.

Of the 27 species of land birds recorded, all were native species and no exotic species was recorded; 24 of these species are endemic to Fiji with nine of the 24 species being

restricted only to Vanua Levu and nearby islands (Appendix 1). The area surveyed is part of the Wailevu/Dreketi Highlands Important Bird Area (IBA X) covering an area of 720 km² (Masibalavu and Dutson, 2006)

Eight avifauna species have been recorded from the Greater Delaikoro Area previously, which are considered focal species, based on their rarity (Appendix 8). Five of these were recorded during the current survey also, the three exceptions being the Long Legged Warbler, the Friendly Ground Dove and the Black-faced Shrikebill.

The Long Legged Warbler, classified as Endangered on the IUCN Red List (Birdlife International, 2012) was not recorded in this survey as we did not survey the Delainacau area, which is the only place it has been documented. However, we did survey areas in Waisali and Mt Sorolevu that have a similar habitat and climate to the Delainacau area but were unsuccessful, perhaps because these areas have been subjected to some form of disturbance from logging in the past. Other bird species like the Friendly Ground Dove and the Black-faced Shrikebill were not recorded in this survey, which like the Long-legged Warbler are sensitive species that tend to disappear with the encroachment of disturbances like logging and other forest clearing activities.

Generally bird diversity and abundance during the survey was low. The only IUCN Red List species documented was *Pteropus samoensis*. The only CITES-listed species recorded were the Tongan flying fox, the Pacific Harrier, the Collared Lory and the Fiji Goshawk. This would probably be due to the fact that the survey time was fairly short and the actual area surveyed was quite small. It also has to be noted that most of the places surveyed during the trip were areas that were easily accessible, which have been subjected to some form of disturbance in the past like logging, thus affecting the results and not giving a true picture of the intact forest system.

Three species of bats were recorded throughout the survey; *Pteropus samoensis,* the Samoan flying-fox, *P. tonganus* the Pacific flying-fox and *Notopteris macdonaldi*, the Fijian Blossom Bat (Figure 10).

Pteropus samoensis is listed on the IUCN Red List as near threatened (Brooke and Wiles, 2008) and *N. macdonaldi* as vulnerable (Palmeirim, 2008). *P. tonganus* was rare, not commonly encountered and no roost was recorded in the study area. Likewise *P. samoensis* was also rare and only recorded in the forested areas near Mt Sorolevu. The local guides also said that there were no big roosts of *P. tonganus* in the survey area. There was no *Notopteris macdonaldi* roost found either, despite the fact that this species was commonly caught whilst mist-netting in the Mt Delaikoro Area. Like the bird surveys, the bat survey was not extensive due to time constraints. A more comprehensive bat survey is needed for the future in this area, to mark out roosting areas for these three species of bats. This would be very important information to obtain if this site is proposed as a protected area in the future.

3.4 Recommendations

To better understand the ecology and abundance of the avifauna of the Delaikoro Area there is a need to carry out more quantitative surveys in the more intact forested areas. This will enable us to get better population estimates, which will be useful for long-term monitoring. The area of the survey is quite large and there needs to more detailed surveys covering as much of the area as possible. A more rapid survey approach is needed for the bat survey in the near future to record locations of bat roosts in the study area or nearby before carrying out quantitative studies.

Conservation should be a priority and logging should not be permitted in this area if you take into account the true value of the site in terms of its ecosystem function, biodiversity, cultural and spiritual importance, all of which are invaluable monetarily.

4 Herpetofauna

Nunia Thomas and Jone Lului

4.1 Introduction

Previous herpetofauna surveys conducted in Vanua Levu have documented the presence of twenty one species, of which eight are endemic, ten native and three introduced (Morrison, 2003; Morrison *et al.*, 2004). Significant finds in Vanua Levu in the past are the rediscovery of the endemic and endangered Fiji ground frog, *Platymantis vitianus* (Morrison *et al.*, 2004) and the discovery of an endemic species of skink, *Emoia mokosariniveikau* (Zug and Einech, 1995). To date, herpetofauna distribution on Vanua Levu is data deficient and this survey contributes to updating the herpetofauna list and mapping their distribution on Vanua Levu. The objectives of this baseline herpetofauna survey were to:

- identify ideal herpetofauna habitats within the Greater Delaikoro Area,
- employ different herpetofauna survey methods to generate a species checklist for the Greater Delaikoro Area.

4.2 Methodology

The herpetofauna surveys were conducted over seven days (26th September to 2nd October 2013) in various sites within the Greater Delaikoro Area, in particular the upland and lowland forests of Mt. Delaikoro, Mt. Sorolevu and the Waisali Reserve (Figure 12). The survey targeted ideal herpetofauna habitat and methods employed depended on the weather and logistics (Appendix 9).

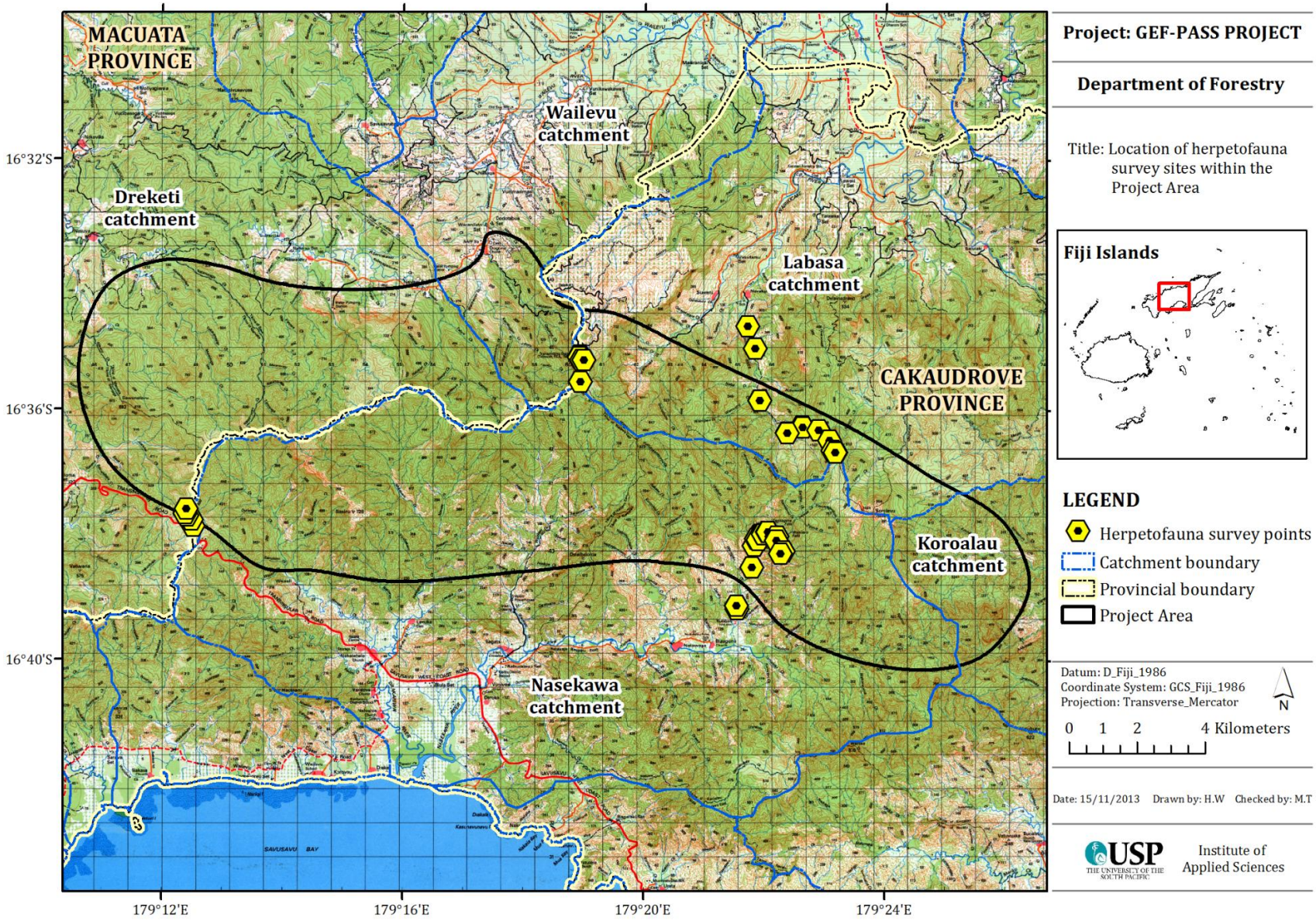

Figure 12: Location of herpetofauna survey sites in the project area

Field Assessment

Weather conditions dictated the number of days, type of traps and survey methods conducted, and these are summarized in Appendix 9.

Habitat Assessment

The objective of the expedition was to record all herpetofauna species captured and/or observed within the study site. For this reason, all potential habitats within good forest cover and outside of the forest were surveyed. The study area generally had ideal herpetofauna habitats: riparian vegetation, ridge forest, forest floor cover of leaf litter and rotting wood, and trees with dense epiphyte cover. Systematically, the survey targeted a ridge habitat, riparian forest habitat and lowland forest habitat, closely following the vegetation and entomology sampling areas. A total of 44 sites were surveyed employing the methods described below.

Diurnal and nocturnal herpetofauna surveys

There are several accepted methods for herpetofauna surveys that generally fall under two categories: **opportunistic** diurnal and nocturnal searches and trapping, and **standardized** nocturnal and diurnal searches and trapping. A summary of the methods used in this survey is given in Appendix 9.

Herpetofauna surveys in Fiji have generally been opportunistic, but their methods standardized to allow for comparison between sites. Long term, standardized herpetofauna monitoring plots exist on Viti Levu: the Sovi Basin Conservation Area and the Wabu Forest Reserve are limited to nocturnal frog searches. Because of the cryptic and heliophilic nature of Fiji's reptiles; and Fiji's climate, the visual survey and trap methods are used, albeit limited by weather conditions.

The herpetofauna surveys in the Greater Delaikoro Area consisted of three techniques but were constrained by rain. These are described below.

Standardized sticky trap transects whereby sticky mouse traps (Masterline®) were laid out at intervals along a transect. Each station was designated a station number (1-10) with a cluster of three traps per station for three placements to represent local habitat structure at each location (tree, log and ground). Transects were laid out along identified ideal habitats e.g. ridge tops and along river banks/riparian vegetation. Leaf litter cover, canopy cover and undergrowth were all recorded. Left overnight (if possible), traps were checked regularly for captured specimens. These traps target both terrestrial and arboreal species.

Standardized (time constrained) nocturnal visual encounter surveys (2 hours) in ideal habitats were used, since frogs and geckoes are active and more visible at night. This method gives an encounter rate for comparison with other surveys within Fiji. Search efforts with a minimum of two observers at any one time targeted streams, adjacent banks/ flood plains and ridge tops.

Opportunistic Visual Encounter Surveys outside of the standardized searches allowed for a record of presence/absence of herpetofauna. Skinks are more likely to be seen during the day, particularly during hot and sunny conditions. Opportunistic diurnal surveys were conducted along trails en route to the camp site, vegetation plots, along stream edges, and in forest habitats surveyed by other survey teams in the expedition. Search efforts targeted potential skink habitat and sunbathing spots, and frog and snake diurnal retreat sites. Diurnal surveys began at 9am and ended at 3pm on each of the survey days. The team had a minimum of two searchers at any one time.

Environmental variables such as air temperature, water temperature, weather conditions (rain/fine) and cloud cover (%) were taken at the beginning and end of each nocturnal survey. Habitat characteristics and other basic ecological and biological information of herpetofauna found were recorded. Observations on possible threats to herpetofauna species and populations were also noted.

Geographic coordinates of survey sites were captured using the Thales Mobile Mapper Pro Navigator and Garmin GPSmap 60*CSx*.

4.3 Results

Average air temperatures recorded for the surveys were 23.5°C (day time) and 20.8°C (night time); average water temperature was 17.3°C at night. Out of the eight days, there were four days of good sunshine, and six in which cloud cover was 100%.

Based on the current knowledge of herpetofauna on Vanua Levu there are a total of 21 species recorded from the island, of which thirteen have been documented from within the Delaikoro Area (Morrison, 2003; Morrison *et al.*, 2004).

In total eight species were encountered over the course of the survey, in 34 of the 44 sites surveyed. Four of the species encountered are endemic: *Emoia concolor*, *Lepidodactylus manni* (Figure 13), *Platymantis vitianus* (Figure 14) and *P. vitiensis* (Figure 15 and Figure 16).

Figure 13: ***Lepidodactylus manni*** **(Photo: Noa Moko)**

Figure 14: ***Platymantis vitianus*** **(Photo: Noa Moko)**

Figure 15: ***Platymantis vitiensis*** **(Noa Moko)**

Figure 16: ***Platymantis vitiensis*** **eggs (Photo: Apaitia Liga)**

Three others are native: *Emoia cyanura* (Figure 17), *Gehyra oceanica* (Figure 18), and *Nactus pelagicus*, and there was one invasive species also recorded (*Bufo marinus*). These findings were the result of over fourteen man-hours of diurnal survey, 436 hours of sticky trapping and six man-hours of nocturnal surveys.

One species was reported to occur by local villagers: the native Pacific boa (*Candoia bibroni*), but was not encountered during the expedition.

Figure 17: ***Emoia cyanura*** **(Photo: Noa Moko)**

Figure 18: ***Gehyra oceanica*** **(Photo: Nunia Thomas)**

Herpetofauna were observed on all the survey days through the methods employed. The majority of the species were encountered during opportunistic surveys (4 species); with lower encounter rates for the sticky traps (2 species), and standard diurnal (1 species) and nocturnal surveys (2 species).

Threats to herpetofauna were also documented. The presence of rats was evident on one sticky trap (Mt Delaikoro). Additionally the mongoose was observed, and cat scat recorded at high elevations in the Mt. Sorolevu area.

4.4 Discussion

This report contributes to the little known terrestrial herpetofauna of Vanua Levu, and more specifically the Greater Delaikoro Area. Despite the impact of introduced mammals on Fiji's terrestrial herpetofauna the widely documented presence of the Fiji ground frog on Vanua Levu is interesting. Two species whose extirpation has been attributed to introduced mammalian predators such as feral cats, feral pigs and the mongoose, and were not encountered on this survey area are the two large terrestrial skinks *Emoia trossular* and *E. nigra*.

The low encounter rates and low diversity of herpetofauna in the study sites do not necessarily mean an absence of the species. Low encounter rates of heliophilic species are not uncommon in Fiji's rainforests and are typical globally in rainforest habitats (Ribeiro-Junior *et al.*, 2006; Ribeiro-Junior *et al.*, 2008). There are efforts being made to develop better quantitative survey methods for forest dwelling herpetofauna.

Sites to target for the establishment of long-term monitoring plots should ideally be adjacent to the vegetation sample plots, because of the dependence of native herpetofauna on the health of the forest.

4.5 Recommendations

Considering that baseline survey within the Greater Delaikoro Area has now been conducted, the best option available will be to build on this by conducting subsequent surveys and standardizing the survey techniques especially for the sticky traps and frog surveys, carrying them out over different seasons and assessing species densities. Any future changes in terms of species presence/absence and

density will be an indication of the status of the habitat and forest. It is recommended that these intensive and dedicated surveys focus on a particular area or along standard transects. It is also recommended that tree climbing techniques be used to enable better capture rates of cryptic arboreal skinks and gecko species.

5 Freshwater Fishes

Lekima Copeland and Kinikoto Mailautoka

5.1 Introduction

The effective conservation of Fiji's freshwater fish requires accurate understanding of the distribution, taxonomic composition, endemicity, and local richness of species assemblages across the Fiji archipelago. This is particularly true when on a global scale the freshwater fishes of Fiji have been recently recognised in terms of endemic species per unit land area (Abell *et al.*, 2008). The freshwater fishes of Fiji have only been extensively studied in the last decade by various researchers that have discovered species new to science and elucidated some of the various factors affecting these insular fish assemblages (Jenkins and Boseto, 2005; Boseto, 2006; Boseto and Jenkins, 2006; Jenkins, 2009; Jenkins and Mailautoka, 2010; Larson, 2010; Jenkins and Jupiter, 2011; Copeland, 2013). The oceanic islands of the Pacific are distinct from continental land masses in that they have developed unique freshwater fish assemblages that have important ecological linkages between marine and freshwater environments (McDowall, 2008). The prospection of this area is important to improve our knowledge of freshwater fish distribution in Fiji.

5.2 Methodology

Due to the remoteness of the study areas, several methods of gathering data were used. Unfortunately, the breakdown of the electrofisher meant that abundance data could not be gathered. The field methods described here were designed to enable the most comprehensive documentation of fishes present in the tributaries originating from the Delaikoro mountain range. A portable Global Positioning System (Garmin eTrex 20) was used to take the position and altitude of the sampling sites. A map of the study area and several pictures of the locations sampled are provided.

Physiochemical parameters

Before fishing commenced, water quality parameters were recorded to minimise disturbances to in-situ water quality characteristics. Temperature, pH, conductivity, salinity and dissolved oxygen were measured using a commercial handheld GPS Aquameter and AP-1000 Aquaprobe.

In-stream fish sampling

The beach seine (3 m x 2 m, 1 mm mesh) was set and held by two people. Several metres upstream one person kicked and dislodged rubble to enable the collection of bottom-dwelling fish. This was done for about an hour, over approximately a 100 m stretch of stream. Snorkeling was also undertaken in streams sampled and visual observations were made from stream bank, as some species of the gobies are easily distinguishable due to their bright colours.

Preservation

Voucher specimens were collected, fixed in a 10% formalin solution and transferred to 70% ethanol solution after five days of fixation. Voucher specimens were deposited at the University of the South Pacific marine collection.

5.3 Results and discussion

Species richness

Overall a total of eighteen species of fish from six families were directly observed or collected (Table 2). The inability to use the electrofisher contributed to the low species number but even taking that into account Fiji's fish fauna is impoverished in comparison to Melanesian countries to the west, such as Papua New Guinea. The community structure of fishes is of the general composition expected within Indo-West Pacific high islands, in that species numbers are relatively low and are characterized by amphidromous species (pelagic lifecycle). The amphidromous life history results in most of these species being found throughout Oceania.

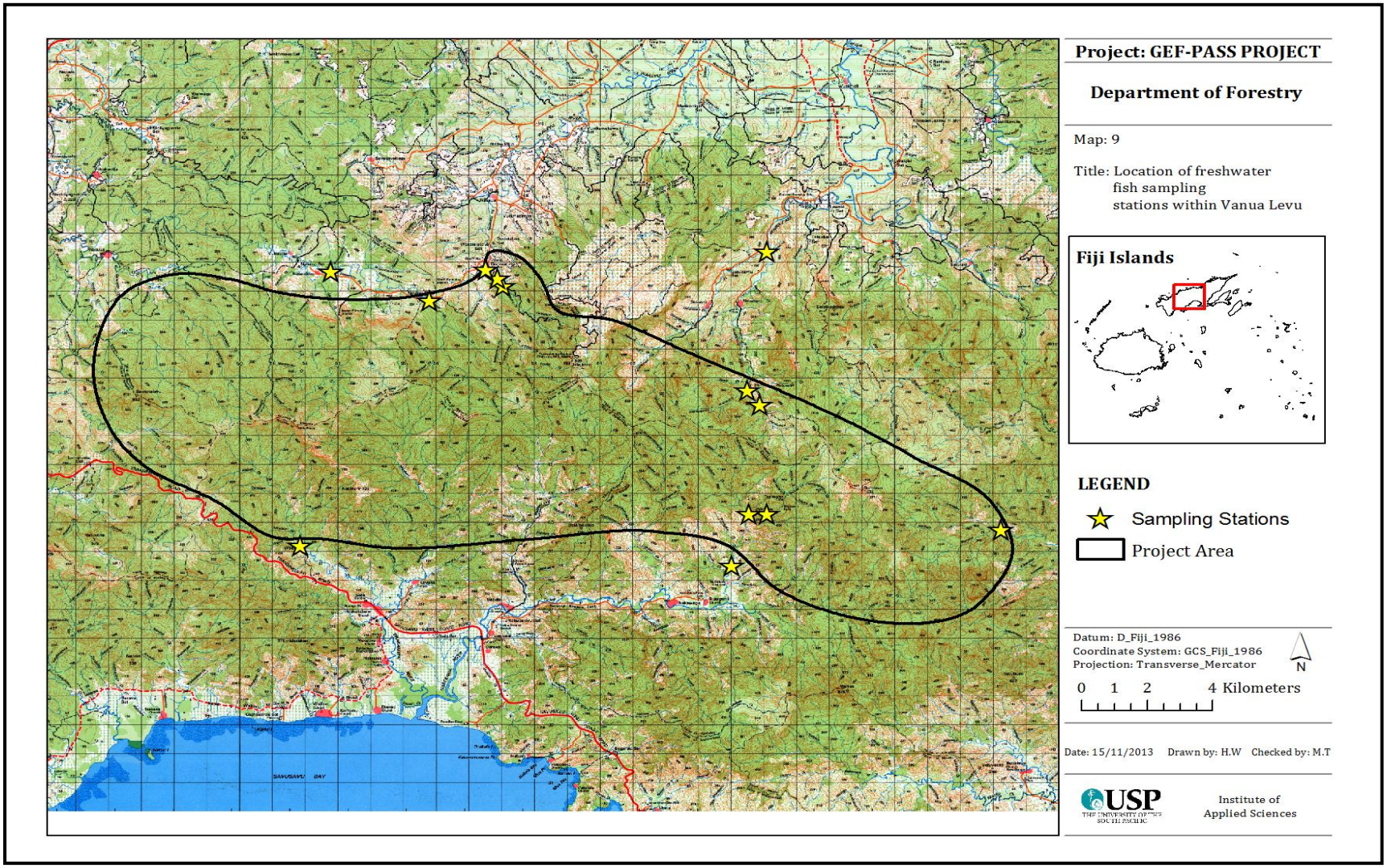

Figure 19: Location of freshwater fish sampling sites

Table 2: Species checklist for the thirteen sites[1] surveyed (*=endemic species)

Family	Species	1	2	3	4	5	6	7	8	9	10	11	12	13
Anguillidae	*Anguilla marmorata*	x	x	x	x		x	x	x	x	x	x	X	x
	Anguilla obscura		x											
Eleotridae	*Eleotris fusca*			x										
	Hypseleotris guentheri			x										
Gobiidae	*Awaous guamensis*		x					x				x	X	x
	Lentipes kaaea										x			
	*Redigobius lekutu**				x	x								
	*Redigobius leveri**						x	x						x
	Sicyopterus lagocephalus	x	x				x		x	x	x	x	X	x
	Sicypus zosterphorum							x	x	x	x			
	Stiphodon n. sp1*										x			
	Stiphodon n. sp2*										x			
	Glossogobius illimis			x										
Kuhliidae	*Kuhlia marginata*		x		x	x	x			x		x	X	x
	Kuhlia rupestris		x			x	x		x	x		x	X	x
Poecillidae	*Poecilia reticulata*				x									
Cichilidae	*Oreochromis mossambicus*					x								
	Oreochromis niloticus				x	x								
Total number of species		2	6	4	5	5	4	3	3	4	5	4	4	5

Four of the species collected are endemic to Fiji; the two described gobies *Redigobius lekutu* and *R. leveri* and the undescribed gobies *Stiphodon* n. sp. 1 and *Stiphodon* n. sp. 2. Three invasive species were collected and observed during the survey. These were the guppy, *Poecilia reticulata* and two species of tilapia, *Oreochromis niloticus* and *O. mossambicus*.

The dominant element of the fauna is the gobioid fishes, mainly members of Gobiidae and Eleotridae. This assemblage accounts for 61% of the overall fauna. Members of the gobiid subfamily Sicydiinae (containing *Sicyopterus*, *Sicyopus* and *Stiphodon*) are especially prominent in clear, rocky streams, which constitute the

[1] 1. Nasealevu Village 2. Upper Dreketi 3. Upper Doguru (1) 4. Upper Doguru (2) 5. Doguru village 6. Qaraloaloa stream 7. Waicacuru stream 8. Suweni stream 9. Waisali stream 10. Camp site upper 11. Camp site 12. Camp site lower 13. Wai Koroalau.

dominant aquatic habitat in the interior of the islands. The depauperate species richness is a feature of insular systems of Oceania where this attenuation in species richness with increase in altitude has been documented by Jenkins & Jupiter (2011).

The highlight of the survey was the discovery of a native goby *Lentipes kaaea* on Vanua Levu. This specimen had only been found previously on the island of Taveuni. A species from the same genus, *Lentipes concolor* (endemic to Hawaii), is renowned for its ability to surmount waterfalls over 100 m high. The discovery of this species and also two undescribed gobies in the genus *Stiphodon* showcases the pristine water quality in this catchment. Amphidromous stream-cling-gobies of the genus *Stiphodon* comprise an important component of the fish communities in insular streams of tropical Indo-Pacific high islands.

Figure 20: Amphidromous goby *Lentipes kaaea*, previously only recorded from Taveuni

Most of the non-gobioid fishes are basically itinerant marine forms restricted to the lower reaches of freshwater streams. The first significant waterfall usually forms a barrier to their upstream dispersal (Figure 21).

Figure 21: A waterfall in Cakaudrove province marks the upstream limit for itinerant fishes such as *Kuhlia rupestris* and *K. marginata*.

Water Quality

Results of the on-site measurements are tabulated in Appendix 11. Temperature at the sites was between 19.7°C and 20.4°C. Dissolved oxygen levels were fairly high, above 8 mg/l, making it readily available for fish at the six stations sampled. Conductivity at all sites ranged from 0.047–0.084 μS which is well within the suitable habitat range for stream fish. Turbidity was very low at all sites (<10 NTU), and the bottom was visible at all the stations.

5.4 Conclusion and recommendations

The proper management and use of aquatic resources in streams originating from the Delaikoro range entails a holistic approach due to the life-history strategies employed by aquatic fauna that traverse different habitats throughout their life. It is true that management must begin at the catchment level; however, it goes hand in

hand with the protection of marine and coastal habitats such as reefs, seagrass meadows, mangrove habitats, including the terminal reaches of rivers and streams. This survey found two endemic gobies (*Redigobius lekutu* and *R. leveri*) and two undescribed gobies from the genus *Stiphodon*. The discovery of the sicydiine goby *Lentipes kaaea* highlights the importance of carrying out further work on the island of Vanua Levu. This goby has only been collected on the island of Taveuni and this is the first record for Vanua Levu.

The following are suggestions for the proper management and conservation of aquatic fauna in the Delaikoro mountain range:

1. The first priority is protection of the catchment areas originating from the Delaikoro mountain range. The headwaters should be set up as a protected area with a complete ban on slash-and-burn techniques around the catchments.

2. Secondly, the other major issue identified is the importance of restoring buffer zones around mid-reach sites. This will also require the proper education of farmers (landowners) on establishing farms near rivers, and the importance of a buffer width and restricting livestock access across streams.

3. Further aquatic biodiversity research is needed in the headwaters of the Delaikoro range especially for streams draining into Cakaudrove province.

6 Freshwater Macroinvertebrates

Bindiya Rashni

6.1 Introduction

The Fijian freshwater macroinvertebrate fauna is represented by 45 families, namely; 25 families of insects, eight families of molluscs, four families of crustaceans, three families of segmented worms, two families of nematodes, two families of sponges, and one family of flatworms (Haynes, 1988; Haynes, 1999; Haynes, 2001; Jeng *et al.*, 2003; Haynes, 2009). Many of these are yet to be fully described to genus and species level and many aquatic insect larvae need to be matched to their described flying adults.

Prior to this study, there have been no surveys conducted on the composition of freshwater macroinvertebrate communities within the waterways of the study sites detailed in this report or their tributaries. There is, however, some documentation of previous macroinvertebrate surveys in other waterways of Vanua Levu focusing on the freshwater gastropods (Haynes, 1988; Haase *et al.*, 2006) and Atyid shrimps (Choy, 1991) only. These studies were conducted to document the aquatic gastropods and shrimps present in easily accessible streams in Vanua Levu. Therefore the present study represents the first detailed and comprehensive study of freshwater macroinvertebrates and the aquatic habitats within the Mt. Delaikoro, Sorolevu and Savusa catchments.

The key objectives of the study were to provide a comprehensive list of taxa, describe community structure and identify taxa that are unique, rare and endangered in Fiji. This report also provides information relating to water physicochemistry that supports macroinvertebrate communities at waterways surveyed in the two main provinces (Macuata and Cakaudrove) of Vanua Levu.

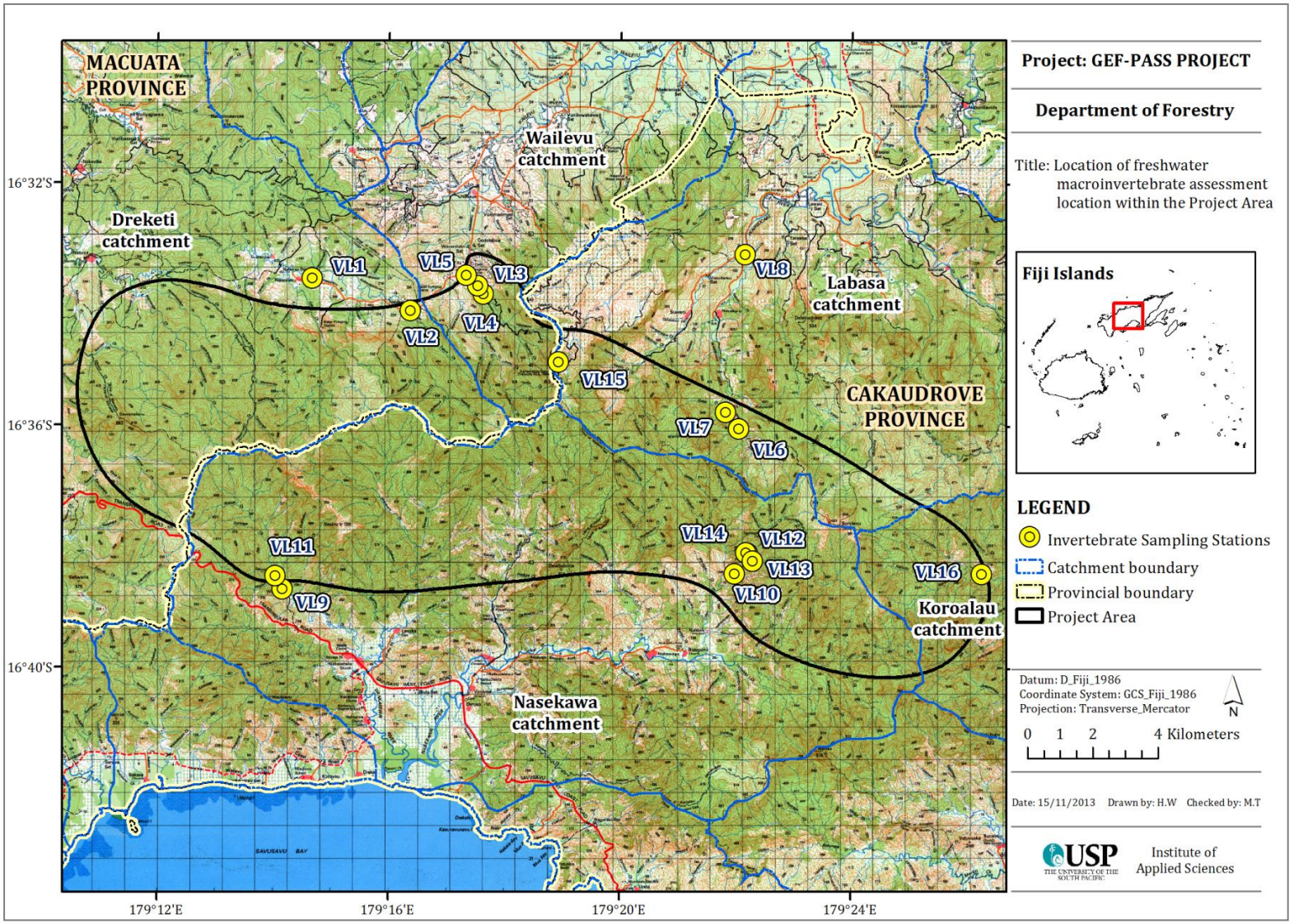

Figure 22: Location of macroinvertebrate sampling stations

6.2 Methodology

Survey Stations

During the Vanua Levu freshwater survey (September-October 2013), eight main stations (VL1-VL8) were sampled within the Macuata province and four major stations (VL9-VL11 and VL13) in Cakaudrove province. The catchments targeted in both provinces include waterways that supply water to the residents of Vanua Levu. The descriptions of the sampling stations are summarized in Table 3 and their locations shown in Figure 22. Photographs of the habitats of the sampling stations are given in Appendix 12.

Table 3: Macroinvertebrate sampling localities and methods used at each

River/Stream	Site Code	Description	Survey type
Nasealevu village	VL1	Upstream	Surber & Kick-netting
Dreketi	VL2	Upstream	Kick-netting
Doguru 1	VL3	Upstream	Kick-netting
Doguru 2	VL4	Upstream	Kick-netting
Doguru village	VL5	Next to village	Kick-netting
Sorolevu/Qaraloaloa	VL6	Upstream	Kick-netting
Waicacuru	VL7	Upstream	Kick-netting
Doguru/Suweni river	VL8	Next to bridge-confluence	Kick-netting
Waisali village	VL9	Next to village	Surber & Kick-netting
Waisali river upper	VL11	Upstream	Kick-netting
Savusa-Savutagitagigagone	VL10	Upstream-above waterfall	Kick-netting
Savusa-tributary	VL12	Upstream-above waterfall	Hand-picking
Spring-Savusa	VL14	Upstream-above waterfall	Hand-picking
Vunidogoloa	VL13	Next to village	Kick-netting
Mt. Delaikoro	VL15	Roadside spring	Hand-picking
Tabia-Savusavu	VL16	Next to current logging site	Hand-picking

Water physicochemistry

Water physicochemical parameters were measured at each sampling station using a calibrated multi-parameter water quality meter (Aquaread AP 1000). Parameters measured included temperature, dissolved oxygen (DO), conductivity (milisiemens per centimeter (mS/cm), pH, Total Dissolved Solids (TDS), turbidity (Nephelometric Turbidity Units (NTU)) and salinity. Water Quality was taken only at major sampling stations where Surber sampling or kick-netting was carried out.

Macroinvertebrate sampling

Macroinvertebrate samples were collected using both quantitative and qualitative survey methods to allow an assessment of macroinvertebrate density at selected stations and to compile a list of taxa present at each site. The quantitative and qualitative sampling methods were adapted from Stark *et al.* (2001) and modified to suit the time period and objectives of this particular survey.

Quantitative assessment – This is a quantitative method that provides a measure of macroinvertebrate density, adapted and modified from Protocol C3 (Stark *et al.*, 2001). Three replicate Surber samples (area 0.1 m^2, 0.5 mm mesh) were collected from riffle habitats at stony streambed sites. A riffle is a shallow area (water depth ≤ 0.5 m) where water flows swiftly over stones, creating surface turbulence. Samples were collected by placing the Surber sampler over a defined area of streambed in riffle habitat and disturbing the habitat by washing the particles with the water flowing through the net to collect dislodged macroinvertebrates. Surber sampling was only carried out for two sites; Nasealevu village [VL1] and Waisali village [VL9] due to time constraints.

Qualitative assessment – a single sample was collected from each sampling station via 3-minute kick-netting over five metre riffle and run habitats, or hand-picking using thumb forceps (opportunistic collection) where necessary. Typical habitats sampled included runs, riffles, chutes, pool edges, woody debris, leaf litter, stream

edges, and tree roots along banks, stream bank vegetation and sand/silt substrates. The purpose of multi-habitat sampling is to provide a list of taxa at the selected station. Kick-netting was carried out at all main stations (VL1-VL11 and VL13), therefore it will be used for the majority of the data analysis. For the remaining sites (VL12 and VL14-VL16), opportunistic collection was conducted for taxa of interest.

Macroinvertebrate samples collected were placed into 250ml specimen jars with 70% ethanol for sorting and identification by the author (Bindiya Rashni). Crustacean (prawn and shrimp) specimen identification was confirmed by Laura Williams, crustacean specialist at the School of Marine Studies, USP. The guides referenced in the identification process included; Haynes (2009), Haynes (in prep.), Haase *et al.* (2006), Williams (1980) Winterbourn *et al.* (2006), and Marquet *et al.* (2003), Choy (1983; 1991). Identified macroinvertebrates were preserved in 100% ethanol for long term storage.

Data analysis

Community composition and structure: the combined Surber and kick-net data set was used to calculate the relative abundance of the main taxonomic groups.

Macroinvertebrate density: an assessment was made of macroinvertebrate density in riffle habitats at selected stony streambed sites based on quantitative Surber sample data by multiplying the mean Surber sample abundance data (per 0.1 m^2) by a factor of ten to give abundance/m^2.

Status & distribution of taxa: taxa were classified as endemic and native to Fiji, native to other regions (e.g. Pacific, South Pacific, Indo-Pacific, and South East Asia), introduced tropical species or other (i.e. unknown for new records).

Functional feeding group (FFG) assessment – FFGs represent the mode by which macroinvertebrate taxa feed (i.e., collector-filterer, scraper, grazer, predator or shredder). The FFG assessment involved calculating the number of taxa within each FFG and the relative abundance each group made up across sampling sites.

Taxa of interest: macroinvertebrate taxa of potential interest suspected to be a new record for Vanua Levu or Fiji or to Science.

6.3 Results

Water physicochemistry

The water physicochemistry parametres measured at the different stations are summarised in Appendix 13. Waterways sampled ranged from almost neutral to slightly acidic. The freshwater macroinvertebrate communities described in this survey are unlikely to be significantly affected by pH values within this range. Conductivity is a measure of the total ions in water and ranged between 1.110 mS/cm in the Nasealevu village waterway (VL1) and 0.054 mS/cm in the Savusa-Savutagitagigagone (VL10).

Turbidity (NTU) is a measurement of particles in the water column and provides an indication of water clarity. Turbidity values ranged between 0 NTU in the majority of sites (VL2-VL5, VL7, VL8, VL9, VL10, and VL13) to 2.4 NTU in the Nasealevu village (VL1). Turbidity in Nasealevu village stream was higher due to heavy rainfall a few nights ago prior to surveying. Turbidity above 5 NTU signifies poor water quality; all the sampling stations had turbidity values less than 5 NTU. In the majority of waterways surveyed turbidity values were 0 NTU, which signifies excellent water quality for macroinvertebrate survival as well as the absence of sediment-raising activities in the catchment, or at least not within the range of the areas surveyed.

Dissolved oxygen concentrations ranged from 8.97 g/m^3 in Waisali village stream (VL9) to 8.24 g/m^3 in Vunidogoloa-Wai Koroalau stream (VL13). All dissolved oxygen concentrations were above the level considered sufficient for macroinvertebrate survival (i.e. >5 g/m^3). Waterway hydrology at sites surveyed was unaltered except for the upper Dreketi (VL2) which had a culvert and Doguru-Suweni river (VL8) which had a bridge, but these do not seem to have affected the

DO levels required for survival of macroinvertebrates, although alteration of flow is highly possible. Salinity measurements at the survey stations demonstrated levels that are expected in the waterways of any tropical inland river or stream.

Taxa richness and abundance

A total of 70 distinct macroinvertebrate taxa were collected across all sampling sites during the surveys (Appendix 15 and Appendix 16). Macroinvertebrates were distributed among the taxonomic groups as shown in Table 4. The most diverse group was Insecta with 48 taxa and representing 69% of the total number of taxa recorded. Of the 48 insect taxa, fourteen were dipterans (true flies), eleven were caddisflies and seven were mayflies. The next most diverse taxonomic group was Crustacea (14 taxa) followed by Mollusca (6 taxa) and Annelida (2 taxa).

Table 4: Number of macroinvertebrate taxa recorded in each of the taxonomic groups across all sampling sites.

Higher group	Order / Class	Common name	Number of taxa
Insecta	Trichoptera	caddisfly	11
	Ephemeroptera	mayfly	7
	Lepidoptera	moth	3
	Diptera	true-fly	14
	Zygoptera	damselfly	5
	Anisoptera	dragonfly	3
	Hemiptera	water bug	2
	Coleoptera	water beetle	3
Crustacea	Atyidae	shrimp	10
	Palaemonidae	prawn	4
Mollusca	Gastropoda	snails	6
Annelida	Oligochaeta	worms	2

The number of macroinvertebrate taxa recorded from sites ranged between nine taxa from the upper Doguru (VL3) and Vunidogoloa-Wai Koroalau (VL13) and 26 taxa

from the Nasealevu village (VL1) and Waicacuru (VL7). The Nasealevu village waterway (VL1) supported a diverse insect fauna (22 insect taxa) while Waicacuru supported seventeen insect fauna and six distinct crustacean fauna.

The Upper Doguru (VL3) and Vunidogoloa-Wai Koroalau (VL13) had riparian vegetation removed (burning & cutting down of trees) and easy access to farming areas. The Upper Doguru (VL3) site supported low taxa richness, most likely due to changes in habitat characteristics as this site was dominated by chute habitats supported by huge rocks and deep pools unlikely to support aquatic insects. The Vunidogoloa- Wai Koroalau (VL13) site was next to a village with sluggish gravel dominated uniform run habitat reflecting poor aquatic habitat conditions and general absence of stable aquatic habitats such as run-riffle-pool sequence, woody debris and overhanging stream bank vegetation.

The Surber samples were just taken from the riffle habitats and it was only carried out for two sites while kick-net samples were consistent throughout the sites covering multiple-habitats and hence kick-net data has been used for the majority of the analysis, including taxa richness. The difference in taxa richness recorded from the different sampling methods is shown in Figure 23.

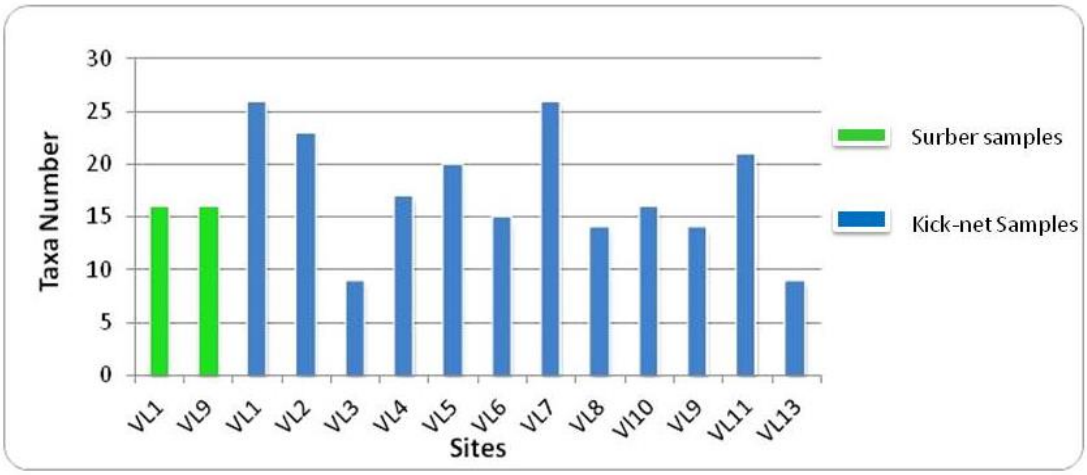

Figure 23: Comparison of the number of macroinvertebrate taxa recorded from Kick-net and Surber Samples

Surber samples for Nasealevu village (VL1) site showed lower taxa richness (16 taxa) than kick-net samples (26 taxa) of the same site. However, Surber samples from Waisali village (VL9) had slightly higher taxa richness (16 taxa) than the corresponding kick-net samples (14 taxa). The Surber samples of the Waisali village site (VL9) had an additional two insect fauna than were sampled by kick-netting.

Macroinvertebrate density

A summary of the freshwater macroinvertebrates collected and their abundance is presented in Appendix 14. The abundance is given as numbers of individuals, and is also grouped into abundance categories as follows: very abundant (>100); abundant (20-99); common (5-19); few (2-4) and very few (1). The overall (all taxa) abundance ranged from 2730 individuals/m^2 at Waisali village site (VL9) to 4550 individuals/m^2 in Nasealevu village site (VL1). It is worth noting that only Surber samples (two sites only) were used to calculate density (Appendix 15).

Insect larvae/nymphs were the most dominant taxa at all sites. This was strongly represented by caddisfly, mayfly and dipteran larvae. This result is typical of the headwaters of tropical inland streams. Insect larvae are well adapted to fast flowing waters of stream/river headwaters, compared to crustaceans and molluscs which are found in higher numbers in lower reaches of streams/rivers with swifter flows.

The small *Fluviopupa* (<4 mm) snails (spring snails) were also recorded as abundant at two sites: Doguru village (VL5) and Upper Doguru (VL3). During an opportunistic collection hand-picking), these snails were highly abundant in an intact spring (VL14) within Savusa catchment; within the forest reserve. These particular gastropods are usually catchment endemic and found in higher densities in headwaters with narrow channels, swift flows and very clean water. They have been found to be only present in streams undisturbed from cattle/horse grazing.

The damselfly nymph (*Nesobasis* spp.) was also abundant at two stations: Doguru village site (VL5) and Waicacuru (VL7). They are known to be found in higher

densities in streams with overhanging vegetation, streamside root mass, open-partial canopy shading and good water quality; hence there abundance in these streams.

The macroinvertebrate communities documented were typical of inland tropical stream headwaters. The streams/rivers sampled provided suitable habitats for diverse taxa composition. The sites surveyed had coarse stony streambed substrates and a high proportion of turbulent riffle/chute habitats, which resulted in caddisflies (Trichoptera) and mayflies (Ephemeroptera)being the most dominant group at the majority of stations. These groups combined to give 95% (VL9), 87% (VL2), 84% (VL5), 81% (VL11), 75% (VL4), 69% (VL10) and 62% (VL8) of the total species recorded (Figure 24).

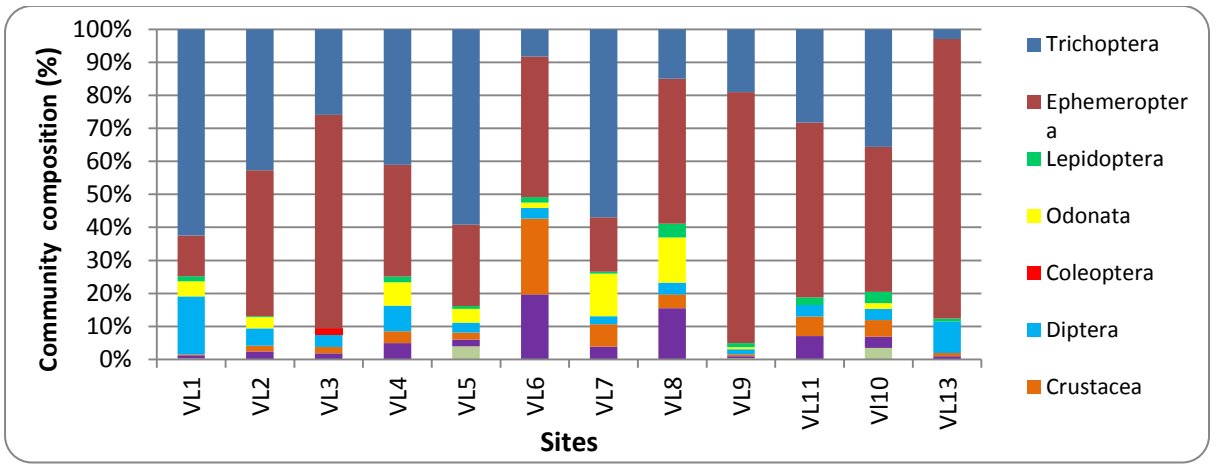

Figure 24: Community composition by major taxonomic group

An exception to this pattern was at sites VL1, VL6, & VL13. At VL1, the Diptera group was more abundant than the Ephemeroptera, and together with the Trichoptera comprised 80% of species composition. At station VL6, the Crustacea group was the second most abundant and together with the Ephemeroptera comprised 75% of species composition. At VL13, the Diptera group was the second most abundant, and together with the Ephemeroptera comprised 96% of species composition.

The most abundant caddisfly taxon (Figure 25) recorded was the net-spinning filter-feeder *Abacaria fijiana*. This species was most abundant in riffle habitats at Doguru

village and Nasealevu village site (VL1) where they represented between 55% and 31% of total abundance respectively. Other caddisfly larvae such as *A. ruficeps*, *Hydrobiosis* spp., *Oxyethira* spp. and Odontoceridae (case) were also common or abundant but generally represented less than 9% of total abundance, except at sites VL1 whereby Odontoceridae represented 21% and at VL9 and VL3, *Oxyethira* spp. represented 15% and 10% of the total abundance respectively.

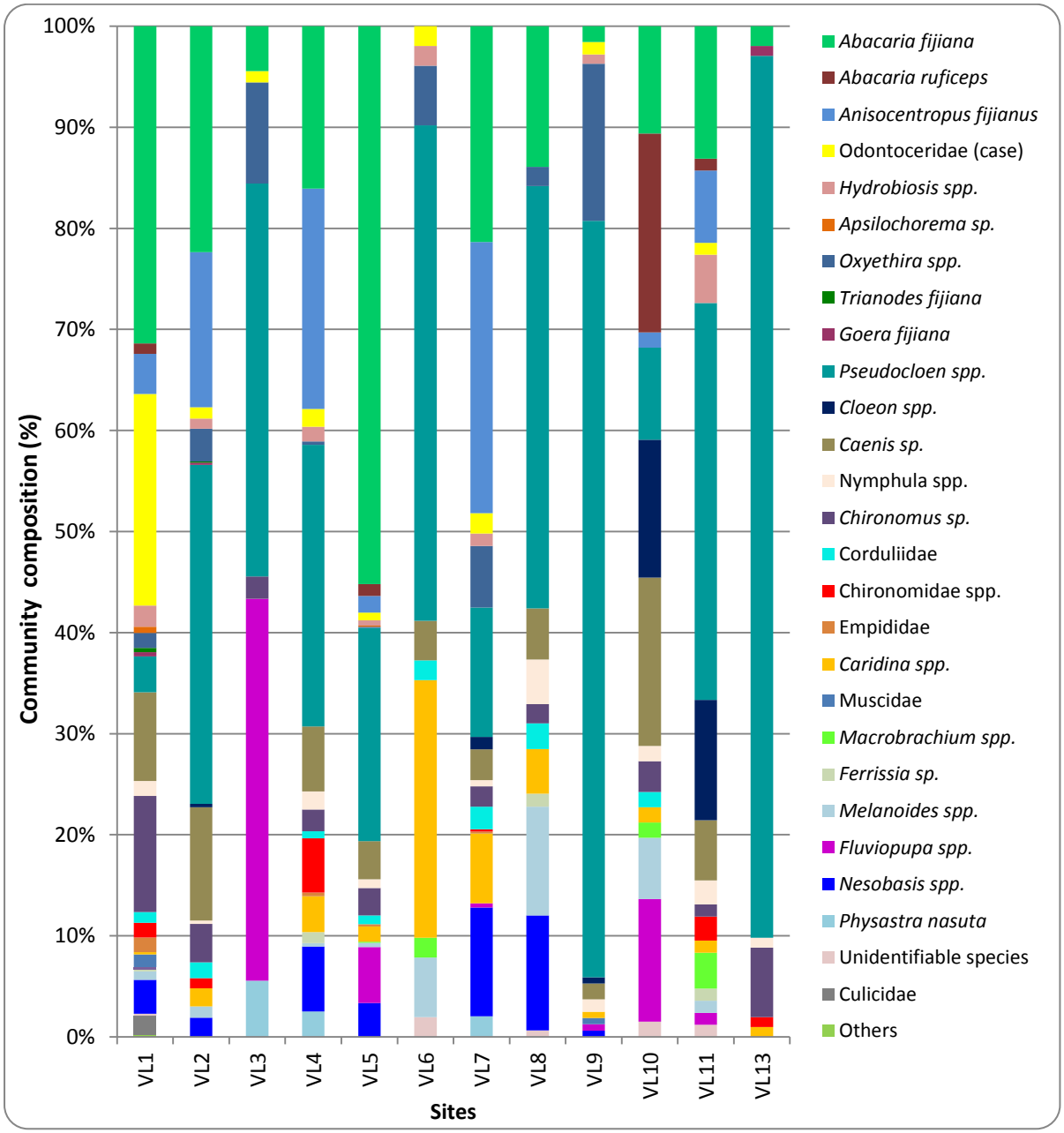

Figure 25: Macroinvertebrate community composition by taxa

Another common caddisfly recorded, the leaf-case *Anisocentropus fijianus*, was present in highest proportions in the Waicacuru (VL7) and Upper Doguru 2 (VL4), representing 27% and 22% of the total abundance respectively. Mayflies were also a dominant taxonomic group recorded at survey sites and represented 86% of the community in the Vunidogoloa stream (VL13) and 76% in the Waisali village stream (VL9).

The most abundant mayfly taxon was *Pseudocloeon* spp. This is because *Pseudocloeon* spp. has a dorso-ventrally flattened body that allows it to graze on thin algal films covering the surfaces of large boulder/cobble substrates in turbulent riffle/chute habitats. In contrast, *Cloeon* spp. mayflies which are mostly associated with gentle flowing habitats and are more common along stream margins and runs were recorded in much lower proportions across the sites. Therefore many *Cloeon* spp. were part of the opportunistic collection. Another commonly recorded mayfly taxon was *Caenis* sp. but represented just under 10% of the total abundance except at sites Savusa- Savutagitagigagone (VL10) and Upper Dreketi (VL2), where it represented 16% and 11% of the total abundance, respectively.

Conservation status and distribution of taxa

A total of six macroinvertebrate taxa recorded as part of the survey were endemic to Fiji and represented 10% of the total number of taxa recorded. A total of 31 macroinvertebrate taxa were Endemic/native (taxa that are known to be endemic to Fiji but the species are yet to be scientifically named) and represented 51% of the total number of taxa recorded (Figure 26). Apart from a few unique specimens (~10), many of the endemic taxa recorded are common throughout the headwaters of Fiji Island streams. The remaining 39% of taxa were either native to Fiji, the Pacific or the Indo-Pacific region, or introduced tropical species or unknown species.

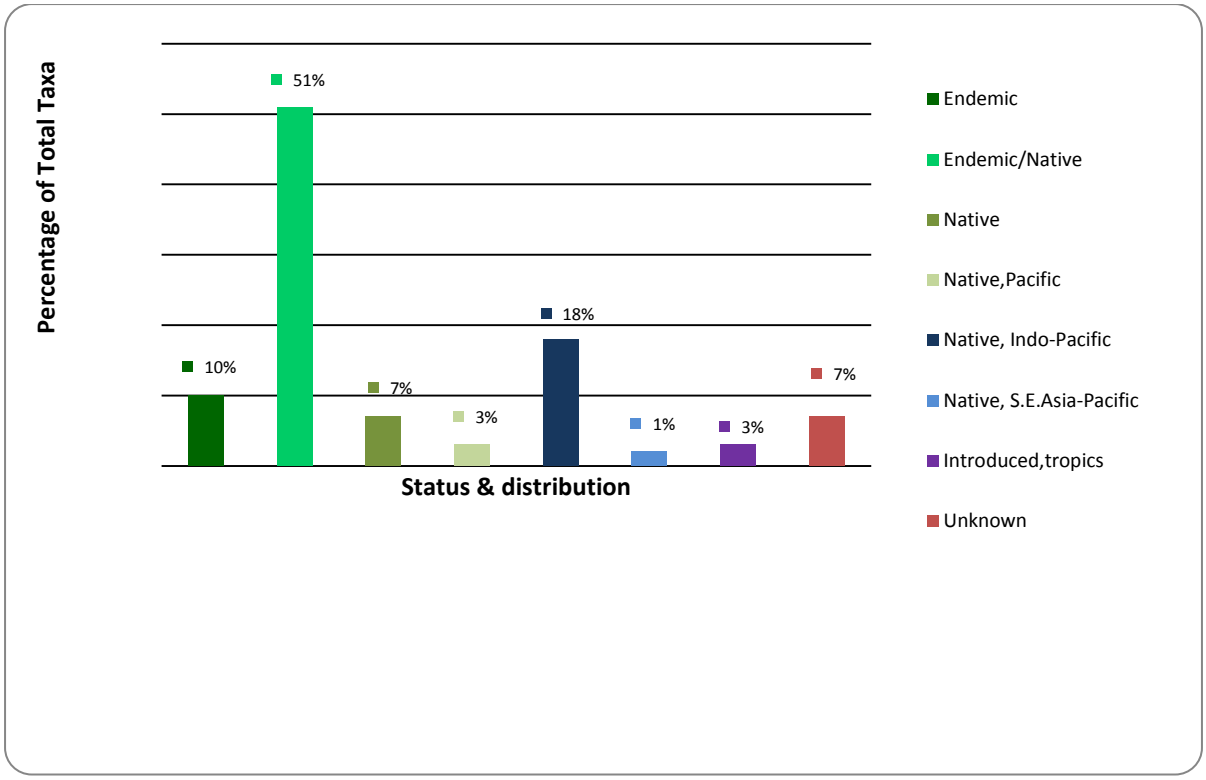

Figure 26: Status and distribution of macroinvertebrate taxa across all sites

Figure 27 shows the total number of taxa recorded at each sampling station and their status/distribution shown as a proportion of total taxa richness within each community. The number of endemic and endemic/native taxa recorded at sampling stations ranged between seven taxa at Upper Doguru stream (VL3) to 22 at Nasealevu village stream (VL1). This amounted to 78% and 85% of the total taxa per sites respectively, highlighting that endemic or native species are the dominant taxa at all sites. The majority of endemic/native taxa recorded were insects; inclusive of both qualitative and quantitative collections (35 taxa in total).

Other endemic taxa recorded were the small (<4 mm) spring snails (*Fluviopupa* spp.). All the crustaceans (shrimps and prawns) are native but also found throughout the Indo-Pacific; the exception was the first record of two atyid shrimps (*Caridina* sp. A and *Caridina* sp. B) which have a very high chance of being new to science as these were compared to shrimp keys from Fiji, PNG, the Philippines and New Caledonia. There were also two new prawn records (*Macrobrachium* sp. A and *Macrobrachium* sp.

B) which did not match the taxonomic keys stated previously. These specimens were placed under unknown origin. Two commonly introduced taxa found were the mosquitoe larvae (Culicidae) and the Thiarid snail *Melanoides tuberculata*. The common introduced mosquitoe larvae (Culicidae) was found at Nasealevu village (VL1) while *M. tuberculata* was found at several sites. These species are common throughout streams in Fiji and the *Melanoides* snail is known to be a hardy species that can successfully make its way to highland streams.

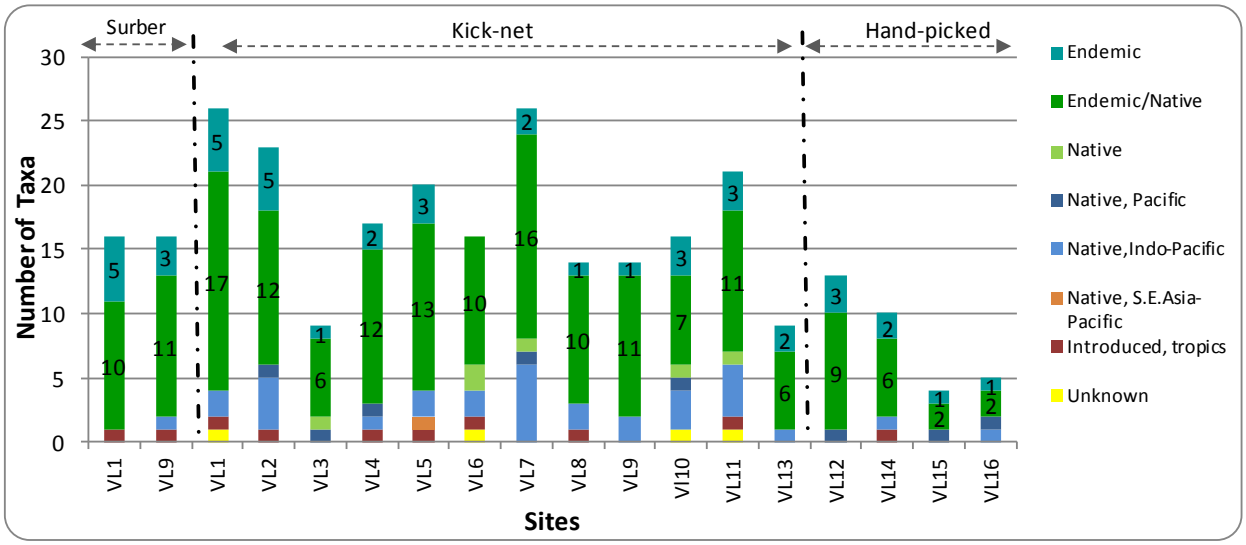

Figure 27: Status and distribution of taxa across individual sites

A lower number of endemic-endemic/native taxa were observed as part of the quantitative survey at upper Doguru (VL3) (7 taxa) and Vunidogoloa village stream (VL13) (8 taxa). This is probably due to the absence of a stable aquatic habitat (natural riffle-run-pool sequence coupled with stream sides trees providing mass fibrous roots extended into the channel) for aquatic insect fauna such as mayflies damselflies, shrimps, whirligig beetles and caddisfly species which generally contributes to the highest proportion of endemic-endemic/native fauna in Fiji inland streams. Another possibility could be the removal of stream site trees that would have contributed to food availability of the macroinvertebrate community. The streamside trees provide leaf matter and indirectly maintain algal biofilms (prevent washing away of sediments that would otherwise smother the algal film on submerged rocks), both of which are food sources for aquatic invertebrates.

Functional Feeding Groups (FFG)

Functional feeding groups include collector-filterers, filter/gatherers, scrapers, grazers, shredders and predators. An overview of macroinvertebrates and their FFG categories is presented in Table 5 with the relative proportions of each group at each site shown in Figure 28.

Table 5: Functional feeding groups for freshwater macroinvertebrate taxa

Collector-filterers	**Scrapers**	**Predators**	**Shredders**	**Filter/ gatherers**	**Grazers**
Culicidae (mosquitoe)	*Anisocentropus* (caddisfly)	*Hydrobiosis* (caddisfly)	*Trianodes* (caddisfly)	*Abacaria* (caddisfly)	*Neritina* (snail)
Stratiomyidae (soldier flies)	*Goera* (caddisfly)	*Apsilochorema* (caddisfly)	*Limonia* (crane fly)	Muscidae (stable fly)	*Physastra* (snail)
Scirtidae (marsh beetles)	*Odontoceridae* (caddisfly)	Corduliidae (dragonfly)	*Tipula* (crane fly)		*Fluviopupa* (snail)
Chironomidae (midge)	*Cloeon* (mayfly)	*Nesobasis* (damselfly)	*Dineutus* (whirligig beetle)		*Melanoides* (snail)
Simulium (black fly)	*Pseudocloeon* (mayfly)	*Limnogonus* (water bug)	*Paralimnophila* (crane fly)		*Ferrissia* (snail)
Stratiomyidae (solider fly)	*Nymphula* (moth)	*Microvelia* (water bug)			
Atyopsis (shrimp)	Oligochaeta (worm)	Empididae (dance flies)			
Caridina (shrimp)	*Caenis* (mayfly)	Athericidae (watersnipe flies)			
Psychoda (moth flies)	Hydraenidae (minute moss beetle)	*Macrobrachium* (prawn)			

Collector-filterers were diverse and ubiquitous across the waterways sampled but low in relative abundance compared to the scrapers. The collector-filterer feeding group was represented by nineteen taxa while the scraper functional feeding group was represented by ten taxa. The scrapers were the most abundant group and made up between 16% (Nasealevu village site -VL1) to 93% (Waisali village site-VL9) of total community abundance at stony streambed sites. Scrapers recorded included mayflies, caddisflies, oligochaetes, moths, beetles and snails. The most abundant scraper taxon recorded across sites surveyed was the mayfly *Pseudocloeon* spp., which grazes on thin biofilms growing on stable in-stream substrates (e.g., cobbles, boulders, leaf litter). Other widely distributed scrapers included *Cloeon* sp. and

Caenis sp. (mayflies), *Odontoceridae* (caddisfly), *Anisocentropus fijianus* (leaf-case caddisfly) and *Nymphula* spp. (moth).

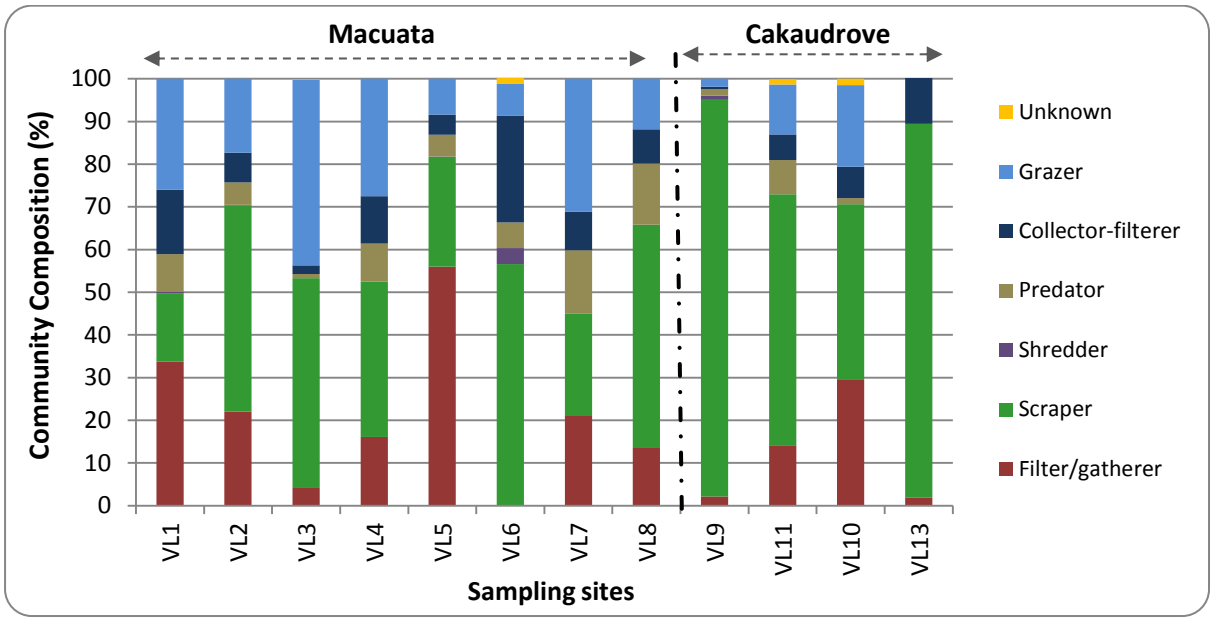

Figure 28: Proportion of total abundance that each functional feeding group made up at sampling sites

Filterer/gatherers included caddisfly larvae and dipterans and also represented a major component of the macroinvertebrate communities recorded. Only three filterer/gatherers were recorded within this functional feeding group, but they made up between 2% (Vunidogoloa) to 56% (Doguru village) of total abundance. The most abundant filterer/gatherer taxon was *Abacaria fijiana* (caddisfly), whilst other widely distributed collector/filterer taxa included *A. ruficeps* and Muscidae (stable fly). Collector-filterers were represented by shrimps, true-flies and beetles and highly diverse (19 taxa) but of low relative abundance making up between 1% (Waisali village-VL9) to 25 % (Sorolevu-VL6) of community abundance at the sites.

Predators were represented by caddisflies, damselflies, dragonflies, water bugs, true-flies and prawns. The predator functional feeding group was diverse (13 taxa) but of low relative abundance and made up between 0% (Vunidogoloa-VL13) and 15% (Waicacuru-VL7) of community abundance at the sites. The shredders were represented by only five taxa making up between 0 and 4% of total community abundance across stony streambed sites. Shredders recorded included *Trianodes*

fijiana (caddisfly larvae), beetles and cranefly larvae (*Tipula* sp.). The highest proportion of shredders occurred at upland forested sites (Sorolevu mountain forests (VL6 and Waisali Forest reserve-VL9), where leaf litter was abundant and retained within the waterways long enough to be assimilated. The shredders are known to contribute only a minor component of macroinvertebrate community biomass in Fiji and tropical Pacific Island riverine systems (Bright, 1982; Resh *et al.*, 1990; Haynes, 1999). The low proportions of shredder community is due to absence of stoneflies from Fiji ecosystems and the nature of leaves (food) entering streams from surrounding native forests, which tend to be tough with thick cuticles that are broken down slowly (Haynes, 1999).

Taxa of interest

Certain macroinvertebrate taxa that were recorded during the freshwater macroinvertebrate surveys may be of potential ecological interest (pictured in Appendix 17). Some of these taxa, such as *Fluviopupa* spp. and *Nesobasis* spp. have a very high chance of being new to science and either catchment endemic or endemic to Vanua Levu.

These taxa are very good bioindicators for state of streams and the catchment it drains; ranging from highly sensitive to resilient species. The densities (individuals/m^2) of these species reflect the state of streams. These species have previously being surveyed and found to be varying in abundance in slightly degraded to intact streams in Viti Levu.

A major finding of this survey was a prawn species, *Macrobrachium spinosum* (Figure 29) which is a new record for Fiji. This species was first discovered in Halmahera, Indonesia in 2001 (Cai and Ng, 2001) and also recently collected and identified in Vanuatu (Keith *et al.*, 2011). The official documentation of this species is still in process.

Figure 29: ***Macrobrachium spinosum***

6.4 Discussion

The freshwater macroinvertebrate community (in total 70 taxa) of Vanua Levu survey areas showed that the endemic/native taxa were the most dominant with insects making up the majority of the taxa. This is typical of inland tropical riverine system headwaters. In comparison with other studies in Fiji, Viti Levu catchment headwaters (by the author), 76 taxa were identified from waterways in the Emalu area (Navosa highlands), 27 from Wainavadu creek, the headwaters of the Waidina river and 32 taxa were identified from the Wainibuka river headwaters in the Nakauvadra range. Waterways in the Emalu area supported much higher taxa richness than other stream/river headwaters that have been surveyed in Fiji as the headwaters drained intact catchments. The Vanua Levu survey areas mostly supported secondary forest except some part of Waisali reserve and Savusa reserve.

A total of 12 macroinvertebrate taxa collected as part of the survey may be of potential ecological interest (Appendix 17). These include four species of mayfly nymphs (Ephemeroptera: one *Pseudocloeon* sp. and two *Cloeon* spp. and one *Caenis* sp.), four species of damselfly nymphs (Odonata: *Nesobasis* spp.), two species of

caddisfly larvae (Trichoptera: *Apsilochorema* sp., *Hydrobiosis* sp., one cranefly larvae (Tipulidae: *Tipula* sp.) and one snail (*Fluviopupa* spp. (<4 mm). These taxa are very good bioindicators, ranging from highly sensitive to resilient species. Some of them, for example the *Pseudocloeon* sp. and the *Cloeon* sp A, are typical of pristine streams draining intact watersheds. In addition special taxa such as the spring snails (*Fluviopupa* spp.) are very likely to be catchment endemic or area endemic species. Ten species of spring snails are already known to be endemic to Fiji, have restricted distribution and are usually catchment endemic, inhabiting springs and small creeks or riffles (Haase *et al.*, 2006). They almost exclusively live in springs and in the headwater of streams. The presence of these spring snails is indicative of very clean water. These snails are specialists with very low ecological amplitude; reacting to the slightest difference in environmental conditions. They are mostly threatened by human activities that lead to sedimentation and eutrophication such as logging, mining, intensive agriculture, forest burning and removal of riparian vegetation which results in the springs snail density decreasing or the population disappearing altogether (Great Basin EF, 2012)

The damselfly nymphs collected (*Nesobasis spp*. W, X, Y, Z) were morphologically different from those commonly found in Viti Levu streams and have a high chance of being endemic to Vanua Levu. Further scientific research is needed to confirm this. Additionally these larval stages will need to be matched to an adult stage before it can be confirmed if they are a new species or not. In addition this survey documented for the first time two atyid shrimps (*Caridina* sp. A and *Caridina* sp. B), which have a very high chance of being new to science as these were compared to shrimp keys from Fiji, PNG, Philippines, New Caledonia, Japan, Malaysia, Singapore and Indo-West Pacific. There were also two new records of prawn specimens (*Macrobrachium* sp. A and *Macrobrachium* sp. B). These specimens seem to have partial resemblance to *Macrobrachium placidulum* (Holthuis, 1952; Chace, 1997; Short, 2004; Cai and Shokita, 2006; Cai *et al.*, 2006; Cai *et al.*, 2007).

Another interesting observation during the survey was the absence of the fingernet caddisflies of the genus *Chimarra*. These caddisfly larvae (Figure 30) have been observed in slightly disturbed to intact streams in Viti Levu and has been highly abundant (average= 66 individual/m^2) in intact (primary forested) catchment such as Emalu in Navosa highlands. Their absence in the areas surveyed could be due to the species not being able to reach the areas as the water quality recorded supported their usual habitat water physicochemistry.

Figure 30: Fingernet caddisfly *Chimarra* sp. (Philopotamodae)

7 Invasive Species

Sarah Pene

7.1 Introduction

Invasive alien species are described in the context of the Convention on Biological Diversity as "alien species whose introduction and/or spread threaten biological diversity" (CBD, 2002). The Millennium Ecosystem Assessment (UNEP, 2005) confirms that invasive alien species have been a significant driver of biodiversity loss over the last century, and forecasts that this trend will continue or increase in all biomes across the globe. Island ecosystems like those in the Pacific are particular vulnerable to the impact of invasive alien species (CBD, 2003).

The list of plant invasives in Fiji (Meyer, 2000) is currently composed of 52 species, classified under three groups according to their degree of invasiveness, namely: 13 dominant invaders, 17 medium invaders and 22 potential invaders).

Pernetta and Watling (1978) compiled a list of introduced vertebrates in Fiji which includes most of the globally common invasive species such as rats, mongooses and the Indian mynah. Fiji has, however, successfully prevented the entry of the giant African snail and the brown tree snake, which have had devastating impacts on other islands in the Pacific (Sherley, 2000).

Invasive species management in Fiji has focused for the most part on control methods; physical, biological and chemical. A few eradication programmes have been implemented on small islands, for example Vatu-i-Ra, where the Pacific rat (*Rattus exulans*) was successfully eradicated to protect seabirds (Seniloli *et al.*, 2011). Whilst eradication programmes are feasible for small isolated islands, it is not a realistic approach for widespread plant and animal invasives in larger areas on the bigger islands.

This invasive species survey was conducted as part of a rapid biodiversity assessment of sites in inland Vanua Levu that are being considered for designation as protected areas.

7.2 Methodology

A checklist of invasive plant species was compiled based on observations at all areas surveyed, which included the Mt Delaikoro summit road, the Navakuro to Mt Sorolevu road, and part of the Waisali reserve. A more detailed assessment of invasive plant species was made on the Navakuro to Mt Sorolevu road. This logging road has been made within the last 10 years and ascends close to the peak of Mt Sorolevu, Vanua Levu's highest mountain. The survey team followed this road as close as possible to the summit of Mt Sorolevu, making records of invasive plant species encountered along the way that were visible from the road. These points were georeferenced and aligned to the corresponding elevation profile of the track.

A checklist of the invasive animal species was compiled based on reports from the vertebrate fauna specialists. Both direct sightings as well as indirect observations (scat, chewing marks etc.) were recorded. Where reports were based on indirect observations identification to species level could not be reliably made, the list indicates the possible species ("cf."). Invertebrate invasive species (such as agricultural insect pests) were not recorded.

7.3 Results

Invasive plant species were readily observed in all areas surveyed, and as anticipated were most abundant in disturbed habitats such as roads, tracks, waterways, agricultural areas and near human habitation. The checklist comprised 21 species (Appendix 18), including most of the dominant and moderate invaders listed by Meyer (2000).

The distribution of some of the most common invasive species along the altitudinal gradient on Mt Sorolevu is shown in Figure 31. A greater variety of invasive species were observed in the lowland areas nearer to human habitation and agricultural land.

The giant reed, *Arundo donax*, was very common sight, not only along the many streams and rivulets on the Mt Sorolevu track (Figure 32), but also along the track itself. In areas where there was still or slow-moving water, such as ponds and ditches, the presence of water hyacinth (*Eichornia crassipes*) was noted (Figure 33).

Some species, such as *Mimosa invisa*, and *Stachytarpheta urticifolia* were very common along most of the track, forming thickets or large stands of groundcover along the roadside.

Merremia peltata was one of the most highly visible invasive species and dominated, not just as a blanketing climber over large shrubs and trees, but also spreading out over the road itself (Figure 34). *Clidemia hirta*, a very common shrub species, was less noticeable at the lower altitudes but became more visible as *Merremia* became less dominant at higher altitudes (Figure 35).

Dissotis rotundifolia, classified as potentially invasive (Meyer, 2000), was recorded in great abundance along most of the track, even at higher altitudes. Since it was flowering, the African tulip was visible at long distances, and was observed not just near the roadside but also penetrating into forest. The individual recorded at the highest altitude was at 500 m, over 5 km away from the village of Navakuro (Figure 36).

In areas of intact forest (such as at the Waisali reserve), the only invasive species generally observed were *Clidemia hirta* and the climber *Mikania micrantha*.

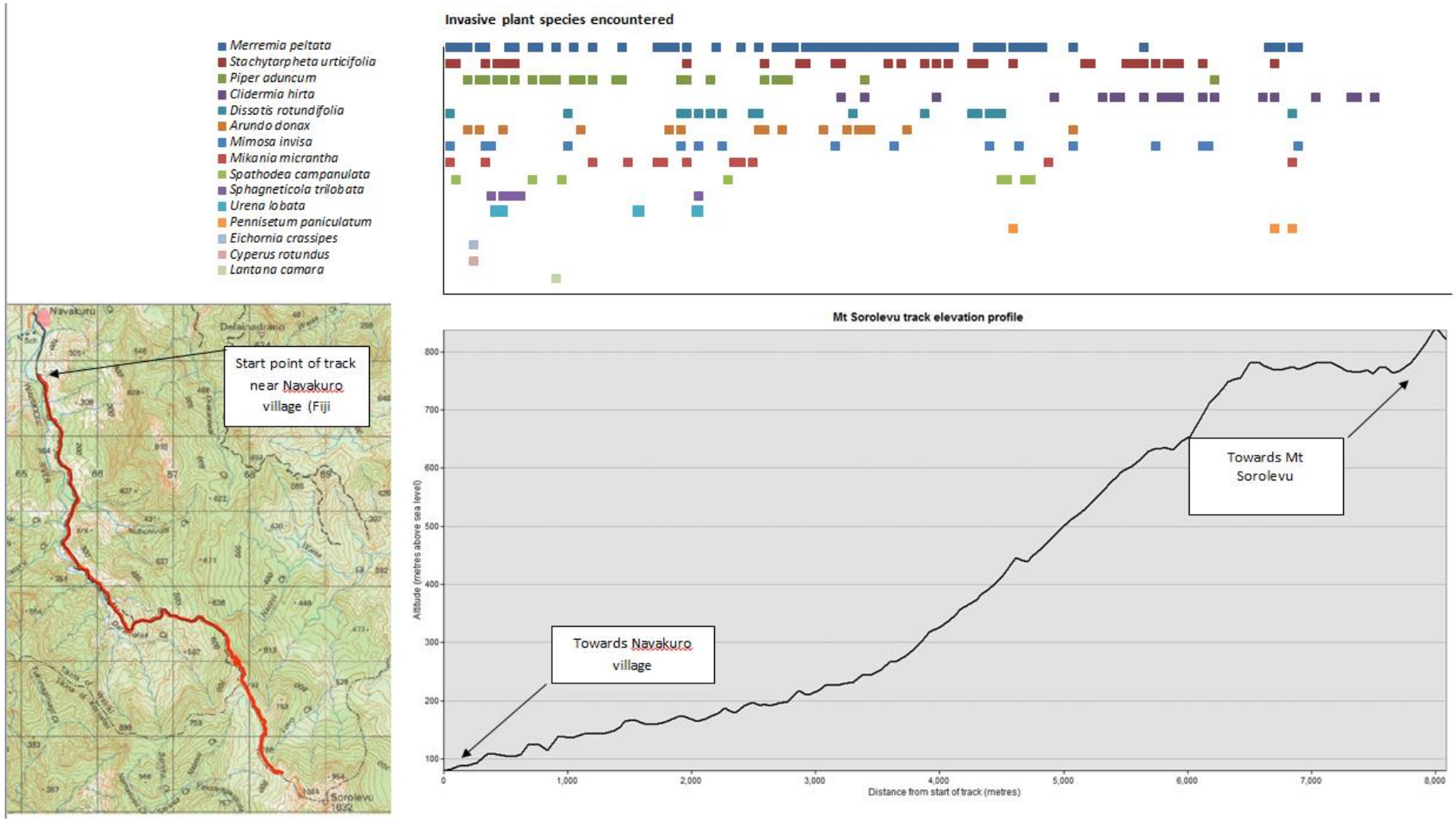

Figure 31: Elevation profile of Mt Sorolevu and invasive plant species recorded

Figure 32: The giant reed, *Arundo donax*, was common along waterways as well as the side of the track.

Figure 33: Water hyacinth, *Eichornia crassipes*, was found in areas of still or slow-moving water.

Figure 34: Low altitude track dominated by *Merremia peltata*

Figure 35:Higher altitude track, showing no encroachment of *Merremia peltata*

Figure 36: An African tulip tree, *Spathodea campanulata*, growing over 100m from the road at an elevation of 750m

Figure 37: Tooth marks made by rats indicated by the arrow on this pandanus fruit, located at 900m elevation near the summit of Mt Sorolevu

The checklist of invasive animal species is given in Appendix 19, and comprises birds, mammals and an amphibian. The mammalian invasives are generally domesticated animals, such as pigs, cats and dogs which have become feral, as well as several species of invasive rodents (mice, rats and mongooses). Evidence of the presence of rats was found near the summit of Mt Sorolevu, at almost 900 m elevation in cloud forest. Here, pandanus fruits were found with tooth markings characteristic of rats (Figure 37).

The invasive bird species, the bulbul and the mynah, were restricted to the low-lying areas near human habitation and agricultural land and pastures.

7.4 Discussion

As expected, the areas surveyed in Vanua Levu were home to a wide variety of the invasive plant and animal species known to be present in Fiji. Whilst for the most part these species were restricted to the disturbed areas associated with roads, plantations, tracks and settlements, there was evidence of incursion into primary forest areas by some species, in particular *Clidemia hirta*, a highly successful understory shrub; and rats, which appear to have penetrated to altitudes of almost 900 m, 8 km away from the nearest human habitation.

The impacts of invasive species can be both direct and indirect, and some effects are immediate whereas others are more long-term. Rodents such as mongooses and rats, for example can have immediate and devastating effects on native birdlife by killing adults and juveniles and feeding on eggs. They can also have a long-term effect on the regenerative capacity of certain plant species by feeding on their seeds or fruit. Invasive plant species can impact on the native flora generally through the process of outcompeting them, since invasive plants tend to have very rapid growth, high dispersal capabilities and high reproductive success.

Any proposal for a protected area will have to take into account how to protect the biodiversity in the area from the negative impacts of invasive species. Invasive

species are an inevitable threat to protected areas not just from surrounding or marginal localities, but also from disturbed habitats within the protected area itself.

Invasive species control and/or monitoring should be a component of any proposal for the designation and long-term management of a proposed protected area in Vanua Levu. Without management to prevent and address invasive alien species, protected area values, including ecosystem services and biodiversity, will inevitably be eroded (Poorter *et al.*, 2007).

8 Archaeological Survey

Elia Nakoro and Sakiusa Kataiwai

8.1 Summary

The Greater Delaikoro Area is rich in historical and cultural material remains many of which are being documented here for the first time. According to elders in the villages surrounding the Delaikoro mountain range, historical remains are believed to be scattered throughout the entire study zone, forming a widespread distribution of elaborate hilltop and lowland settlement and fortifications. Regrettably, many of these sites were not visited during this survey period due to the poor choice of field guides.

Nevertheless, several sites were encountered and recorded both within and outside the study boundary. Some of these were sites that have been previously recorded and mapped by the Fiji Museum.

Generally, the archaeological finds during this survey have considerable cultural value to the local community as well as at national level. The significance of these sites can be determined and derived by deconstructing the value of the individual sites into the following components: aesthetic, symbolic, social, historic, authenticity and spiritual values.

8.2 Introduction

Archaeological investigation on Vanua Levu is somewhat limited due to its location and size. The centralised cultural and archaeological activities on Viti Levu further contribute to the poor documentation and survey of cultural sites on Vanua Levu. In his paper, the late Aubrey Parke[2] generally stated that Vanua Levu regrettably lacks evidence of remains. The gap in the information is probably due to the evidence

[2] Parke was a Colonial District Officer in the early 60's and also an archaeologist by profession.

simply not being recorded. He also stated that cultural sites found on Vanua Levu may be different from those found on Viti Levu (Parke, 1961; Parke, 1970).

Between 1960 and 1980, G. Parker, L. Thompson, K. Moce and A. Parke established the first records in the documentation of archaeological surveys for Vanua Levu. This provided the collection of 151 sites[3] which are recorded in the Fiji Museum's national register of cultural sites. However, a considerable amount of work which was contributed by Parke, Frost and Cabaniuk is not captured in the national register, one of the loopholes in the current system. Studies have also been undertaken recently by Professor David Burley of Simon Fraser University, Canada who focused mainly along the coasts in identifying Lapita sites or sites of initial island habitation. It should be noted that Burley, in collaboration with the Fiji Museum, was able to confirm an early Lapita occupation on Vorovoro Island dating to as early as 3000 years before present (BP) and no later than 2900 BP (Burley, 2012).

This report aims to document the collaborative biodiversity and archaeological survey carried out by the Fiji Museum and the University of the South Pacific in 2013. The archaeological component of the survey focused on outlining the cultural connection the land has to the people, with an emphasis on identifying and describing cultural sites of significance for which there is tangible evidence. The study focused on those people living along the foot of the mountain range that divides the windward province of Cakaudrove from the leeward province of Macuata. Some of the villages visited, e.g. Nasealevu, Sueni and Lomaloma, possess a rich historical background with ancestral ties and links connected to the forest within the study area in which their generational history and cultural livelihood have been strongly maintained. The forest, mountains and other natural features along the range plays a primary role in the cultural identity and history of the people

[3] 107 sites in Macuata Province, 40 sites in Cakaudrove Province and 40 sites in Bua Province.

of the two provinces, as their forefathers inhabited the area, utilizing its resources and settling extensively throughout the land.

8.3 Methodology

With the assistance of village guides and through collaboration of oral history and correspondence, areas of interest were identified and located. Location data of each site was captured utilizing a GPS unit (Garmin GPSmap 76CSx). Site notation was carried out and photographs taken with a Fujifilm Finepix AX.

8.4 Results

During the field survey, a total of eleven sites were documented. Their locations are shown in Table 6 and a brief description of each site is given below.

Table 6: Summary of archaeological sites documented

Site Name/ID	Site type	Site evidence	Vegetation zone	Coordinates		Date visited
				Lat.	Long.	
Nukubolu Q23-00001	ring ditch fortification	fortification ditches, causeways and house mounds	lowland	-16.656132	179.3589	Oct 1994[4]
Muaicivicivi Q23-00002	hill fortification	house mounds	lowland	-16.653511	179.3578	Oct 1994
Vanua ni yadra Q23-00004	look out	fortification ditch	lowland	-16.657613	179.3601	Oct 1994
Bulubulu i Lele Q23-00005	burial	burial mounds	lowland	-16.655773	179.3593	Oct 1994
Nabuna Q23-00006	*koro makawa*	mound stones	lowland	-16.596363	179.364	27/09/2013
Unknown Q23-00007	house mound	house mound	lowland	-16.636638	179.3713	30/09/2013
Unknown Q23-00008	house mound	house mound	lowland	-16.638145	179.37	30/09/2013
Unknown Q23-00009	house mound	house mound	lowland	-16.624576	179.2088	01/10/2013
Unknown Q23-000010	house mound	house mound	lowland	-16.626521	179.2068	01/10/2013
Qaraivini Q23-000011	cave	skeletal remains	lowland	-16.562849	179.2273	01/10/2013
Unknown Q23-000010	*koro makawa*	House mounds	lowland	-16.596424	179.36401	27/09/2013

[4] These sites were surveyed by Christine Burke, Hiroshi Kiguchi and Sepeti Matararaba in 1994

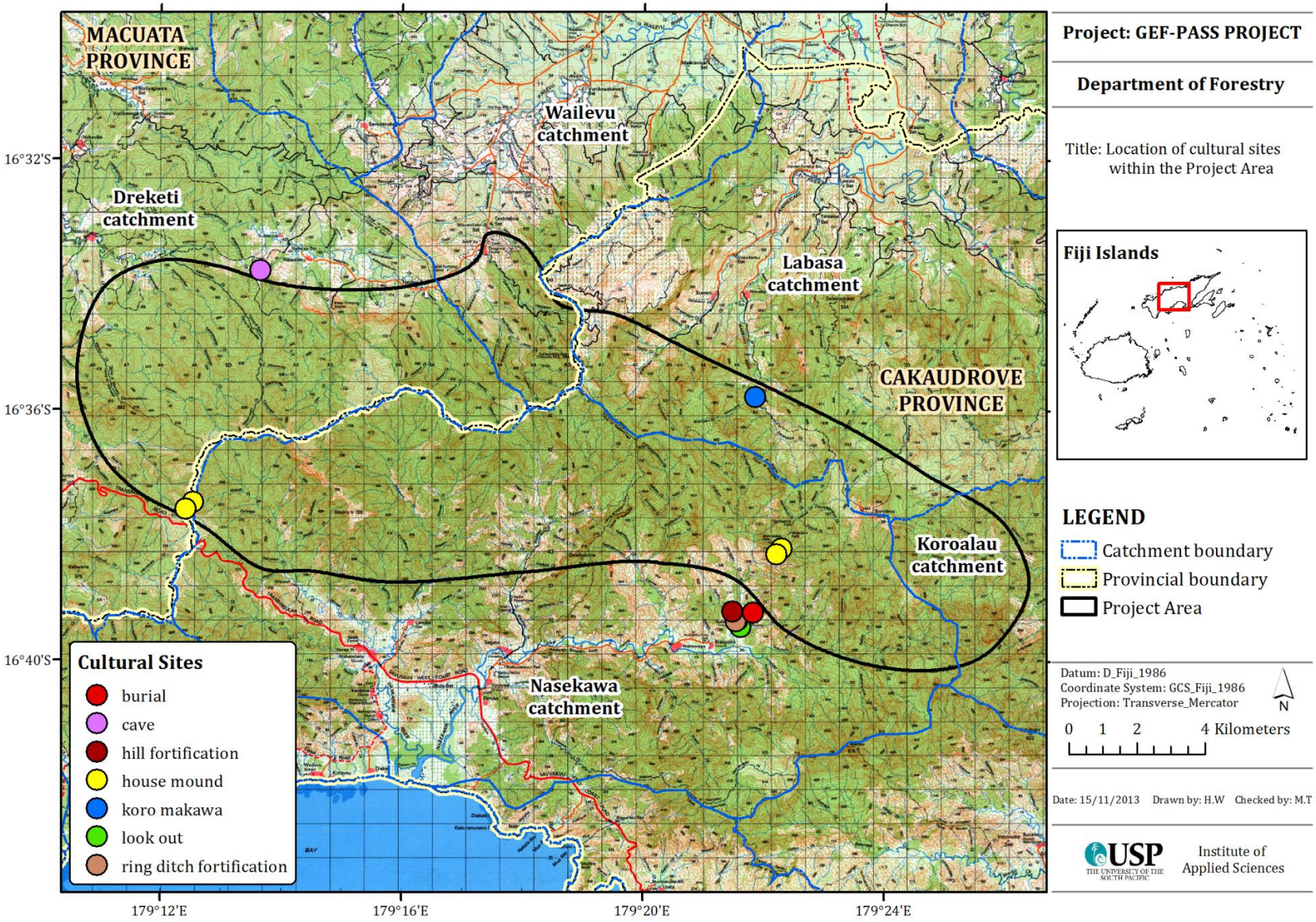

Figure 38: Cultural sites location in the Greater Delaikoro Area visited during the survey.

8.4.1 Site descriptions

Nukubolu/Q23-00001

Defined as a ring ditch fortification, this site (Figure 39) incorporates various cultural features of house mounds, burials and causeways that are associated to the cultural site.

Figure 39: The overgrown site of Nukubolu

Altogether, a total of five house mounds with stone alignment were identified including two burials (Bulubulu i Lele/Q23-00005) situated on raised land to the northeast.

Figure 40: Signboard placed at the home and also the resting place of the deity god Lele

The site is traditionally linked to the district of Koroalau, as their cultural fortress during the era of tribal warfare and cannibalism in Fiji. The site displays a partial preserved state as the area is currently being utilized for agricultural purposes with crop farming and cattle breeding occurring in the area and contributing severely to the site disturbance. The ring ditch fortification extends along a diameter of approximately 60 m with the ditch feature only occurring along the north and partially covering the west with both identified causeways included along this system. The southern section of the site is unclear due to severe damage by flooding and agricultural activities. Thus, an accurate description of the ring ditch environment could not be made.

Apart from the ring ditch site, the team also inspected a hill situated 195 m to the south of the site (Figure 41), which according to the local communities was a lookout point or *vanua ni yadra* (Q23-00004). The hill site contains a ditch feature that dissects the west portion of the hill site including other features of stone alignments, however, much of this alignment was not visible due to overgrown vegetation.

Figure 41: View of Nukubolu fortified site from the lookout vantage point

The sites of Nukubolu and Muaicivicivi have been the subject of previous surveys carried out by the Fiji Museum. The Archaeology Department of the Fiji Museum had undertaken detailed inspection and mapping of both sites over a period of three phases between the 11th October, 1994 and 20th October, 1995. The basis of this assessment was for the development of an eco-tourism project proposed by the Nukubolu Eco-Tourism Board from the village of Biaugunu, however, as a result of the recent monitoring inspection of the Nukubolu site, additional disturbances was identified and this is a major concern. The protection of what remains not only of this site but other identified sites within the project area is a key component integrated within the relevant policy that would greatly assist in the awareness and importance conveyed to local communities on the cultural significance and development contributed through such sites.

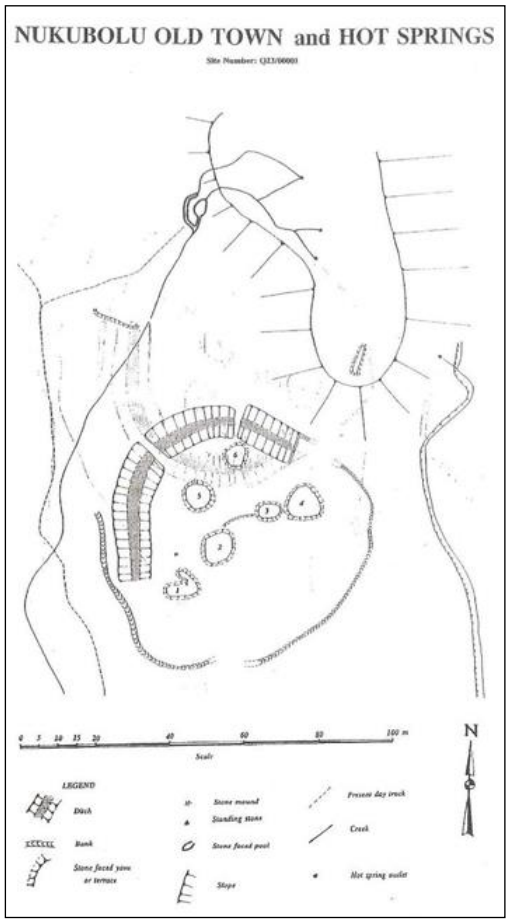

Figure 42: A map of the Nukubolu Ring-ditch fortification as recorded in October, 1994 (Burke and Matararaba, 1994).

Muaicivicivi/Q23-00002

This site displays a significant number of cultural features that are well preserved, distributed extensively. The site area covers approximately 95 m x 75 m, according to the layout of cultural features. The area is flanked by two creeks – the Davatu creek flowing along the northwest while Cabeu creek is situated along the southeast. During inspection, the team was not able to sufficiently identify the actual layout of the site including additional cultural features as the site area is densely vegetated, dominant of *Urochloa mutica* (Paragrass) and *Piper aduncum*, locally known as yaqoyaqona.

Figure 43: Field guide clearing a highly raised and intact house mound with stone alignment at Muaicivicivi cultural site

Altogether, a total of six house mounds were identified, displaying stone alignment with a particular mound of significance situated along the bank of the Davatu creek, to the east of the site area, displaying a stepped structure reaching a height of 2 m and dimensions of 7 m x 6.5 m. According to local guides, additional mounds are

situated around the area, however, due to the thick vegetation, it could not be viewed during inspection.

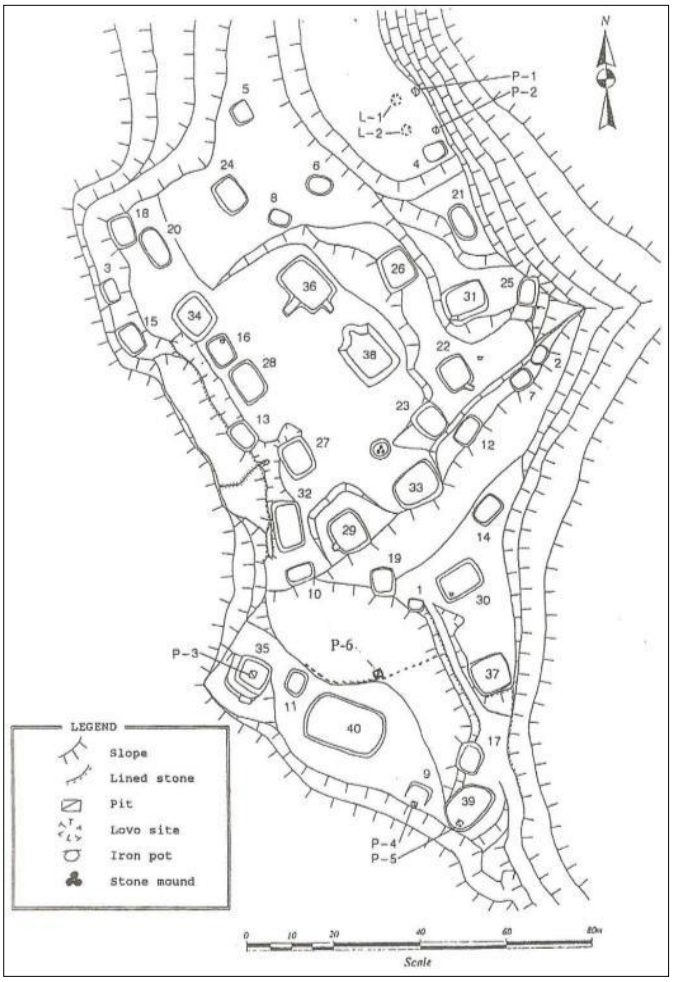

Figure 44: Detailed mapping of the Muaicivicivi site as recorded in June, 1995 (Burke *et al.*, 1995)

Nabuna/Q23-00006

Cultural features could not be ascertained as the site area has undergone severe disturbances through agricultural activities (Figure 45). The site is primarily utilized by local communities for subsistence crop farming, which has greatly affected the state of preservation of the site. These agricultural plots have permanently demolished cultural features that may have existed with only remains of mound stones that are scattered among the site surface. The cultural landscape is uncertain, however, with oral accounts associated to the site area with its significance confirmed from local guides, the site has been noted.

Figure 45: Agricultural activities that have permanently obliterated Nabuna old village

Unknown/Q23-00007

Defined by a single house mound, this site may represent a temporary settlement as no other associated features were evident in the area. This mound is rectangular, 6 m x 5m and is gradually eroding as the mound is situated along a declining ridgeline which is vulnerable to erosion processes, as evident during inspection.

Unknown/Q23-00008

The site consists of two earthen-raised mounds, both displaying rectangular structure. This site is a typical settlement, situated on flatland along the ridgeline. The site area covers approximately 30 m with additional cultural features situated within the site zone, however, due to various disturbance factors, these possible features have been permanently destroyed.

Unknown/Q23-00009

The site is located along a ridgeline within the Waisali study area. The area is significant as rock boulders are strewn over the site surface, possibly belonging to rock formations that were once constructed in the area.

Through detailed inspection, a raised mound was discovered about 50 meters to the east of the initial area of significance, this mound measured at 8 m x 7 m, displaying a rectangular-structure and raised at 150 cm. through this finding, it would be logical that the rock boulders were an associated feature to the identified mound, possibly stonewall barricades which had been altered through years of disturbance factors, primarily from natural processes. The vegetation in the area was dominated by vukavuka.

Unknown/Q23-000010

Defined by three house mounds that have undergone disturbance, this site depicts a temporary settlement typical during the migration lifestyle of early Fiji. The mound structures are diminutive in size and have all been affected by erosion processes, as evident during inspection. Evidence of human occupation was initially derived from the anthropogenic plants predominating in the area: *Codiaeum variegatum* (sacasaca), *Amomum cevuga* (cevuga), *Freycinetia milnei* (vukavuka) and *Cordyline terminalis* (vasili).

Qaraivini/Q23-000011

The three villages at the foot of the Delaikoro mountain ranges are Vatuwa, Nasealevu and Viriqilai. These remote villages are 30 km from Labasa town center and, according to some of the village men, there are numerous other cultural sites of old villages and fortifications that exist and are intact in the mountains.

Qaraivini is a small cave (Figure 46) located west-southwest of Nasealevu village and was accessed through Viriqilai village. This is a man-made cave, constructed by people who sealed off the bottom of a rock outcrop with boulders to bury their dead.

Several meters directly below the cave mouth is a remnant of what appears to be a ring ditch fortified settlement. Due to time constraints, it was impossible to investigate the cultural feature. However, the cave was thoroughly examined. In size, the cave can fit two adults to lying horizontally on the floor.

The content of the cave is astonishing as a total of 57 skulls and three incomplete craniums were tallied, piled and some were buried under the rest of the skeletal remains. Outside the cave mouth which was raised to about one and a half meters from the ground, several skulls were aligned as if to decorate the phase of the outcrop and the boulders. In close examination, it is possible that 34 were males, 23 females while three were unknown. Amongst the 60, less than ten of these were children judging by the size of the skulls.

Figure 46: Field guides from Nasealevu posing in front of the small cave entrance

Outside the cave, four shaped poles close to 2 m in length stand below the entrance. The poles according to Sepeti Matararaba, a senior archaeologist at the Fiji Museum, could have been used to close the cave entrance by levering the huge boulders to seal off and hide the bodies.

According to the village men and women, the dead are the victims of the measles epidemic that wiped out almost a third of Fiji's total population in 1875. It was believed that the ship that brought Ratu Seru Cakobau from Australia introduced the deadly disease.

Unknown/Q23-000012

This site is situated beside the main access road in the area. It has been disturbed through various forms of agricultural activities also considering the resulting effect of the construction of the access road in the area. The site is predominantly overgrown with paragrass and *Ageratum conyzoides*, locally known as botebotekoro. The site has been utilized by local communities for agricultural purposes with taro plots and some banana plants.

Upon detailed inspection, the team managed to identify two house mounds that displayed scattered stones that were once embedded along the mound walls. The cultural landscape is evident with the identified mound forms and other possible features, however, these could not be determined due to the deficient state of the site.

8.4.2 Monitoring sites

The increasingly intensive use and modification of the landscape resulting from modern demands for efficient infrastructure and land use (agricultural production, mining, energy sources, logging, telecommunications etc.) exerts growing pressure on cultural heritage in the landscape.

A summary of the threats and disturbances affecting the sites is provided in Table 7.

Table 7: Site disturbance factors and threats within Delaikoro study area

Type of disturbance/threat	Disturbance/threat description	Sites affected
Nature	These threats occur naturally and cause irreversible damage - tropical cyclones, earthquakes, heavy rain and erosion processes contribute to changing and shaping the natural and cultural landscape.	All the sites documented the effects of natural events on the remains of cultural heritage site features. The dominant natural element affecting the structures is heavy rain which leads to the erosion of the edges of the house mounds, infilling of fortification ditches and causeways. Heavy rain also results in fluvial formation of rills and gullies thus displacing stone alignment and washing away the material remains.
Human	These are threats that are caused or related to human inhabitance & activities in and around the area of study.	About 95% of the sites identified contained human trails, for travelling between provinces or for hunting and gathering.
Animal	These are threats that are caused or related to animals-grazing, breeding and inhabitation activities specifically wild pigs	Pig hooves and snout trails covered about 60-70% of the sites surveyed. Dog trails were also encountered but pose little threat to the sites.

The eleven culturally significant sites encountered and documented during this survey are widely distributed across the study area, five of which are within the study area while four are located outside the study boundary. Since the Delaikoro study boundary is vast and accessibility is hindered by rugged terrain, the Archaeology team recommends that a thorough investigation be carried out by utilising field guides. These guides, who frequent the study area as pig hunters and food gatherers, could identify sites that are outstanding and noteworthy for preservation and monitoring. A summary of the framework within which this monitoring could occur is presented in Table 8.

Sites identified can be used for comparison of threats that affect cultural heritage sites. The degradation of the sites will be examined every two years by using traditional methods of site visitation and capturing still images of the area during the period of the FAO program. Data from other teams such as aerial/satellite images of the forest cover can also be a tool used for the process depending on data availability.

Table 8: Indicators and monitoring plan for cultural sites

Theme	Indicators	Monitoring Tool	Reporting
Cultural heritage sites	State of the sites	Assessing the current state of the sites and monitor the changes through time	Assessment report every 2 years
	Threats to the sites	Identifying the threats that affect the state of the sites	
	Access to the sites	Choosing two sites for the assessment of the above variables with access to the site as comparison	
	Cultural valuation of the sites	The two sites differ in cultural value	

Remote sensing even though costly, could also be a useful tool to map out the changes in the monitoring site by using laser-based sensors and radar in particular Synthetic Aperture Radar to see the ground or surface changes or identify subsurface remains.

8.5 Conclusion

According to several elders from the villages of Sueni, Nasealevu and Vunidogoloa, the land belonging to the different mataqalis included in the Delaikoro study area is rich in historical cultural material remains that have never been documented. The historical remains are scattered all throughout the study area, most of which are symbolic and associated with the old religious and superstitious beliefs of early hill tribes of Vanua Levu.

The study of the cultural footprints within the Delaikoro study area is vital in understanding the patterns and motivational factors related to inland migration: why the early iTaukei people chose to live in such remoteness and rugged terrain, socio-cultural relations and their responses to altering natural and climatic conditions.

Generally, the archaeological finds during this survey have considerable cultural value to the local community and at national level. The significance of these sites can be determined and derived by deconstructing the value of the individual sites into the following components; aesthetic, symbolic, social, historic, authenticity and spiritual values. All the sites identified include one of these values while some may incorporate all, however an absent values does not lessen the significance of a site as it holds the ancestral history of the hill tribes of Fiji.

8.6 Conservation recommendations

Fiji has an ancient, complex and unique cultural heritage preserved in its archaeological sites. Unfortunately much of this record has been carelessly destroyed through human activity. The large scale of current and planned land development activity in Fiji poses a great threat to remaining sites. Preservation activities are therefore crucial to saving Fiji's archaeological heritage. Fiji's archaeological environment represents a valuable and irreplaceable record of the nation's cultural and social development. For this reason alone it is important that these sites be well maintained. In addition to its historical, cultural and archaeological merits the historic heritage also forms a readily available resource of considerable amenity, education, scientific, recreational and tourism value to the people of Fiji and visitors alike.

The archaeological assessment revealed valuable information pertaining to the different mataqali landowners within the Delaikoro mountain range and neighbouring communities historically linked to the land. Various findings of

cultural assets were able to ascertain that these ancestral sites conveyed immeasurable knowledge and understanding of the history pertaining to traditional and cultural developments, linked closely to the identity of its people. It depicts the movement and settlement patterns of their ancestors and the forms of survival which defined their everyday lives.

Such history must be preserved whether tangible or intangible, however, various threats and disturbances of these cultural sites have, to an extent, altered important aspects of material history of the vanua of Cakaudrove and Macuata. All the sites identified are protected in Fiji under the Preservation of Objects of Archaeological and Palaeontological Interest Act (1940).

Our recommendations are:

- that proper documentation of the assessment and oral history be undertaken to avoid the loss of traditional knowledge and history of the study area.
- the Fiji Museum Archaeology department is included in any future surveys to allow for completion of assessments of areas that have been overlooked.
- that pig hunters and food gatherers from the villages at the periphery of the study area (Nasealevu, Dogoru, Navisei, Nabuna, Lomaloma, Vunidogoloa, Korosi, etc.) be used as field guides in identifying features and places of cultural heritage significance in their respective hunting grounds.
- That a presentation of significant findings be done to raise awareness in the region, an activity for which the Fiji Museum is available.

9 Socioeconomic Baseline Study

Patrick Fong

9.1 Introduction

The Greater Delaikoro Area has been identified as an important terrestrial biodiversity area due to its pristine nature and for its roles in supporting ecosystem services. Located in the interior of Vanua Levu, the Greater Delaikoro Area consists of three high densely forested peaks: Nasorolevu, Waisali and Delaikoro. Mt Delaikoro is a key area in terms of development, as it is the location of the communication towers that receive telecommunication signals from mainland Viti Levu and transmit to other parts of Vanua Levu.

The Greater Delaikoro Area supports local communities in terms of food security and economic development, and also is an important water source for the major rivers in Vanua Levu. Understanding the social, cultural, economic and livelihood importance of the Greater Delaikoro Area is important in the quest to sustainably develop and protect it. Unless policy makers align resource management policies with community livelihood needs, resource management programs are most likely to fail or be unsustainable in the long term. Community resource use patterns and seasonal trends of important activities are just some of the few examples of typical information that needs to be considered if conservation programs are going to be planned and implemented in this region.

To conserve Fiji's terrestrial biodiversity, protected areas should be managed as a coordinated system and scientific perspectives on ecological sustainability need to incorporate social science, in particular human behaviours and aspirations. This is important given that human behaviour and aspirations are generally the drivers of resource degradation and overexploitation.

In this study, information on the livelihood relevancy of the Greater Delaikoro Area is the main focus. The area has been identified as a potential protected area in Fiji's State of the Environment Report (1995) and the Fiji National Biodiversity Strategic and Action Plan draft report (1998), due mainly to its ecological and watershed significances.

The overall goal of this survey was to better understand the economic and social settings of people living around the potential protected area of the Greater Delaikoro Area and to better understand people's view and attitudes towards the proposed protection of the forest. Specific objectives were to understand:

- the economic situation of people living in the Greater Delaikoro Area,
- people's use of the forest and how much this contributes to their livelihoods,
- their attitudes towards the conservation of the forest and their ideas about what they would like to see created to protect the forest.

This information, together with that provided by the biodiversity assessment team, will provide a package for the relevant authorities in Fiji to develop a management program of the area that takes into account the linkages between natural resources and community livelihood needs.

9.2 Methods

The study used both primary and secondary data sources. It blended qualitative and quantitative methods of inquiry buttressed by participatory research techniques. A mixture of key informant, focus group and household interviews were conducted at all the study sites. All interviews were conducted in the common Fijian language (Bau dialect) by the interviewers; and the information was recorded in English.

To maintain a collaborative effort, all stakeholders in the study sites were first informed prior to any field visits. The Macuata and Cakaudrove Provincial Council Offices were informed of the research during a reconnaissance visit, and later on, the eight villages were contacted and informed. During this consultation activity,

relevant stakeholders were also consulted and some background information related to the study sites was collected. Through this exercise, the team was able to identify possible key informants and focus groups to be interviewed.

9.2.1 The study sites

The survey was carried out in six villages in Cakaudrove Province (Nakawaga, Biaugunu, Nabalebale, Levuka, Suweni and Navakuru), and two in Macuata Province (Dogoru and Nasealevu). These sites are all within the Greater Delaikoro Area and were sampled to provide the general socioeconomic setting of communities within this region.

9.2.2 Focus groups and key informants

A team consisting of seven members visited the eight study sites during the period of 25 September - 2 October, 2013. In each village, interviews were held with the village chief and other key personnel to explain the study and to elicit background information on the village. The key informant interviews and focus group discussion gathered qualitative data using open-ended questions which were then used to support the explanations for some findings from the statistical analysis. The intention of the focus group discussions and key informant interviews were to gain insights into:

- general perceptions of the Greater Delaikoro Area
- general perceptions on the livelihood importance of the forest
- cultural importance of the forest area
- perceptions on waste management, hygiene and sanitation
- resource governance and village social systems
- access to and use of resources and rights
- vulnerability (including maintenance of cultural and spiritual values)
- resource threats and resource management opportunities

The focus group discussions were conducted in small groups of 4-10 individuals who work together or have similar social responsibilities within the study site. Three focus group discussions from each village were undertaken: with the village elders, the women's group and the youth group. The key informants interviewed in all the study sites consisted of a range of people including local chiefs, village headmen, youth leaders, women's group leaders and village elders.

The focus group discussions and key informant interviews were followed up by interviews with 20 different households in the village. In villages with less than 20 household all households were interviewed. A household was defined as all people sharing the same kitchen and who work together to "put food on the same table" through economic activities. The village headman helped the researchers select the 20 households in each village. As a general guide the survey aimed to interview five relatively wealthy households, ten of medium wealth and five relatively poor households. Interviews took on average two hours to complete.

9.2.3 Questionnaire survey

Quantitative data were collected in this interview using a structured questionnaire (see Appendix 20). The questionnaire administered included questions about the household, its members, ages, sex, education levels and occupation, followed by questions about house structure, possessions, livestock and land under farming. These were followed by questions about their use of the forest, fuel wood collection, and water collection. Questions were then asked about what the household consumed each month and also how much they produced in their fields and the value of these products in the market. Use of forest products was similarly quantified to estimate the value of the resources collected from the forest to the annual income of the household. This was followed by questions about fishing and the income derived from that. Finally the questionnaire asked for responses to the idea of creating a protected area, and the benefits and problems that could arise.

9.2.4 Data processing and analysis

A data code sheet was developed by the team, and used to code the data uniformly for data entry purposes. The data was then entered and analyzed using MS Excel. The research team specified the most crucial questions to be analyzed and the kind of analysis needed. Some of the survey questions allowed the respondent to give more than one response. The advantage of this method of inquiry is that it allows the respondent to give all possible responses to the issue in question, with the various responses aggregated according to their frequencies.

9.2.5 Quality control

Interviewers were instructed to check questionnaire completeness and accuracy at the interview site. At the end of each day, questionnaire debriefing sessions were held between the supervisor and all interviewers, to identify any complications, and to agree on common definitions. Interviewers were asked to write down all additional qualitative information, which was analyzed by the team. This was important in capturing important data that would have otherwise been left out by the restrictive design of the research instruments.

The following section summarizes the results of the surveys: Section 9.3.1 focuses on the household structure and village infrastructure, section 9.3.2 gives results for the use of the forest by people and section 9.3.3 summarizes people's attitudes towards the creation of a protected area. The last section pools all the information together and proposes how a protected area might be created that is acceptable to most people living around this region.

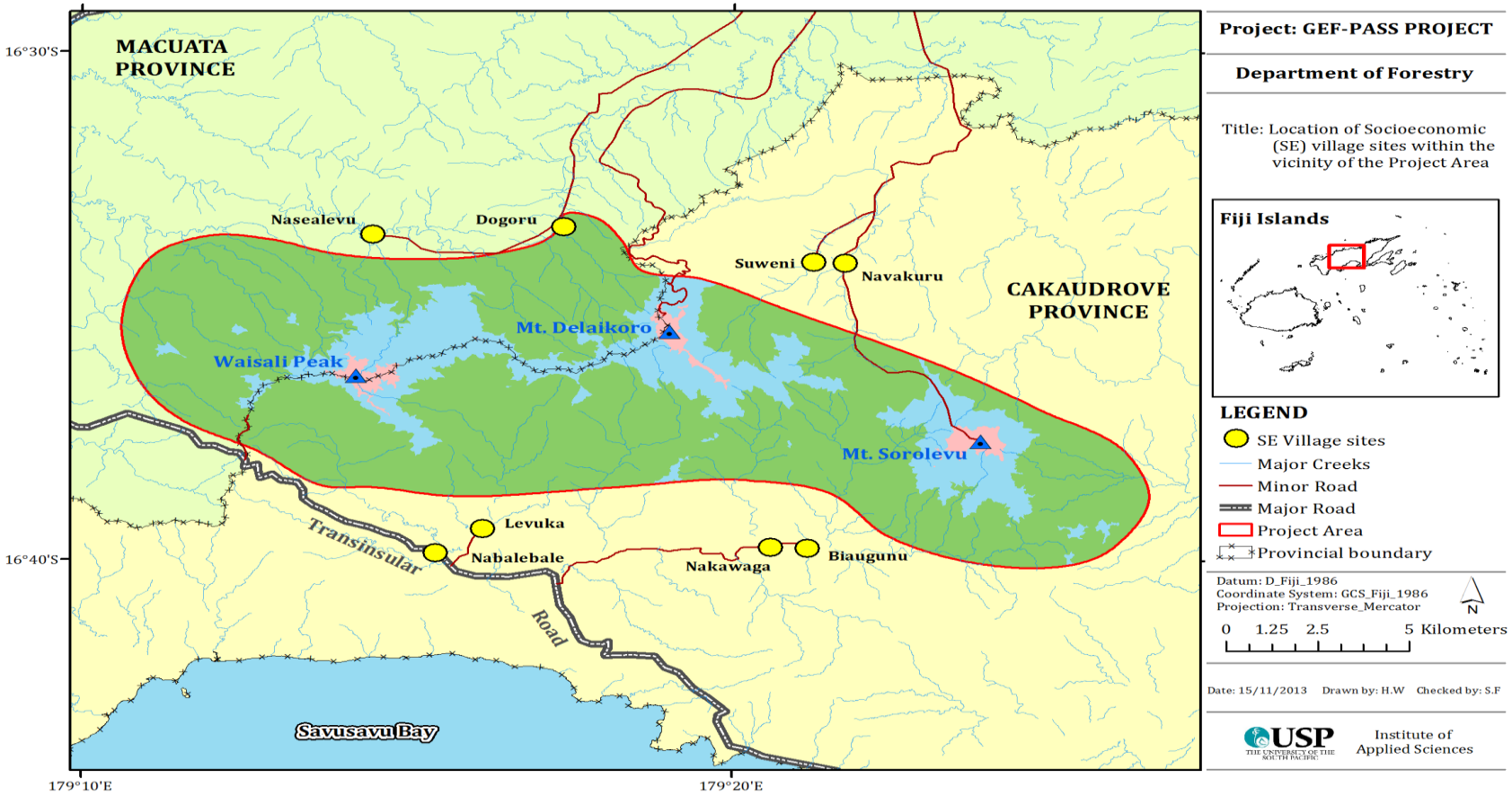

Figure 47: Map of the study sites of the socioeconomic survey

9.3 Results

9.3.1 Population, education and infrastructure

Table 9 summarizes the demographic information of the eight study sites. The total population within the eight study sites is 1164 with Nabalebale village being the most populated at 431. Located along the Savusavu-Seaqaqa highway, Nabalebale village is part of Wailevu district in Cakaudrove and has easy access to the two main urban centers in the Northern Division, Labasa and Savusavu. Nasealevu village has the lowest population of 84. The average number of people per village is 146. The total number of households within the eight study sites is 239, with the highest in Nabalebale village (55) and lowest in Nasealevu (17). The average number of households per village is 30.

Table 9: Summary of demographic information of the study sites

Village name	Number of households	Total population	Age of oldest inhabitant	Average size of a household
Dogoru	27	165	85	6
Navakuru	29	120	78	4
Suweni	37	158	74	4
Nasealevu	17	84	54	5
Biaugunu	27	131	75	5
Nakawaga	25	127	78	5
Levuka	22	95	67	4
Nabalebale	55	284	89	5
Total (all study sites)	239	1164	89	5

The overall average number of people in a household in the study area is five, with all villages having an average of between four and six people per household. This shows that the majority of the households are large, implying a high demand for food and other household needs, which in turn implies increasing pressure on forest resources to satisfy basic needs. For households already involved in forest

utilization, this may translate into further forest exploitation. The fact that cultivation is the major economic and social activity for the majority of the communities adjacent to forested areas is confirmation that pressure on the natural resource base is high.

The age-sex population structure of the study area (Figure 48), shows a predominantly young population, with the largest age groups being 5-9 and 10-14 years old. The lowest age category (0-4 years old) is smaller than those immediately above it, which implies a decline in birth rate in the eight villages in recent years. The pyramid also clearly shows that women in the eight villages live longer than men. Women are however fewer in number, comprising only 46% of the sampled population. The median age of the sampled population is 25, closely matching the national average of 24.6 years.

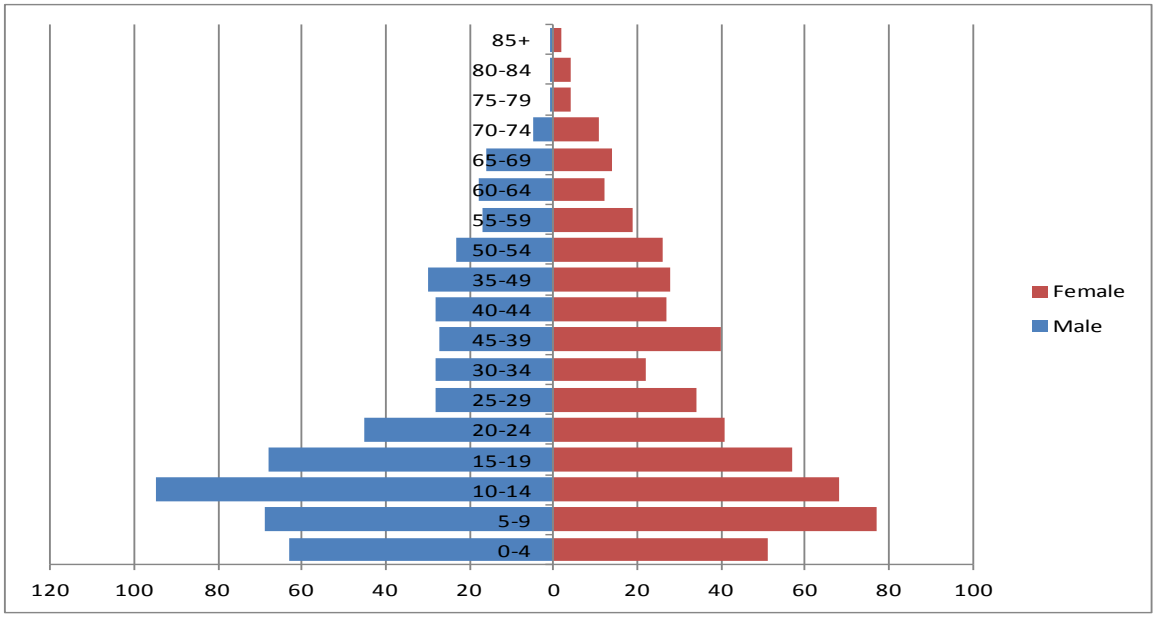

Figure 48: Population breakdown by gender and age group

Almost half (48%) of household heads were educated up to primary school level. About 41% were educated above secondary level while only 9% had no formal education at all. Around 4% had attained some tertiary education. Similarly, the respondents were mainly primary level-educated people (50%), 42% had secondary education and above while only around 8% had no formal education at all. Formal

education in Fiji usually begins at the age of five (kindergarten or pre-school). 10% of the population fall below this age group. The remaining 90% of the population are either still undertaking or have obtained primary education (38%), still undertaking or have obtained secondary education (23%), still undertaking or have obtained tertiary education (10%), or have never had any education (9%).

Across the eight study sites, the average year of education is 8.3 years. The overall educational attainment of household members in the sites is high in comparison to the national average and this can be largely attributed to the easy accessibility of the schools, as well as being close to the Northern Division education offices so that school management bodies more easily access infrastructural development assistance for the improvement of school facilities.

In terms of educational infrastructure, each village has access to a nearby primary school (Table 10) which is either owned by the village or by the district that the village is a part of. Suweni, Navakuru and Dogoru villages have access to a wider range of primary schools within the greater Labasa area and also have regular public transport services to transport students to and from these schools. The schools in the other five villages are all accessible by foot. The average distance from the village to the primary school for these villages is 2.8 km, with Nasealevu village to Vudibasoga Catholic School being the furthest distance that children travel to attend primary school (3.6 km).

Table 10: Community primary school information

Village name	Primary School	Level	Distance from village (km)
Dogoru	Various schools within wider Labasa area	Class 8	varies depending on school
Suweni	Wairiki District School	Class 8	1.1
Navakuru	Wairiki District School	Class 8	1.6
Nasealevu	Vudibasoga Catholic School	Class 8	3.6
Levuka	Nabalebale Primary School	Class 8	1.8

Nabalebale	Nabalebale Primary School	Class 8	next to village boundary
Biaugunu	Nukubolu Primary School	Class 8	next to village boundary
Nakawaga	Nukubolu Primary School	Class 8	1.3

Most (44%) of the houses in the eight study sites have houses with wooden walls, while 38% and 18% have corrugated iron walls or brick/cement walls, respectively (). All the houses in the eight study sites have corrugated iron roofs.

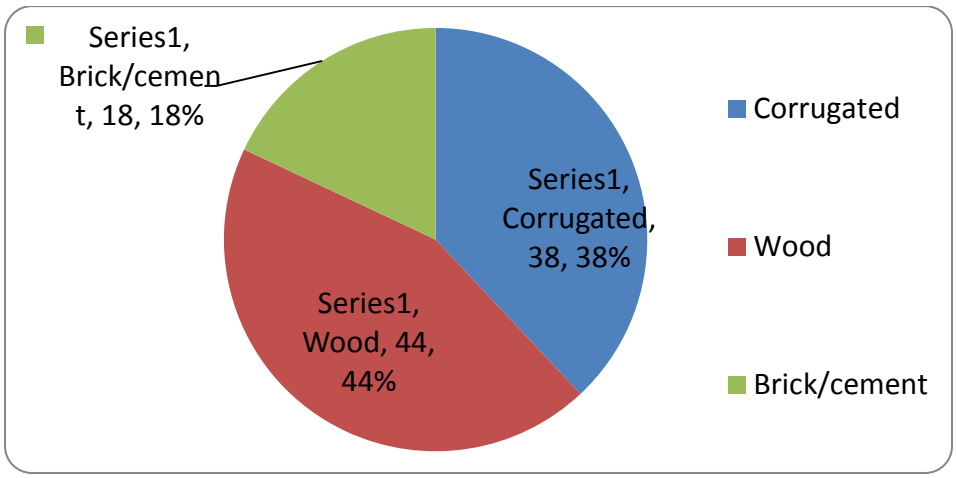

Figure 49: House wall materials of households surveyed

Half of all households have a flush toilet, while 38% have a water seal toilet. A small proportion of the households have pit toilet (5%), while the remaining 7% stated that they do not have a proper toilet facility (Figure 50).

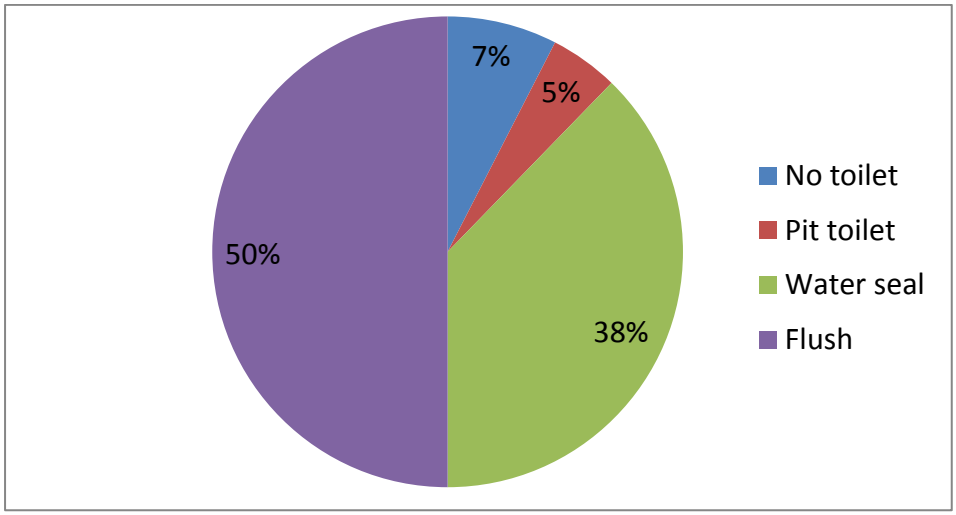

Figure 50: Toilet type in households surveyed

Table 11 summarizes communally owned infrastructure present in the villages surveyed, as well as the importance of these key village buildings as mentioned by the respondents.

Table 11: Village infrastructure

Infrastructure	Purpose according to respondents	Village
Village hall	• Place for hosting village events such as wedding,, traditional ceremonies and other key occasions • Village Council meeting place • Traditional Council meetings such as Bose Vanua are also conducted in village halls • For village social gathering such as kava session in the evening after completion of a communal task or at times for casual social gatherings. • A key physical asset in promoting social cohesion within a community • In some of the villages, a section of the village hall is usually closed off for storage of key	All eight villages
Village dispensary	• This facility is important of the storage of medical supplies • The village nurse perform basic medical procedures such as treating the common skin illness, cleaning and dressing wounds, supply basic medicine such as paracetamol tablets. • The facility usually has a bed whereby a patient can rest while the full medical assistance in terms of ambulance evacuation arrives.	Nabalebale, Nakawaga, Biaugunu, Suweni, Dogoru
Church	• For religious gathering and venue for meetings of the various religious institutions such as the Christian Youth Group and monthly meetings • Place where the blessing of wedding takes place • Also, the structure itself is a physical asset in maintaining communal cohesion	All eight villages
Pastor's house	• Where the village religious leader resides • The house is constructed by the village that host the religious leader	Suweni, Nabalebale, Nakawaga

Five of the villages (Dogoru, Biaugunu, Nawaqaga, Levuka, Nabalebale) are connected to the main FEA supply. Within these villages all households are now connected to the main supply. Prior to this connection being made, these villages relied on a village generator or kerosene lantern for light.

The other three villages (Nasealevu, Navakuru and Suweni) each own and rely on a communal village generator and all households are connected to this generator. The village generators are run normally between the hours of 7 pm and 10 pm. Each household makes a contribution to the central fund for purchasing fuel and maintenance of the generator; typically this contribution is in the region of FJD5-15 per month. The operation and maintenance of the generator is the responsibility of the village development committee. It is common for village generators to be inoperative for extended periods of time.

All villages have a communal water catchment which is often a concreted section of a naturally occurring creek which has at its base a small dam. Pipes run from this dam into a single centralised storage water tank or straight to the village and water is either reticulated to individual households through PVC pipes or terminates in one or more communal standpipes which are shared by multiple households. There is no form of metering system in any of the villages.

On average 74% of all households surveyed noted that their water supply sometimes runs out; either from a lack of water or insufficient water pressure necessary for it to reach their houses. During such times all households rely on the various creeks that run close to the village for their main water supply. These creeks are sourced from Greater Delaikoro Area, therefore, the area of focus is also very important in supplying water to nearby communities and natural resources.

The Water Authority of Fiji has responsibility for the installation of water infrastructure and major works. Day-to-day maintenance of the system is commonly done by community members; in each village there is typically one or more individuals skilled in basic plumbing work. Piped water is mostly used for drinking,

cooking and, to a lesser extent, washing. Frequent use is made of the rivers that run through the area for washing both clothes and for personal washing. Amongst the younger age groups the rivers also form an important recreational facility; with children frequently play around and in the rivers when not at school.

9.3.2 Household income and resource dependency

As shown in Figure 51, the main income source in the study area is from the sale of yaqona, which is the main income source for 44% of the total households. This is followed by the farming and selling of other cash crops (14% of households). The sale of vegetables, non-timber forest product such as wild pig, wild ferns and freshwater fish are also important income sources for these communities.

12% of households state that their main source of income is from formal employment in urban centers. The majority of these households are from Suweni, Navakuru, Dogoru, Nabalebale and Nakawaga villages, all of which have access to the public road as well as daily public transportation services. The other villages also have access to the public road, but not to reliable public transport.

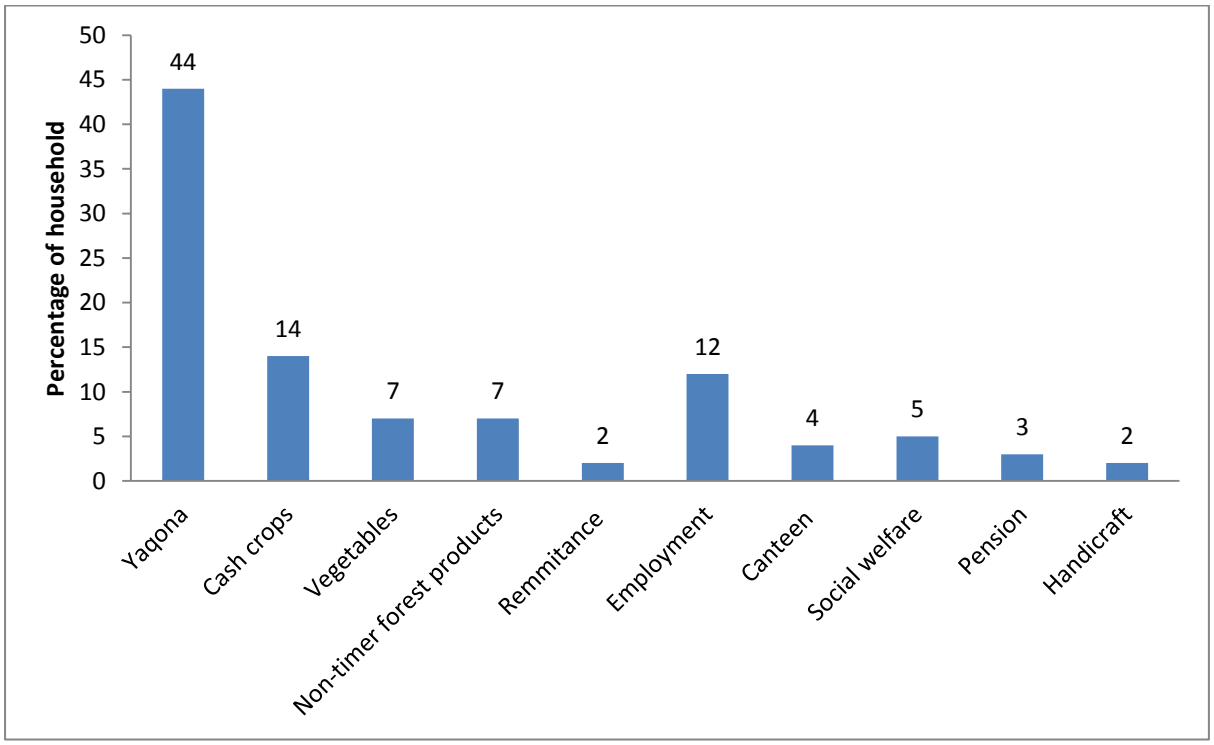

Figure 51: Main income source of households surveyed

In terms of income value, the average household monthly income is $719. The highest income as highlighted in Figure 52 is gained from yaqona at $387 followed by selling of cash crops at $156. The third highest income comes from employment at $56 followed by selling vegetables and non-timber forest products at $54 and $31, respectively.

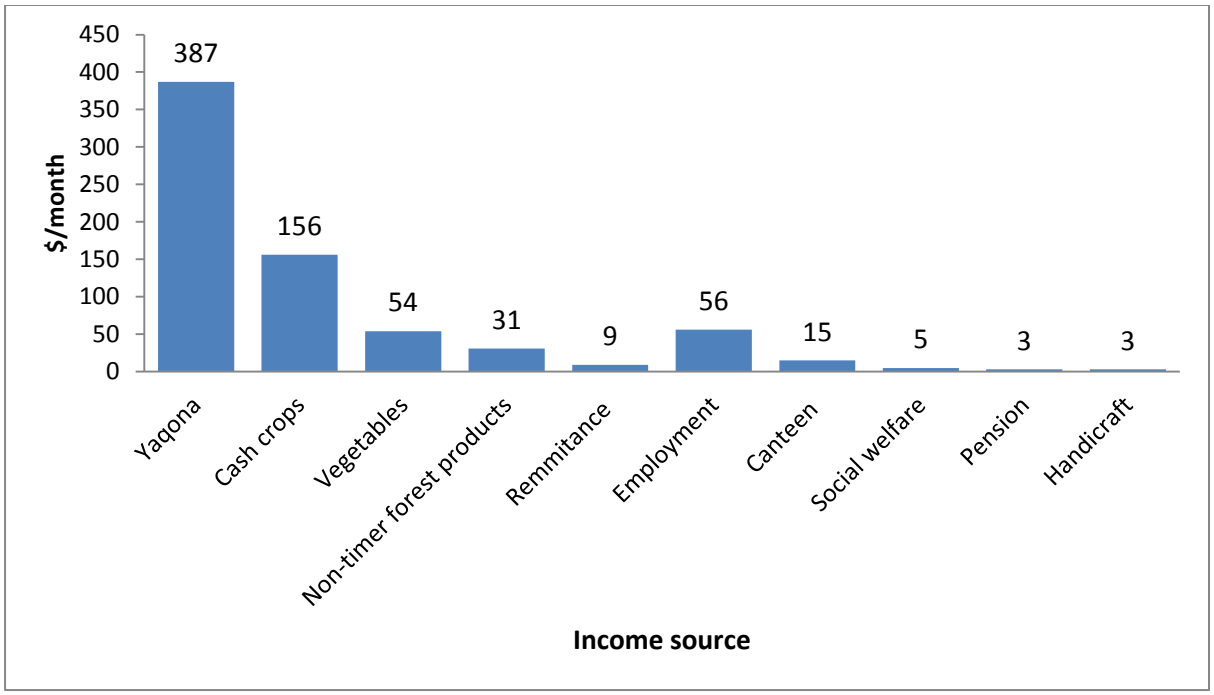

Figure 52: Average household income with income source

The focus groups were asked to list the top three resources that are not farmed but are very important for their livelihood. Fuelwood (from trees), wild pigs and freshwater resources were the three most commonly cited. The discussions also highlighted that these resources are mainly harvested within the Greater Delaikoro Area.

From this result, it can be noted that the forest and farming area within the Greater Delaikoro Area plays an important role in the economic activities and livelihood of the eight study sites. The majority of income gained is from farming and collection of non-timber forest products within the Greater Delaikoro Area. Therefore, it is clear from these summaries that the majority of the population in the study sites relies on

the natural resources within the Greater Delaikoro Area for their livelihood and everyday survival.

Crops and livestock

In addition to the economic importance of crops and livestock discussed in the previous section, crops and livestock play an important role in the daily life of eight communities. Across all villages 91% of households stated that they eat food grown by household members either at every meal (21%) or daily (70%).

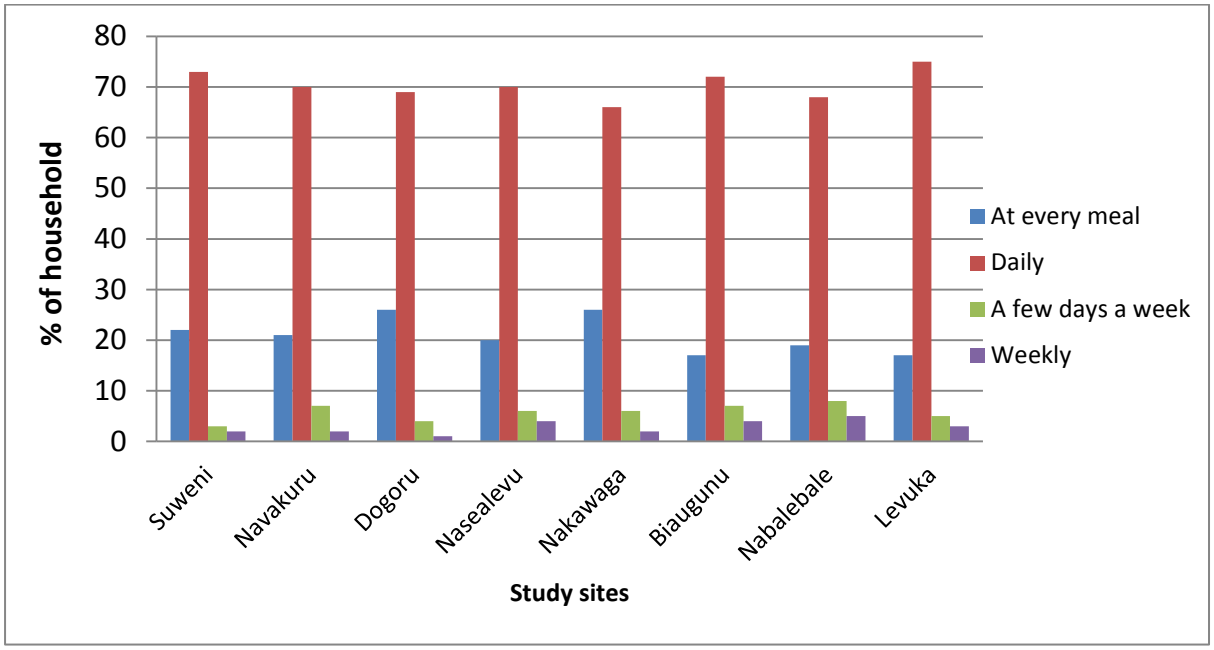

Figure 53: Percentage of households with frequency of consumption (grown food)

Households were asked to rank the frequency with which they consume specific foods grown by household members (1= at every meal, 2= daily, 3= every other day, 4= weekly and 5= less often). These results are shown in Figure 53. The main types of home-grown foods consumed by households are rourou (average rank 2), dalo (average rank of 2.1), cassava (average rank of 2.7) and bele (3.7). Additional foods grown that are consumed less frequently include plantain, bananas, sweet potato, yams and cabbage.

Cows and pigs are infrequently eaten by individual households; instead they are supplied either for large village functions or for sale to generate income. Poultry

typically run free-range within the village surroundings and provide eggs and meat to individual households.

Given the importance of subsistence land use and growing root crops in particular, it is not surprising that the rate of ownership of agricultural tools and assets is ubiquitously high across all villages (Figure 54). Every single household across all villages own one or more cane knives used in planting and tending crops. On average, 73% of households across all villages own one or more spring spade, spade or fork.

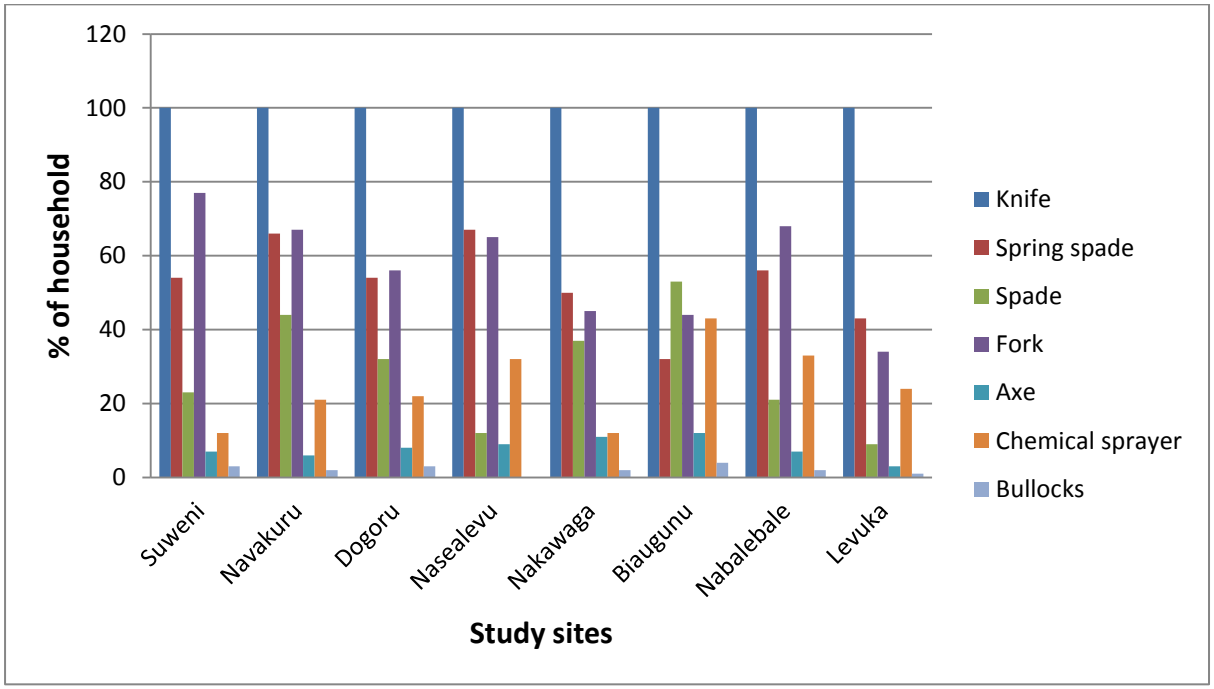

Figure 54: Percentage of households with farming assets

Hunting and fishing

Wild pigs are hunted throughout the extensive tracts of the forest within the Greater Delaikoro Area. During large village gathering, group of young men in the village are always tasked to hunt wild pigs for eating. There is a pig hunting season around the Christmas and New Year period and at Easter as a means of supplementing protein due to increased visitor numbers.

The local freshwater fishery for food security and subsistence purposes is very important in all these communities. The frequency with which households consume

fish and prawns caught by household members was recorded (1 = at every meal, 2 = daily, 3 = every other day, 4 = weekly and 5 = less often). On average, fish were eaten slightly less often than weekly (average rating 4.2) whilst prawns were even less frequently than that (4.6).

Fisheries are known to be seasonal. The main targeted fisheries products of eels (mainly *Anguila marmorata)*, tilapia (mainly *Oreochromis niloticus*), grass carp (*Ctenopharyngodon idellus*) and prawns are targeted in the months of August and September and again around Christmas and into the early New Year. During these times, fisheries products are consumed on average at least weekly. The most commonly owned fishing equipment are hook and line which owned by 72% of households, spears (66%) and mask and snorkel (57%).

Gathering

Food gathered from the forest in the vicinity of the villages includes ferns (mainly *Diplazium esculentum* or ota), Tahitian chestnut (*Inocarpus fagifer* or ivi) and wild yams (*Dioscorea sp.*).

Non-timber forest products are consumed less often than weekly (33% of households) or a few days a week (26% of households). Only a few households consume them more often. The most commonly eaten resource is ota which is consumed on average across all households every other day. It is worthy of note that rourou is more commonly used for home consumption than ota, ota being more commonly sold.

The fruit of the ivi tree is a seasonal non-timber forest product that is consumed on average every other day during the season which runs from January-March. Wild yams are collected during November-January and are consumed weekly on average across all villages.

Other uses of the Greater Delaikoro Area

Most households in the study area (93%) used the Greater Delaikoro Area to obtain forest products. The majority of timber used to construct houses in these communities is cut from trees within the region. Quantifying the volume of trees chopped down for this purpose is hard given that it is usually done on an ad hoc basis, generally when a couple have got married and need a new house or when house repairs are needed. Other uses of forest products mentioned by the respondents include herbal medicine, carving, fence posts, thatching reed, collection of firewood and clearing of forest areas for farming.

9.3.3 Forest Resource Management

Respondents were asked for their opinion on they thought had the authority to develop and manage the forest. 75% felt that they have full jurisdiction through the mataqali tribal council, whilst 15% thought that mataqali chiefs have the sole jurisdiction. 5% thought that they together with the government have the power while the remaining 5% thought that the government had sole authority. Some of the government departments and affiliates that respondents mentioned as having shared authority with them over forest areas include the Forestry Department, the Environment Department, the Land Department and the iTaukei Land Trust Board.

Value attachment to Greater Delaikoro Area

The survey revealed that communities derive a number of benefits from the Greater Delaikoro Area, which they say contribute enormously to their livelihoods. Asked for their opinions on whether or not the Greater Delaikoro Area in their respective localities should be maintained under its current land use, 99% answered in the affirmative. However, the appreciation seemed to be largely limited to tangible benefits derived from the area. Only 11.9% of the respondents were able to articulate some intrinsic values of the area. The inability to adequately comprehend Greater Delaikoro Area values in totality highlights a gap in the awareness level of these communities on the importance of this area. Some of the main values mentioned by

the respondents included water source for domestic use, land for cultivation, fish, building materials, hunting, crafts materials, wild fruits, herbal medicine, firewood and ownership and sense of belonging.

Interventions to ensure sustainability of the Greater Delaikoro Area

Respondents were asked what needs to be done to ensure sustainable resource utilisation. The majority of the respondents (35%) listed the need to intensify sensitization on sustainable resource use as very important, followed by the need to enforce environmental, water and forest laws and enact by-laws at community level (28.3%). Also important was the need to clearly demarcate areas of biological importance (26.3%). People also identified the need for planning at the local level, to draft village resource management plans. Other suggestions hinged on training in improved natural resource management (forest and soil conservation), and interventions that would reduce community threats such as tree planting and banning bush fires.

Respondents were asked whether, according to them, there are any aspects in which their communities needed to be trained in order to improve protection of Greater Delaikoro Area and the resources therein. Virtually everybody (99%) answered in the affirmative. Training needs cited included awareness on forest use and importance and sustainable agricultural practices. Most of the other training needs mentioned were to do with improving resource management (such as farming methods within the area, beekeeping, livestock management, craft making) and training in options to reduce direct dependency on the Greater Delaikoro Area (such as alternative income generating projects and fuel saving technologies).

Factors affecting surveyed communities

The analysis of community social interactions and economic lifestyles pointed to a number of factors with a bearing on their socioeconomic wellbeing. Whereas the Greater Delaikoro Area is looked at as a source of livelihood, community needs are

not met adequately. The survey also generated information to the effect that the current practices are not sustainable, and there is evidence of shrinking forest size, and a reduction in associated community and individual benefits.

There is a general lack of awareness among the population of the adverse consequences of their actions on the Greater Delaikoro Area. Communities here are generally agro-based, and look at this region as a means towards achieving high production levels. There is little thought given to the survival of the region and its ability to adequately meet future needs. It is therefore not surprising that when asked about the importance of the Greater Delaikoro Area, respondents mainly thought of tangible benefits until probed to think about other ecological aspects.

The sites visited exhibited a lack of trained and committed personnel in terrestrial resources management at community level. The only service provider in this region is the Fiji Forestry Department in Labasa town and the Forestry Department Station in Korotari. There is inadequate and/or weak institutional coordination and links on environment management in general and natural resource management in particular in this region.

The other notable factor concerns the selfish nature of community members that prevents them from looking at a community as a whole but rather themselves as individuals. During the discussions, it emerged that respondents did not attach much value to the benefits that accrue to the community, singling out only benefits that come to them in their individual capacities. Such an attitude is challenging to programme design in terms of how interventions are framed to meet the needs of their target beneficiaries in an environmentally friendly manner.

Overdependence on agriculture and an apparent minimal diversification of livelihoods is a limiting factor to the sustainability of this region. Most people are entirely dependent on *yaqona* and cash crop cultivation. Most of these crops require very fertile soil, therefore, communities tend to expand into pristine forest after only a few years of planting in a particular area. The relocation to these pristine areas

means the cutting down and destruction of forest coupled with the disturbance of the soil structure.

Community attitudes towards conservation and the idea of a protected area

Community attitudes and views of their natural resource are very important for resource developers and managers because the success of any development or conservation project mainly depends on how people value their resources. In order to capture this, a few statements were read out to respondents during the interview. These statements point out to some important components regarding the future management of the Greater Delaikoro Area. The results shown in Table 12 confirm that the majority of the respondents do value their resources and see the need for resource management.

Table 12: Responses to value statements

Statement	Percentage of respondents				
	Totally agree	Agree	Neutral	Disagree	Totally disagree
It is not important to protect/conserve forest biodiversity	0%	5%	4%	6%	85%
Money is more important during logging than ensuring sustainable practices	5%	10%	6%	12%	67%
If a portion of mataqali land is reserved, my household livelihood will be badly affected	0%	4%	3%	6%	87%
Social cohesion in the village is strong	65%	10%	5%	15%	5%
Women and youths are part of decision making in the village	68%	12%	5%	5%	10%

The respondents were then asked what they thought about the creation of a protected area of some sort within the Greater Delaikoro Area. Most respondents stated that creating a protected area would be a good idea, with 85% supporting it. Only 8% thought it was a bad idea while the remaining 7% mentioned it was up to the mataqali chiefs to decide, a response that reflects upon the Fijian social structure and system of revering those in authority. When asked why they favored the creation of a protected area, the following reasons were given:

- Conserve natural resources,
- Conserve of the environment for future generation,
- Develop tourism opportunities such as the Waisali Forest Reserve,
- Protect water-head sources,
- Create employment.

Reasons not to create the protected area included the loss of crops and restricted access to forest resources, as well as the loss of hunting areas, and therefore less bush meat

9.4 Recommendations

The survey also gave participants an opportunity to make recommendations from their own perspective. The survey team used these and their general understanding of the proposed project to advance a number of next steps in an effort to advise relevant stakeholders.

Intensify awareness raising programs: to influence a positive shift in attitudes and practices **e**ducational programs are needed to raise awareness on the ecological roles and importance of the Greater Delaikoro Area to community livelihoods.

Develop and implement community natural resource management plans: the survey found out that there are some resource management strategies and agreements already in place in some of the study sites. Scaling-up this effort to cover all communities within the Greater Delaikoro Area is important to ensure the sustainability of this important region.

Formulate by-laws: to complement community natural resource management plan, by-laws need to be formulated and enacted to give legal power for compliance and enforcement.

Demarcate boundaries and create buffer zones: with the support of the relevant stakeholders, efforts should be made to demarcate areas of biological importance in the Greater Delaikoro Area from community and mataqali land. Once these

boundaries have been demarcated, then buffers zones can be put in place as a way to reinforce the 'respect' for those boundaries.

Conduct a needs assessment: the current level of reliance on agriculture for community livelihoods is too overwhelming and in most areas the footprint can be seen. The high demand for agricultural resources coupled with the increase in population in communities is a risk to the area's ecosystem carrying capacity which could lead to resource degradation, reduced production, poor community health and aggravated poverty. Therefore, an assessment of community needs should be undertaken to determine how such needs can be addressed without further degrading natural resources.

Factor in rural livelihood and poverty: there is a need to promote alternative sustainable resource-based and non-resource-based activities to reduce rural poverty, while at the same time easing the pressure on resources.

Information packaging: the survey revealed that formal education levels of most of the people in the study sites are generally low. Information needs to be tailored to suit the audience, with an emphasis on direct communication methods such as attending village meetings, radio communication, and posters in the local languages.

Protected area and access: It is clear that most of the people living around the Greater Delaikoro Area would be willing to have some form of protected area created for the forest and resources in the region. It is also clear that they would also want to have some form of access to forest products which we have shown are an important part of their livelihoods. The types of access that will be allowed will need to be discussed and agreed upon. For instance, will wild pig hunting be allowed to continue – will it be allowed throughout the forest or will hunting areas be designated? The same discussions are needed for other products, such as timber harvesting, wild ferns and others.

10 Training Program

10.1 Background

In all biological surveys a gasp of taxonomy, and the ability to not only recognise but identify organisms is of the utmost importance. Without this understanding and knowledge the study or survey is incomplete. Unsurprisingly, the majority of resource/landowners know very little of what they have in their remote forests, beyond the plants and animals that are consumed or used in day-to-day living. Hence the opportunity was taken to include them in the surveys so as to provide some basic training in taxonomy and survey methodology, whilst this work was carried out on their land.

A capacity building training program on developing and improving taxonomical expertise for resources and landowners and personnel from Fiji's departments of Forestry and Fisheries was also implemented during this survey. More precisely the para-taxonomic training is for selected members of the landowning units and other community members (who were used as local guides and porters) in the area of botany, vegetation ecology, herpetology, ornithology, archeology, freshwater ichthyology and entomology (terrestrial and freshwater).

Each trainee was initially given the opportunity to choose whatever area of training they would like to undergo. The detailed description of the survey methodologies is outlined in the methodology sections of the relevant chapters of this report. For this section of the report a short summary of who the trainer and trainers wer,e and what sort of training was carried out is summarized.

10.2 Training methodology

A total of sixteen people received training during the survey work. The trainees were selected based on their active involvement in the utilization of their natural resources as a means for economic development and/or for livelihood. Six of the

trainees were personnel from Forestry Department, one was from the Fisheries Department and the remaining nine were resource owners and landowners from the local communities.

The table below lists the persons who were trained, the village or institutions they represented and has a brief summary of the type of training or upskilling that they received.

Table 13 List of trainees for the Greater Mt Delaikoro proposed protected area survey

Trainee	Village /Institution	Tikina/province	Designation	Notes
Vilimoni	Bagata village	Wailevu, Cakaudrove	Villager	Botanical and vegetation surveys. Common tree species identification. Habitat types.
Panapasa	Fiji Forestry Dept	Colo-i-Suva – Forestry	Research officer	Plots & transect layout, tree identification and plot measurements. Specimen collection
Jale	Kenani settlement	Dogotuki, Macuata	Villager	PSP survey methods – tree measurements, tree identification, carbon measurements
Netani	Sarafini settlement	Dogotuki, Macuata	Villager	PSP survey methods – tree measurements, tree identification, carbon measurements
Ra Jale	Fiji Forestry Dept	Coloisuva - Forestry	GIS personnel	Forest stratification
Ropate	Fiji Forestry Dept	Labasa	Community leader	Forest ecology, status of forest due to impacts, indicator species, invasive alien species presence
Senivalati Vido	Fiji Forestry Dept	Colo I Suva - Forestry	Forest Park Ranger	Ornithology- bird identification and survey techniques, catching and handling birds using Mist nets and botany (plots and tree identification)
Waisea	Fiji Forestry Dept	Colo-i-Suva – Forestry	Forest Park Ranger	Ornithology – bird identification and survey techniques, catching and handling birds using Mist nets
Veresa	Biaugunu village	Koroalau, Cakaudrove	Villager	Bird survey techniques and botanical survey. Identification of common tree species
Jone	Fiji Forestry Dept	Sueni, Cakaudrove	Villager	Herpetofauna surveys – survey techniques of reptiles and amphibians. Identification of common reptiles and amphibians

Sala	Fiji Forestry Dept	Colo-i-Suva - Forestry	Research officer	Entomology survey – light traps,
Iowane	Dogoru village	Wailevu, Macuata	Villager	Entomology survey techniques. General groups (taxonomy) of insects. Collection methods.
Vilisoni	Fiji Fisheries Dept	Nausori	Fisheries officer	Freshwater fish survey techniques and methods. Identification of common freshwater fish
Joeli	Navakuru village	Cakaudrove	Villager	Archaeological survey methods. Identification features of sites in the field
Sikeli	Naikawaga village	Koroalau, Cakaudrove	Villager	Archaeological survey methods. Identification features of sites in the field
Vili Tupua	Fiji Forestry Dept	Colo-i-Suva	Forest Guard	Socio-economic survey techniques in local communities.

10.2.1 Para taxonomy in Botany and Ecology

Trainers: Marika Tuiwawa -botanist and ecologist; Sarah Pene – Invasive species.

The group did opportunistic collections of higher vascular plants that were fruiting and or had flowers. Botanical naming systems were explained and discussions held to document and record the common names generally used in Fiji, as well as the local Macuata dialect.. For the ecological component the group and the trainees used plots (10 m x 10 m) to quantitatively assess tree biomass in selected forest types. Some trainees also assisted in processing specimens as herbarium voucher materials. During this activity finer taxonomic details were discussed, which included leaf, fruit and flower morphology characterisations, as well as discussion on growth, habit form and distribution. When other landowners were present discussions on the uses (including traditional uses) of certain plant species were also held.

10.2.2 Entomology Training

Trainers: Hilda Waqa, Bindya Raksha and Apaitia Liga - entomologists

The group and the trainees targeted a diversity of habitats (slopes, flats, ridges and riparian areas) and vegetation types (lowland and upland systems within primary, secondary and native forests) to carry out the survey. The trainees learned how to use a variety of collection techniques that included active surveys (UV light traps,

leaf litter sampling, winkler bags sticky tapes) as well as opportunistic surveys (using hand held nets and a Surber sampler). For the opportunistic surveys the trainees learned how to capture wild butterflies, damsel flies, mayflies, stick insects, cicadas, beetles and freshwater invertebrates and for some of the larger insects caught they were taught the local and common names. Later at the base camp some basic preservation techniques were carried out with the trainees. Discussions on the conservation significance of some of these species were also carried out between the trainee and trainer.

10.2.3 Avifauna and Mammal Parataxonomy Training

Trainer: Alivereti Naikatini – Bird and mammal specialist

The trainee joined the avifauna group to survey birds and bats encountered along tracks, areas accessible by dirt roads and locally known bat roosts. The survey methods used included the point count method (for both bats and birds), mist netting in open high areas for bats at night and birds in the early mornings, bat detector surveys in the evenings, opportunistic surveys through observations using binoculars and recognizing bird calls and from interviews with local community members.

More than 45 bird and three bat species were documented during the survey. Both the local and generic common names were given for the birds and for the later the trainees played a key role in providing these names (usually after consulting other guides). For this group the trainee presented a brief summary of their findings during a debriefing workshop at the end of the survey.

10.2.4 Herpetofauna Training

Trainer: Nunia Thomas - herpetologist

The trainee joined the herpetofauna group to assist with diurnal and nocturnal herpetofauna surveys, opportunistic visual encounter surveys, standardized sticky trap transects and standardized (time constrained) nocturnal visual encounter

surveys. For all herpetofauna collected from these surveys the trainee was familiarized with the most distinguishable feature typical of each species to enable him to correctly distinguish different species fror each other. The trainee co-presented a brief summary of the findings of the herpetofauna survey during a debriefing workshop at the end of the survey.

10.2.5 Freshwater Fish Training

Trainers: Lekima Copeland and Kinikoto Mailautoka – Freshwater fish specialists

The trainees were taught the use of equipment to collect physiochemical data from the field. They were also involved in using field methods that were designed to enable the most comprehensive documentation of fishes present in the tributaries, including beach seine and snorkeling. Overall a total of eighteen species of fish from six families were directly observed or collected and local names were also discussed with trainees and documented.

10.2.6 Archaeological Survey Training

Trainers: Elia Nakoro and Sakiusa Kataiwai – Archeology specialist

The trainees were elderly village guides and through dsicussions with them on oral histories and their knowledge of the area, areas of interest were identified and located. Information regarding these areas was also discussed and verified with other elders in the village before it was documented. A total of 11 new sites were documented.

10.2.7 Conclusion

It is envisaged that the inclusion and exposure of trainees in the survey will not only broaden their recognition and knowledge about these natural resource, but would also assist in the dissemination of this information to members of the greater community that they come from.

Recommendations

Recommendations specific to the individual components of the study have been included at the end of each section of this report. Below is an overview of the general recommendations that have been elicited as a result of this study.

The survey has shown that the area is of high biodiversity value and it is recommended that it be accorded a protected status, however, further work is required to fully clarify certain species identifications and to more thoroughly document species range extensions throughout the entire proposed protected area.

- the surveys of all the major taxonomic groups showed that the areas surveyed contained high species diversity, including both national and island endemics, many of which either already have protection status, or would be deserving of such.
- some new finds and range extensions highlight the high possibility that the full scope of the biodiversity has not been fully described, and that further work will reveal an ever greater scope of biodiversity.

Community awareness:

- It is recommended that a community awareness program ensure that communities are appraised of the significant findings of the surveys, and highlights the ecological roles and importance of the Greater Delaikoro Area to community livelihoods.
- The types of access to the protected area that will be allowed to communities will need to be discussed and agreed upon.
- The medium of community awareness-raising needs to be tailored to suit the audience, with an emphasis on direct communication methods such as attending village meetings, radio communication, and posters in the local languages.

Some factors to take into consideration when considering the protection of the area:

- Ecological connectivity: catchment headwaters must be a protection priority to ensure the health of habitats in downstream areas of the catchments.
- Agricultural encroachment poses a significant threat to high-biodiversity areas, in particular in forested areas subjected to slash-and-burn clearing, or in riparian areas that lack a buffer zone between the waterway and agricultural or pastoral land.
- Invasive species control and/or monitoring should be a component of any proposal for the designation and long-term management of a proposed protected area.
- An evaluation of existing resource management strategies and agreements in place in some parts of the study area should be undertaken, including the potential to upscale these to cover all communities within the proposed protected area.
- Once the protected area boundary has been demarcated, buffer zones can be put in place as a way to reinforce 'respect' for that boundary.

Further survey work required for a more comprehensive biodiversity assessment:

- Additional survey work would cover a greater proportion of the proposed protected area, and thus ensure that recommendations for the boundary delimitations are based on a wider sampling range.
- More work is needed to confirm identifications of sampled species, and to ensure as comprehensive a species checklist as possible. Some species known to occur in the area were not sampled due to their seasonality, weather conditions at the time of the survey, or the highly restricted nature of their range, therefore additional survey time is necessary to get a current confirmation of their presence. Additional survey time would also yield more confirmed identifications with additional collections of flowering and fruiting material or different life stages of the organism.

- The current survey provided a snapshot of biodiversity at the sampling sites. However, surveys over longer time periods would be necessary to get more comprehensive data on species population size and density, their complete geographical ranges and ecological requirements. It is this information that is required for long-term monitoring of the ecological health of a protected area, and the evaluation of the effectiveness of protection.

Further work required under the Archaeological and Socioeconomic surveys:

- Archaeology survey – suggested further work includes the recording of oral histories to complement the site assessments, and avoid the loss of traditional knowledge and history of the study area.
- Socioeconomic – suggested further work includes the conducting of a needs assessment with communities in the area. The high demand for agricultural resources coupled with the increase in population in communities could lead to resource degradation, reduced production, poor community health and aggravated poverty. Therefore, an assessment of community needs should be undertaken to determine how such needs can be addressed without further degrading natural resources.

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Appendix 1 Flora species checklist

Vouchers - Species recorded and/or collected by MT (Marika Tuiwawa), SP (Sarah Pene), AW (Arthur Whistler) and SHT (Senilolia H Tuiwawa); Numbers are specimens verified by AW.				
Key: ^IUCN List, ^^New record for Vanua Levu, *CITES List, **Range Extension, ∞Type locality				
GYMNOSPERM				
Family	**Species Name**	**Local name**	**Distribution**	**Vouchers**
Araucariaceae	Agathis macrophylla (Lindl.) Mast.	dakua makadre	Indg., comm.	AW, MT
Casuarinaceae	*Gymnostoma vitiense L.A. S. Johnson	velau, caukuro	End., comm.	MT
Casuarinaceae	Casuarina equisetifolia J.R. & G. Forst.	nokonoko	Indg., comm.	MT
Cycadaceae	Cycas seemannii A. Braun	cycad, logologo	Indg., uncomm.	MT
Gnetaceae	^Gnetum gnemon L.	sukau	Indg., comm.	13284
Pinaceae	Pinus caribaea Morelet	carribean pine	Intrd., comm.	MT
Podocarpaceae	^*Dacrydium nidulum de Laubenfels	yaka	Indg., comm.	13414
Podocarpaceae	^*Podocarpus neriifolius D. Don	kuasi	Indg., comm.	13276
Podocarpaceae	^Retrophyllum vitiense (Seem.) C.N. Page	dakua salusalu	Indg., comm.	AW, MT
Podocarpaceae	Podocarpus decipiens N.E. Gray	kuasi	End., comm.	13170
FERN and FERN ALLIES				
Family	**Species Name**	**Local name**	**Distribution**	**Vouchers**
Adiantaceae	***Coniogramme fraxinea** (D. Don) Fée ex Diels		Indg., comm.	MT
Aspidiaceae	*Dryopteris subarborea* (Baker) C. Christensen		Indg., comm.	13402
Aspidiaceae	Tectaria decurrens (Presl) Copeland		Indg., comm.	MT
Aspidiaceae	*Tectaria latifolia* (G.Forst.) Copel.	ota loa	Indg., comm.	MT
Aspidiaceae	Tectaria tripartita (Baker) Copeland		End.., comm.	MT

Aspidiaceae	Tectaria vitiensis Brownlie	ota loa	Indg., comm.	13187
Aspleniaceae	Asplenium amboinensis Willd.		Indg., comm.	13234
Aspleniaceae	Asplenium australasicum Hook.	bird's nest	Indg., comm.	MT
Aspleniaceae	Asplenium bipinnatifidum Baker		Indg., comm.	13334
Aspleniaceae	Asplenium laserpitiifolium Lam.		Indg., comm.	MT
Aspleniaceae	Asplenium nidus L.		Indg., comm.	13357
Aspleniaceae	Asplenium polyodon Forster		Indg., comm.	MT
Athyriaceae	Diplazium melanocaulon Brackenridge		Indg., comm.	AW
Blechnaceae	**Blechnum doodioides (Brack.) Brownlie		Indg., comm.	13409
Blechnaceae	*Blechnum milnei* (Carruth.) C. Chr.		End., comm.	13400
Blechnaceae	Blechnum orientale L.		Indg., comm.	AW
Blechnaceae	Blechnum vittatum Brack.		End., comm.	MT
Cyatheaceae	**Cyathea affinis* (Forster) Swartz	balabala	Indg., comm.	MT
Cyatheaceae	*Cyathea alta Copel.	balabala	Indg., comm.	13205
Cyatheaceae	*Cyathea decurrens (Hooker) Copel.	balabala	Indg., comm.	13425
Cyatheaceae	**Cyathea hornei* (Baker) Copeland	balabala	Indg., comm.	MT
Cyatheaceae	*Cyathea lunulata (Forst.) Copel.	balabala	Indg., comm.	13419
Cyatheaceae	*Cyathea propinqua Copel.	balabala	Indg., uncomm.	13213
Cyatheaceae	*Cyathea spp.	balabala	Nat., uncomm.	SHT
Cyatheaceae	**Cyathea truncata* (Brackenridge) Copeland	balabala	Indg., comm.	MT
Cyatheaceae	*Culcita staminea* (Labill.) Maxon		Indg., loc. comm.	AW
Cyatheaceae	Cyathea (red)	balabala	Nat., comm.	MT
Davalliaceae	*Arthropteris repens* (Brackenridge) C. Christen.		Nat., comm.	13345
Davalliaceae	Davallia fejeensis Hooker		End., comm.	MT
Davalliaceae	*Davallia solida* (Forster) Swartz		Indg., comm.	SHT

Davalliaceae	Humata botrychioides Brackenridge		End., comm.	AW
Davalliaceae	Humata heterophylla (Smithii) Desvaux		Nat., comm.	MT
Davalliaceae	Nephrolepis biserrata (Swartz) Schott		Indg., comm.	SHT
Davalliaceae	Nephrolepis hirsutula (Forst. f.) Presl		Indg., comm.	AW, MT
Davalliaceae	*Nephrolepis tuberosa* (Bory ex Willd.) Presl		Indg., comm.	AW
Davalliaceae	Oleandra neriiformis Cav.		Nat., comm.	AW, MT
Dennstaedtiaceae	**Lindsaea ensifolia Swartz		Indg., comm.	MT
Dennstaedtiaceae	***Orthiopteris tenuis* (Brackenridge) Brownlie		End., comm.	MT
Dennstaedtiaceae	**Sphenomeris chinensis (L.) Maxon		Indg., comm.	MT, 13209
Dicksoniaceae	Dicksonia brackenridgei Mett.	balabala	Indg., comm.	13257
Gleicheniaceae	Ctenopterella blechnoides (Grev.) Parris		Indg., comm.	MT
Gleicheniaceae	Dicranopteris linearis (Burm.) Underwood	qato	Nat., comm.	AW, MT
Gleicheniaceae	Diplopterygium longissimum (Blume) Nakai		Indg., comm.	MT
Gleicheniaceae	Gleichenia longissima Blume		Nat., comm.	MT
Grammitidaceae	*Ctenopteris blechnoides* (Grev.) Wagner & Grether		Nat., comm.	13416
Grammitidaceae	*Grammitis hookeri* (Brackenridge) Copel.		Nat., comm.	13399
Hymenophyllaceae	Trichomanes asae-grayi van der Bosch		Nat., comm.	13397
Hymenophyllaceae	Trichomanes atrovirens (C.Presl) Kunze		Indg., comm.	SHT
Hymenophyllaceae	Trichomanes boryanum Kuntze		Nat., comm.	13295
Hymenophyllaceae	Trichomanes cf. caudatum Brackenridge		Nat., comm.	13302
Hymenophyllaceae	Trichomanes dentatum van der Bosch		Nat., comm.	13293
Hymenophyllaceae	Trichomanes intermedium van der Bosch		Nat., comm.	13375
Hymenophyllaceae	Trichomanes sp.		Nat., uncomm.	13372
Hypodematiaceae	**Didymochlaena truncatula (Sw.) J. Sm.		Indg., comm.	MT
Hypolepidaceae	Histiopteris incisa (Thunb.) J. Sm.		Indg., loc. comm.	AW

Hypolepidaceae	Pteridium esculentum (Forst.) Cockayne		Indg., loc. comm.	13440
Lindsaeaceae	Lindsaea aff. harveyi Carr. ex Seem.		Nat., comm.	13407
Lindsaeaceae	Lindsaea vitiensis Kramer		End., comm.	13396
Lomariopsidaceae	Elaphoglossum feejeense Brackenridge		Indg., comm.	MT
Lomariopsidaceae	Lomariopsis oleandrifolia (Brackenridge) Mett.		Indg., comm.	13410
Lycopodiaceae	Huperzia magnificum (Brownlie) Holub		End., comm.	SHT, MT
Lycopodiaceae	*Huperzia phyllantha* (Hooker et Arnott) Holub		Indg., comm.	MT
Lycopodiaceae	*Huperzia serrata* (Thunb. Ex Murray) Trevis.		Indg., comm.	MT
Lycopodiaceae	*Lycopodium cernua* (L.) Pic. Serm.		Indg., comm.	MT
Lycopodiaceae	Lycopodium cernuum L.	lewa nini	Indg., loc. comm.	13405
Lycopodiaceae	Lycopodium cf. foliosum Copel.		Indg., loc. uncomm.	13332
Lycopodiaceae	Lycopodium cf. serratum		Nat., comm.	MT
Lycopodiaceae	Lycopodium nummularifolia Blume		Nat., comm.	MT
Lycopodiaceae	Lycopodium phlegmeria L.		Nat., comm.	13290
Lycopodiaceae	Lycopodium phyllanthum H. & A.		Nat., comm.	13331
Lycopodiaceae	Lycopodium squarrosum Forst.		Indg., comm.	AW
Marattiaceae	Angiopteris evecta (Forst.) Hoffm.	basovi	Indg., comm.	AW, MT
Marattiaceae	*Ptisana smithii* (Mett. Ex Kuhn) Murdock		Indg., comm.	MT
Polypodiaceae	Belvisia mucronata (Fee) Copel.		Indg., comm.	13415
Polypodiaceae	Dipteris conjugata Reinw.		Indg., loc. comm.	13436
Polypodiaceae	*Drynaria rigidula* (Swartz) Beddome		Indg., comm.	MT
Polypodiaceae	Lemmaphyllum accedens (Bl.) Donk		Nat., comm.	13356
Polypodiaceae	Loxogramma parksii Copel.		Nat., comm.	13313
Polypodiaceae	Microsorium linguaefrome (Mettenius) Copeland		Nat., comm.	MT
Polypodiaceae	Microsorium punctatum (L.) Copeland		Nat., comm.	MT

Polypodiaceae	*Phymatosorus grossus* (Langsdorff et Fischer) Brownlie	vativati	Indg., comm.	MT
Psilotaceae	Psilotum complanatum Swartz		Indg., uncomm.	13368
Psilotaceae	*Psilotum nudum* (L.) Palisot de Beauvois		Indg., uncomm.	MT
Pteridaceae	Antrophyum alatum Brack.		Indg., comm.	MT, 13355
Schizaeaceae	Lygodium reticulatum Schkuhr		Indg., uncomm.	MT
Schizaeaceae	Schizaea dichotoma (L.) J. Sm.		Nat., comm.	MT
Selaginellaceae	Selaginella cf. breynoides Baker		End., comm.	13444
Selaginellaceae	Selaginella firmula A.Braun ex Kuhn		Nat., comm.	MT
Selaginellaceae	Selaginella sp.		Nat., comm.	MT
Selaginellaceae	Selaginella viridangula Spring		End., comm.	13347
Thelypteridaceae	*Christella harveyi* (Mettenius) Holttum		Indg., loc. comm.	MT
Vittariaceae	Pteris ensiformis Burmann		Indg., loc. comm.	MT
MONOCOT				
Family	**Species Name**	**Local name**	**Distribution**	**Vouchers**
Agavaceae	Cordyline terminalis (L.) Kunth	qai , vasili	Arb. intrd., loc. comm.	MT, SHT
Amaryllidaceae	Crinum asiaticum L.	viavia	Indg., comm.	MT
Araceae	**Epipremnum pinnatum Nicolson	yalu	Indg., comm.	MT
Araceae	**Xanthosoma sagittifolium (L.) Schott	dalo ni tana	Arb. intrd., loc. comm.	MT
Araceae	Alocasia macrorrhiza (L.) G. Don	via	Arb. intrd., loc. comm.	MT
Araceae	Rhaphidophora spuria (Schott) Nicolson		End., comm.	MT
Arecaceae	^***Physokentia thurstonii (Becc.) Becc.	niuniu	End., comm.	MT
Arecaceae	^***_Balaka seemannii_ (H.Wendl.) Becc.	balaka	End., comm.	MT
Arecaceae	^*Clinostigma exorrhizum (H.Wendl.) Becc.	niuniu	End., comm.	SHT, MT
Arecaceae	^*Cyphosperma trichospadix (Burret) H.E.Moore		End., comm.	SHT
Arecaceae	^Veitchia joannis H.Wendl.	saqiwa	End., comm.	SHT

Arecaceae	Cocos nucifera L.	niu, coconut	Cult., comm.	SHT
Arecaceae	Veitchia sessilifolia (Burret) H.E. Moore	niuniu	End, comm.	SHT, MT
Cyperaceae	***Kyllingia nemoralis** (J.R. & G.Forst.) Dandy ex Hutchinson & Dalziel		Exo., loc. comm.	MT
Cyperaceae	**Kyllingia polyphylla		Exo., loc. comm.	MT
Cyperaceae	Scleria lithosperma (L.) Sw.		Indg., comm.	MT
Cyperaceae	Scleria polycarpa Boeck.		Indg., comm.	MT
Dioscoreaceae	Dioscorea bulbifera L.	kaile	Indg., loc. comm.	MT
Dioscoreaceae	Tacca leontopetaloides (L.) Kuntze	Yabia	Indg., comm.	MT
Liliaceae	Collospermum montanum (Seem.) Skottb.		End., comm.	MT, SP, SHT
Liliaceae	Dianella intermedia Endl.	varavara	Indg., loc. comm.	MT
Orchidaceae	**Appendicula bracteosa Reichenb.f.		End., comm.	MT
Orchidaceae	**Bulbophyllum longiscapum Rolfe		Indg., comm.	MT
Orchidaceae	**Calanthe hololeuca Reichenb.f.	varavara	Indg., comm.	MT
Orchidaceae	**Corymborkis veratrifolia (Reinw.) Bl.		Indg., comm.	MT
Orchidaceae	**Dendrobium biflorum (G.Forst.) Sw.		Indg., comm.	MT
Orchidaceae	**Diplocaulobium tipuliferum (Rchb.f.) Kraenzl.		End., comm.	MT
Orchidaceae	***Eria robusta* (Blume) Lindl.		Indg., comm.	MT
Orchidaceae	**Eria rostriflora Rchb.f.		Indg., comm.	MT
Orchidaceae	***Flickingeria comata* (Blume) A.D.Hawkes		Indg., comm.	MT
Orchidaceae	***Phreatia micrantha* (A.Rich.) Lindl.		End., comm.	MT
Orchidaceae	**Pseuderia platyphylla L.O.Williams		End., comm.	MT
Orchidaceae	**Robiquetia bertholdii (Rchb.f.) Schltr.		Indg., comm.	MT
Orchidaceae	**Sarcanthopsis nagarensis (Rchb.f.) Garay		Indg., comm.	MT
Orchidaceae	Agrostophyllum aristatum Kores		Indg., comm.	MT
Orchidaceae	Appendicula pendula Bl.		Indg., comm.	MT

Orchidaceae	Appendicula reflexa Bl.		Indg., comm.	MT
Orchidaceae	Appendicula sp.		Nat., comm.	MT
Orchidaceae	Bulbophyllum longiflorum Thouars		Indg., comm.	MT
Orchidaceae	Bulbophyllum sp.		Nat., comm.	MT
Orchidaceae	Cleisostoma longipaniculatum Kores		Indg., comm.	MT
Orchidaceae	Coelogyne macdonaldii F.Muell. & Kraenzl.		Indg., comm.	MT
Orchidaceae	Cynorkis fastigiata Thouars		Indg., comm.	MT
Orchidaceae	Dendrobium macrophyllum A.Rich.		Indg., comm.	MT
Orchidaceae	Dendrobium platygastrium Rchb.f.		Indg., comm.	MT
Orchidaceae	Dendrobium prasinum Lindl.		End., comm.	MT
Orchidaceae	Dendrobium tokai Rchb.f.		Indg., comm.	MT
Orchidaceae	Dendrobium vagans Schltr.		Indg., comm.	MT
Orchidaceae	Earina valida Rchb.f.		Indg., comm.	MT
Orchidaceae	Liparis cf. gibossa Finer		Indg., comm.	MT
Orchidaceae	Malaxis cf. latisepala (Rolfe) C. Schweinf.		End., uncomm.	AW
Orchidaceae	Malaxis cf. resupinata (Forst. f.) Kuntze		Indg., uncomm.	13321
Orchidaceae	Malaxis sp. 1		Nat., uncomm.	13268
Orchidaceae	*Oberonia equitans* (Forst. F.) Mutel		Indg., uncomm.	AW
Orchidaceae	Oberonia heliophila Rchb.f.		Indg., comm.	MT
Orchidaceae	Peristylis traduscantifolius (Reichenb. f.) Kores		Indg., comm.	AW
Orchidaceae	*Phaius tankervilleae* (Banks ex L'Her.) Bl.	varavara	Indg., uncomm.	AW
Orchidaceae	Phreatia cf. neocaledonica Schlechter		Indg., uncomm.	AW
Orchidaceae	*Phreatia cf. stenostachya* (Reichenb. f.) Kraenzlin		Indg., comm.	AW
Orchidaceae	Phreatia flavovirens Kores		End., comm.	13385
Orchidaceae	Spathoglottis pacifica Reichenb. f.	varavara	Indg., loc comm.	AW

Orchidaceae	Species indet.			AW
Orchidaceae	Taenophyllum fasciola (Forst.) Seem.		Indg.,comm.	MT
Orchidaceae	Tropida enffisa Rchb.		Indg., comm.	MT
Pandanaceae	**Freycinetia caudata Hemsl.	wame	End., comm.	SHT
Pandanaceae	**Freycinetia storckii Seem.	wame	Indg., comm.	SHT
Pandanaceae	**Pandanus thurstonii C.H.Wright	pandanus	End., comm.	MT
Pandanaceae	**Pandanus vitiensis Martelli	pandanus	End., comm.	MT
Pandanaceae	Freycinetia hombronii Martelli	wame	Indg., comm.	13188
Pandanaceae	*Freycinetia impavida* (Hombron & jacquinot) Stone	wame	Indg., comm.	MT
Pandanaceae	Freycinetia urvilleana Hombron & Jacquinot	wame	Indg., comm.	13393
Pandanaceae	Freycinetia vitiensis Seem.	wame	End., uncomm.	13376
Pandanaceae	Pandanus cf. joskei	vadra	End., uncomm.	MT
Poaceae	**Centosteca lappacea (L.) Desv.		Arb.intrd., comm.	MT
Poaceae	**Digitaria ciliaris (Retz.) Koeler		Exo., loc. comm.	MT
Poaceae	***Setaria glauca* (L.) Beauv.		Cult., comm.	MT
Poaceae	^***Brachiaria mutica* (Forssk.) Stapf	para	Exo., loc. comm.	MT
Poaceae	^Paspalum scrobiculatum L.		Exo., loc. comm.	MT
Poaceae	^Paspalum vaginatum Sw.		Exo., loc. comm.	MT
Poaceae	Arundo donax L.	gasau	Exo., loc. comm.	MT
Poaceae	Axonopus compressus (Sw.) Beauv.		Exo., loc. comm.	AW
Poaceae	Bambusa vulgaris Scrader	bamboo/bitu ni valagi	Arb.intrd., loc. comm.	MT
Poaceae	Coix lacryma-jobi L.	Job's tears	Indg., loc. comm.	MT
Poaceae	*Cyrtococcum oxyphyllum* (Hochst. ex Steudel) Stapf		Arb. intrd., comm.	AW
Poaceae	Eleusine indica (L.) Gaertn.	co vatu	Exo., loc. comm.	AW
Poaceae	Imperata conferta (Presl.) Ohwi	white grass	Arb. intrd., comm.	MT

Poaceae	Miscanthus floridulus (Labill.) Warb.	gasau	Indg., loc. comm.	AW, MT, SHT
Poaceae	Paspalum conjugatum Berg.		Exo., loc. comm.	AW
Poaceae	Paspalum orbiculare Forst. f.		Exo., loc. comm.	13412
Poaceae	Paspalum paniculatum L.		Exo., loc. comm.	AW
Poaceae	*Pennisetum polystachyon* (L.) J.A. & J.H. Schultes	mission grass	Exo., loc. comm.	AW
Poaceae	Pennisetum purpureum Schumacher		Exo., loc. comm.	AW
Poaceae	Saccharum edule Hassk.	duruka	Arb. intrd., comm.	MT
Poaceae	Sacciolepis indica (L.) Chase		Arb. intrd., comm.	AW
Poaceae	Schizostachyum glaucifolium (Rupr.) Munro	Bitu wai	Indg., loc. comm.	MT
Poaceae	Sporobolus diander (Retz.) Beauv.		Exo., loc. comm.	AW
Poaceae	Sporobolus indicus (L.) R.Br.		Exo., loc. comm.	MT
Zingiberaceae	**Alpinia boia Seem.	boia, vava	End., comm.	AW, MT
Zingiberaceae	**Alpinia macrocephala K. Schum.	vava	End., uncomm.	13261
Zingiberaceae	***Alpinia parksii* (Gillespie) A.C.Sm.	vava	End., uncomm.	13183
Zingiberaceae	***Alpinia purpurata* (Vieill.) K. Schum.		Exo., uncomm.	MT
Zingiberaceae	**Alpinia vitiensis Seem.	vava	End., uncomm.	MT
Zingiberaceae	*Zingiber zerumbet* (L.) Roscoe ex Sm.	lalaya	Arb. intrd., loc. comm.	MT
DICOTS				
Family	**Botanical Name**	**Local Name**	**Distribution**	
Acanthaceae	Graptophyllum insularum (A.Gray) A.C.Sm.		Indg., comm.	AW, MT
Alangiaceae	Alangium vitiense (A. Gray) Harms	Dokonisau	Indg., comm.	MT
Anacardiaceae	Buchanania attenuata A.C.Sm.	maqo ni veikau	End., comm.	MT
Anacardiaceae	Buchanania vitiensis Engl.	damanu ni yaqaqa	End., comm.	MT
Anacardiaceae	Pleiogynium timoriense (DC.) Leenh.	Manawi	Indg., comm.	MT
Anacardiaceae	Rhus simarubifolia A.Gray	Manawi	Indg., comm.	MT

Anacardiaceae	Semecarpus vitiensis (A.Gray) Engl.	Kaukaro	Indg., comm.	AW, MT
Annonaceae	*Cananga odorata* (Lam.) Hook.f. & Thomson	Makosoi	Indg., comm.	MT
Annonaceae	Cyathocalyx spp.	makosoi ni veikau	Nat., uncomm.	MT
Annonaceae	Cyathocalyx suaveolens A.C.Sm.		End., comm.	13297
Annonaceae	Xylopia pacifica A.C.Smith	Dulewa	End., comm.	MT
Annonaceae	Xylopia sp.	Dulewa	End., comm.	MT
Apiaceae	Centella asiatica (L.) Urb.	Totodro	Indg., comm.	AW, MT
Apocynaceae	***Alstonia pacifica* (Seem.) A.C.Smith	Sorua	Indg., comm.	MT
Apocynaceae	Alstonia montana Turrill	Sorua	Indg., comm.	13194
Apocynaceae	Alstonia vitiense Seem.	sorua levu	End., common.	MT
Apocynaceae	Alyxia cf. bracteolosa	Vono	Nat., comm.	AW, MT
Apocynaceae	Alyxia spp.	Vono	Nat., comm.	MT
Apocynaceae	Cerbera manghas L.	vasa rewa	Indg., comm.	MT
Apocynaceae	Ervatamia obtusiuscula Markgraf	vueti naitasiri	Indg., comm.	MT
Apocynaceae	*Pagiantha thurstonii* (Horne ex Baker) A.C.Sm	Tadano	End., comm.	MT
Araliaceae	Plerandra cf. grandiflora A.C.Sm.	Sole	End., uncomm.	13196
Araliaceae	Plerandra grayi Seem.	Sole	End., comm.	MT
Araliaceae	Plerandra insolita A.C.Sm.	Sole	End., comm.	13361
Araliaceae	Plerandra vitiense (Seem.) Bailey	Sole	End., loc. comm.	13237
Araliaceae	Polyscias joskei Gibbs	Danidanini veikau	End., loc. comm.	13163
Araliaceae	Polyscias multijuga (A. Gray) Harms	Danidanini veikau	Indg., comm.	MT
Araliaceae	Schefflera costata A.C.Sm.		End., uncomm.	13390
Asclepiadaceae	*Hoya australis* R. Br. ex Traill	biti, bitibiti	Indg., comm.	MT
Asclepiadaceae	Hoya vitiensis Seem.	biti, bitibiti	End., uncomm.	MT
Asteraceae	**Vernonia cinerea (L.) Less.		Exo., loc., comm.	MT

Asteraceae	**Wollastonia biflora (L.) DC.		Exo., loc., comm.	MT
Asteraceae	Ageratum conyzoides L.	botebotekoro	Exo., loc. comm.	AW, SP
Asteraceae	Bidens pilosa L.	batimadramadra	Exo., loc. comm.	AW
Asteraceae	Blumea milnei Seem.		Exo., loc. comm.	13212
Asteraceae	Conyza bonariensis (L.) Cronquist		Exo., loc., comm.	MT
Asteraceae	Crassocephalum crepidioides (Benth.) S. Moore		Exo., loc. comm.	AW, SP
Asteraceae	Elephantopus mollis H.B.K.		Exo., loc., comm.	MT
Asteraceae	Emilia sonchifolia (L.) DC.		Exo., loc. comm.	AW
Asteraceae	Mikania micrantha H.B.K.	Wabosucu	Exo., loc. comm.	AW, SP
Asteraceae	*Pseudelephantopus spicatus* (B.Juss. ex Aubl.) C.F.Baker		Exo., loc., comm.	MT
Asteraceae	Sonchus oleraceus L.		Exo., loc. comm.	AW
Asteraceae	Sphagneticola trilobata (L.) Pruski		Exo., loc., comm.	MT
Asteraceae	Synedrella nodiflora (L.) Gaertn.		Exo., loc., comm.	MT
Asteraceae	Youngia japonica (L.) DC.		Exo., loc. comm.	AW
Balanopaceae	*Balanops pedicellata* (Guillaumin) Hjelmq.		Indg., comm.	MT
Balanophoraceae	*Balanophora fungosa* J.R.Forst. & G.Forst.		Indg., comm.	MT
Barringtoniaceae	Barringtonia seaturae H.B.Guppy	Vutu	End., comm.	13330
Begoniaceae	Begonia vitiensis A.C.Sm.		End., comm.	MT
Bignoniaceae	Spathodea campanulata Beauv.	african tulip	Exo., uncomm.	AW, SP
Burseraceae	**Canarium harveyi Seem.	Kaunigai	Indg., comm.	MT
Burseraceae	**Canarium vanikoroense Leenh.	Kaunigai	Indg., comm.	MT
Burseraceae	**Canarium vitiense A.Gray	Kaunigai	Indg., comm.	MT
Burseraceae	**Haplolobus floribundus (K.Schum.) H.J.Lam	Kaunicina	Indg., comm.	MT
Caesalpiniaceae	***Caesalpinia major* (Medik.) Dandy & Exell		Indg., comm.	MT
Caesalpiniaceae	***Senna tora* (L.) Roxb.		Exo., loc. comm.	MT

Caesalpiniaceae	**Intsia bijuga* (Colebr.) O. Kuntze	Vesi	Indg., comm.	MT
Caesalpiniaceae	^*Cynometra insularis A.C.Sm.	Moivi	End., comm.	MT
Caesalpiniaceae	^*Kingiodendron platycarpum B. L. Burtt	Moivi, cibicibi	End., uncomm.	MT
Caesalpiniaceae	^*Storckiella vitiensis Seem.	marasa, vesida	End., uncomm.	MT
Caesalpiniaceae	^Cynometra falcata A.Gray	Moivi lailai	End., uncomm.	MT
Caesalpiniaceae	^Maniltoa floribunda A.C.Sm.	Cibicibi	Indg., comm.	MT
Caesalpiniaceae	Chamaecrista nictitans (L.) Moench		Exo., loc. comm.	MT
Caesalpiniaceae	Maniltoa grandiflora (A. Gray) Scheff.	Cibicibi	Indg., comm.	MT
Caesalpiniaceae	Senna occidentalis (L.) Link		Exo., loc. comm.	MT
Campanulaceae	Lobelia zeylanica L.		Intrd., comm.	AW
Cannabaceae	Trema cannabina Lour.		Indg., loc. comm.	MT
Chloranthaceae	Ascarina swamyana A.C.Sm.		End., uncomm.	MT
Chrysobalanaceae	Atuna racemosa Raf.	Makita	Indg., loc. comm.	MT
Chrysobalanaceae	Parinari insularum A. Gray	sa, sea	Indg., comm.	AW, SHT
Clusiaceae	Calophyllum cerasiferum Vesque	damanu lailai	End., uncomm.	MT
Clusiaceae	Calophyllum leptocladum A.C.Smith	damanu lailai	End., uncomm.	MT
Clusiaceae	Calophyllum neo-ebudicum Guillaumin	damanu dilo	Indg., comm.	MT
Clusiaceae	Calophyllum vitiensis Turrill	Damanu	End., comm.	MT, SHT
Clusiaceae	*Garcinia adinantha* A.C.Sm. & S. Darwin	Bulu	End., uncomm.	13342
Clusiaceae	Garcinia myrtifolia A.C.Sm.	Laubu	Indg., comm.	MT
Clusiaceae	Garcinia pseudoguttifera Seem.	bulu m	Indg., comm.	13176
Clusiaceae	Garcinia spp.	Bulu	Nat., comm.	MT
Combretaceae	Terminalia catappa L.	Tavola	Indg., loc. comm.	MT
Combretaceae	Terminalia sp.	Tivi	Nat., uncomm.	13264
Commelinaceae	**Aneilema vitiense Seem.		Indg., comm.	MT

Connaraceae	Connarus pickeringii A. Gray	wa vatu	End., comm.	MT
Convolvulaceae	Merremia peltata (L.) Merr.	wa bula	Indg., comm.	AW, SP
Cunoniaceae	**Pullea perryana A.C.Sm.		End., uncomm.	13162
Cunoniaceae	^***Weinmannia vitiensis Seem.		End., comm.	MT
Cunoniaceae	^**Spiraeanthemum graeffei Seem.		End., loc. comm.	MT, 13177
Cunoniaceae	^*Weinmannia exigua A.C.Sm.		End., uncomm.	13185
Cunoniaceae	Geissois sp.	vure, vota	Nat., comm.	MT
Cunoniaceae	Geissois ternata A. Gray	vure, vota	End., comm.	AW, MT
Degeneriaceae	^*Degeneria vitiensis* I.W. Bailey & A.C.Sm.	vavaloa, masiratu	End., comm.	13235
Dichapetalaceae	Dichapetalum vitiense (Seem.) Engl.		Indg., comm.	MT
Dilleniaceae	*Dillenia biflora* (A. Gray) Mart. ex Dur. & Jacks.	Kuluva	Indg., comm.	AW, MT
Ebenaceae	**Diospyros elliptica* (J.R. &G.Forst.) P.S.Green		Indg., comm.	MT
Ebenaceae	Diospyros gillespiei (Fosb.) Kostermans	Kau loa	End., uncomm.	13370
Ebenaceae	*Diospyros major* (Forst.f.) Bahk.		Indg., comm.	MT
Ebenaceae	Diospyros vitiensis Gillespie	Kau loa	End., uncomm.	MT
Elaeocarpaceae	**Elaeocarpus kambi Gibbs.	Kabi	End., comm.	MT
Elaeocarpaceae	Elaeocarpus cf. amphiflorus A.C.Sm.	Kabi	End., uncomm.	13159
Elaeocarpaceae	Elaeocarpus cf. gillespieanus	Kabi	End., uncomm.	MT
Elaeocarpaceae	Elaeocarpus sp. 1	Kabi	Nat., uncomm.	13168
Elaeocarpaceae	Elaeocarpus sp. 2	Kabi	Nat., uncomm.	13250
Elaeocarpaceae	Elaeocarpus sp. 3	Kabi	Nat., uncomm.	MT, AW
Elaeocarpaceae	Elaeocarpus storckii Seem.	Kabi	End., uncomm.	MT
Epacridaceae	Leucopogon septentrionalis Schlechter		Indg., comm.	13184
Euphorbiaceae	**Drypetes vitiensis Croizat		Indg., comm.	MT
Euphorbiaceae	**Macaranga harveyana* (Muell.Arg.) Muell.	Gadoa	Indg., comm.	MT

Euphorbiaceae	**Macaranga magna Turrill	Davo	End., comm.	MT
Euphorbiaceae	***Malaisia scandens* (Lour.) Plaunch.		Indg., comm.	MT
Euphorbiaceae	Acalypha insulana Müll.Arg.	Kalabuci	Indg., comm.	MT
Euphorbiaceae	Acalypha rivularis Seem.	Kalabuci	End., loc. comm.	MT
Euphorbiaceae	Aleurites moluccana (L.) Willd.	Lauci	Indg., comm.	MT
Euphorbiaceae	Antidesma sp.		Nat., comm.	MT, AW
Euphorbiaceae	Baccaurea sp.	Midra	Nat., comm.	MT
Euphorbiaceae	Baccaurea stylaris Muell.	Midra	End., comm.	MT
Euphorbiaceae	*Codiaeum variegatum* (L.) Rumph. ex A.Juss.	Sacasaca	Intrd., comm.	MT
Euphorbiaceae	Codiaeum variegatum var. moluccanum Muell	sacasaca ni veikau	Arb. intrd., comm.	MT
Euphorbiaceae	*Endospermum macrophyllum* (Muell. Arg.) Pax & Hoffm.	Kauvula	End., comm.	13161
Euphorbiaceae	Endospermum robbieanum A.C.Smith	Kauvula	End., comm.	MT
Euphorbiaceae	Euphorbia cyathophora Murray	Wild poinsettia	Exo., loc. comm.	MT
Euphorbiaceae	Glochidion cf. anfractuosum Gibbs	Molau	End., uncomm.	13427
Euphorbiaceae	Glochidion concolor Muell.	Molau	End., comm.	MT
Euphorbiaceae	Glochidion seemannii Muell. Arg.	Molau	End., uncomm.	13180
Euphorbiaceae	Glochidion sp. 1	Molau	Nat., uncomm.	MT
Euphorbiaceae	Glochidion sp. 2	Molau	Nat., uncomm.	MT
Euphorbiaceae	Glochidion sp. 3	Molau	Nat., uncomm.	MT
Euphorbiaceae	Glochidion sp. 4	Molau	Nat., uncomm.	13220
Euphorbiaceae	*Homalanthus nutans* (Forst. f.) Guillem.	Molaca	Indg., comm.	AW
Euphorbiaceae	Macaranga cf. graeffeana Pax ex Hoffm.	Gadoa	End., comm.	13216
Euphorbiaceae	Macaranga cf. magma Turrill	Davo	End., comm.	13256
Euphorbiaceae	Macaranga marikosensis A.C.Sm.	Gadoa	End., uncomm.	13247
Euphorbiaceae	Macaranga vitiensis Pax & Hoffm.	Gadoa	End., comm.	MT

Euphorbiaceae	*Omalanthus nutans* (Forst.f.) Guillemin		Indg., comm.	MT
Fabaceae	Aeshynomene indica L.	sensitive vetch	Exo., loc. comm.	MT
Fabaceae	Centrosema pubescens Benth.		Exo., loc. comm.	AW
Fabaceae	Crotalaria pallida Ait.		Exo., loc. comm.	MT
Fabaceae	Derris malaccensis (Benth.) Prain	duva ni niukini	Arb. intrd., loc. comm.	MT
Fabaceae	Derris trifoliata Lour.	Duva	Indg., comm.	MT
Fabaceae	Desmodium heterophyllum (L.) DC.		Exo., loc. comm.	AW
Fabaceae	Erythrina fusca Lour.	Drala	Indg., uncomm.	MT
Fabaceae	Mucuna gigantea (Willd.) DC.	Wakori	Indg., comm.	MT
Fabaceae	Pongamia pinnata (L.) Pierre	vesi wai	Indg., loc. comm.	MT
Flacourtiaceae	**Homalium pallidum A.C.Smith		End., comm.	MT
Flacourtiaceae	**Homalium sp.		End., comm.	MT
Flacourtiaceae	**Homalium vitiense Benth.	Molaca	End., comm.	AW, MT
Flacourtiaceae	Casearia procera A.C.Sm.		End., comm.	13413
Flacourtiaceae	Erythrospermum acuminatissimum (A. Gray) A.C.Sm.		Indg., comm.	MT
Flacourtiaceae	Homalium nitens Turrill	Molaca	End., uncomm.	MT
Flagellariaceae	Flagellaria gigantea Hook	Alu	End., comm.	MT
Flagellariaceae	Flagellaria indica L.		Indg., comm.	MT
Gesneriaceae	**Cyrtandra jugalis A.C.Smith		End., uncomm.	MT
Gesneriaceae	**Cyrtandra victoriae Gillespie		End., uncomm.	MT
Gesneriaceae	Cyrtandra cf. dolichocarpa A. Gray		End., uncomm.	AW
Gesneriaceae	Cyrtandra cf. ventricosa Gillette		End., uncomm.	13243
Gesneriaceae	Cyrtandra sp. 1		Nat., uncomm.	13244
Gesneriaceae	Cyrtandra sp. 2		Nat., uncomm.	13358
Gesneriaceae	Cyrtandra sp. 3		Nat., uncomm.	SHT

Gonystylaceae	***Gonystylus punctatus A.C.Sm.	Mavota	End., comm.	13291
Goodeniaceae	Scaevola floribunda A. Gray		End., comm.	13218
Heliconiaceae	Heliconia paka A.C.Sm.	Paka	Indg., comm.	MT
Hernandiaceae	Hernandia olivacea Gillespie	duvula, dalovoci	End., comm.	AW, MT
Icacinaceae	**Citronella vitiensis R.Howard	Nuqa	End., comm.	MT
Icacinaceae	Medusanthera vitiensis Seem.	Duvu	End., uncomm.	13300
Joinvilleaceae	*Joinvillea plicata* (Hook.) Newell & Stone		Indg., uncomm.	MT
Lamiaceae	Hyptis pectinata (L.) Poit.		Exo., loc. comm.	AW, SP
Lamiaceae	*Premna protrusa* A.C.Sm. & S.P.Darwin	Yaro	End., comm.	MT
Lamiaceae	Vitex trifolia L.	Vulokaka	Indg., comm.	MT
Lauraceae	***Endiandra elaeocarpa Gillespie		Indg., comm.	MT
Lauraceae	Cassytha filiformis L.		Indg., comm.	MT
Lauraceae	Cryptocarya sp.	Lidi	Nat., uncomm.	MT
Lauraceae	Endiandra sp.	Damabi	Nat., uncomm.	MT
Lauraceae	Litsea sp.	Lidi	Nat., comm.	MT
Lauraceae	*Litsea vitiana* (Meisn.) Drake	Lidi	End., comm.	MT
Lauraceae	Species indet. 1			13378
Lauraceae	Species indet. 2			13424
Loganiaceae	Fagraea berteroana A. Gray	Bua ni viti	Indg., comm.	MT
Loganiaceae	Fagraea gracilipes A. Gray	Buabua	Indg., uncomm.	MT
Loganiaceae	Geniostoma cf. vitiensis Gilg & Benedict	Boiboida	Indg., uncomm.	13214
Loganiaceae	Geniostoma macrophyllum Gillespie		End., comm.	MT
Loganiaceae	Geniostoma rupestre J. R. & G. Forst.	Boiboida	Indg., comm.	MT
Loganiaceae	Geniostoma sp.		Nat., uncomm.	AW, MT
Loganiaceae	*Neuburgia collina* (A.C.Sm.) A.C.Sm.	Bo	End., comm.	13160

Loganiaceae	Neuburgia corynocarpa (A.Gray) Leenh	Bo	Indg., comm.	MT
Loranthaceae	*Decaisnina forsteriana* (J.A. & J.H. Schultes) Barlow	fiji mistletoe	Indg., comm.	13217
Lythraceae	Cuphea carthagenensis (Jacq.) Macbr.		Exo., loc. comm.	AW
Malvaceae	**Sida rhombifolia L.		Exo., loc. comm.	MT
Malvaceae	**Triumfetta procumbens Forst.f.Fl.		Exo., loc. comm.	MT
Malvaceae	Commersonia bartramia (L.) Merr.	Sama	indg., loc. comm.	MT, AW
Malvaceae	Hibiscus tiliaceus L.	Vau	Indg., loc.comm.	MT
Malvaceae	Melochia vitiensis A.Gray		End., comm.	MT
Malvaceae	Sida acuta Burm.f.		Exo., loc. comm.	MT
Malvaceae	Urena lobata L.		Exo., loc comm.	AW
Melastomataceae	**Astronidium victoriae (Gillespie) A.C.Sm.		End., uncomm.	13222
Melastomataceae	**Heterotis rotundifolia (Sm.) Jacq.-Fél.		Exo., loc. comm.	MT
Melastomataceae	^**Astronidium inflatum* (A.C.Smith) A.C.Smith	Dava	End., loc. comm.	13193
Melastomataceae	^Astronidium confertiflorum (A. Gray) Markgraf	Dava	End., loc. comm.	13206
Melastomataceae	^Astronidium robustum (Seem.) A.C.Sm.	Dava	End., uncomm.	
Melastomataceae	Astronidium sp.		Nat., uncomm.	13401
Melastomataceae	Astronidium sp. nova		Nat., uncomm.	13259
Melastomataceae	Clidemia hirta (L.) D. Don	kaurasiga, koster's curse	Inv., very comm.	MT,SP
Melastomataceae	Dissotis rotundifolia (Sm.) Triana		Exo., loc. comm.	MT, SP
Melastomataceae	Medinilla aff. archboldiana A.C.Sm.		End., comm.	13164
Melastomataceae	Medinilla sp. 1		Nat., uncomm.	13285
Melastomataceae	Medinilla sp. 2		Nat., uncomm.	13426
Melastomataceae	Melastoma denticulatum Labill.	Karausiga	Exo., loc. comm.	13408
Melastomataceae	Memecylon cf. vitiense A. Gray		Indg., uncomm.	13226
Meliaceae	**Aglaia elegans Gillespie	Kautoa	End., comm.	13317

Meliaceae	**Dysoxylum mollissimum subsp. molle (Miq.) Mabb.		End., comm.	SHT
Meliaceae	**Swietenia macrophylla King		Cult., loc. comm.	SHT
Meliaceae	**Vavaea degeneri A.C.Smith		End., comm.	SHT
Meliaceae	Aglaia aff. archiboldiana A.C.Sm.		End., comm.	13191
Meliaceae	Aglaia cf. axillaris A.C.Sm.		End., uncomm.	13175
Meliaceae	Aglaia cf. venusta A.C.Sm.		End., uncomm.	13201
Meliaceae	Aglaia spp.	Kautoa	Nat., uncomm.	MT
Meliaceae	Aglaia vitiensis A.C.Smith		End., uncomm.	MT
Meliaceae	Dysoxylum cf. gillespieanum A.C.Sm.		End., uncomm.	13174
Meliaceae	Dysoxylum cf. myriandrum A.C.Sm.		End., uncomm.	13171
Meliaceae	Dysoxylum lenticellare Gillespie		End., comm.	MT
Meliaceae	*Dysoxylum richii* (A. Gray) C. DC.	tarawau kei rakaka	End., comm.	MT, 13172
Meliaceae	Dysoxylum seemannii Gillespie		End., comm.	MT
Meliaceae	Vavaea amicorum Benth.	Cevua	Indg., loc. comm.	13219
Meliaceae	Vavaea harveyi Seem.		End., comm.	MT
Meliaceae	Vavaea megaphylla C.H.Wright		End., comm.	MT
Mimosaceae	Acacia richii A. Gray	Qumu	End., comm.	MT
Mimosaceae	Albizia lebbeck (L.) Benth.		Exo., loc. comm.	MT
Mimosaceae	*Albizia saman* (Jacq.) F.v. Muell.	vaivai, ni valagi, raintree	Intrd., comm.	MT, SP
Mimosaceae	Entada phaseoloides (L.) Merr.	Walai	Indg., comm.	AW
Mimosaceae	Leucaena leucocephala (Lam.) de Wit	vaivai, balori	Exo., loc. comm.	AW, SP
Mimosaceae	Mimosa invisa Mart.ex Colla		Inv., comm.	SP
Mimosaceae	Mimosa pudica L.	sensitive grass	Exo., loc. comm.	AW, MT
Mimosaceae	Serianthes cf. melanesica Fosberg	vaivai ni veikau, vaivai ni viti	End., comm.	MT
Monimiaceae	Hedycarya dorsteniodes A. Gray		Indg., comm.	13198

Moraceae	**Ficus theophrastoides Seem.	Lolotagane	End., comm.	MT
Moraceae	*Ficus barclayana* (Miq.) Summerh.	ai masi	End., comm.	MT
Moraceae	Ficus cf. storckii Corner	Nunu	Indg., comm.	13179
Moraceae	Ficus fulvo-pilosa Summerh.	Nunu	End., comm.	13363
Moraceae	Ficus greenwoodii Summerhayes	Nunu	End., comm.	MT
Moraceae	*Ficus masonii* Horne ex Baker	ai masi, masimasi	End., uncomm.	MT
Moraceae	Ficus obliqua Forst.	baka ni viti	Indg., uncomm.	MT
Moraceae	Ficus pritchardii Seem.	Losilosi, masi	End., uncomm.	MT
Moraceae	*Ficus smithii* Horne ex Baker	Kabi	Indg., comm.	13294
Moraceae	Ficus spp.		Nat., comm.	MT
Moraceae	Ficus tinctoria Forst.f.Fl.		Indg., comm.	MT
Moraceae	Ficus vitiensis Seem.	Lololo	End., comm.	MT
Moraceae	Streblus anthropophagorum (Seem.) Corner	Malawaci	Indg., uncomm.	MT
Myrisinaceae	**Rapanea hadrocarpa A.C.Sm.	Dasia	End., comm.	MT
Myrisinaceae	Maesa insularis Gillespie	kutumirase	End., comm.	MT
Myrisinaceae	Tapeinosperma megaphyllum (Hemsl.) Mez	Dasia	End., comm.	MT
Myristicaceae	*Myristica castaneifolia A.Gray	male , kaudamu	End., comm.	MT
Myristicaceae	^Myristica macrantha A.C.Sm.	kaudamu male	End., comm.	MT
Myristicaceae	Myristica chartacea Gillespie	kaudamu drau lailai	End., comm.	13343
Myristicaceae	Myristica gillespieana A.C.Sm.	Kaudamu	End., comm.	MT
Myristicaceae	Myristica grandifolia A. DC	kaudamu draulevu	End., comm.	MT
Myrsinaceae	Maesa persicifolia A. Gray	bubu, kutumirase	End., uncomm.	13197
Myrsinaceae	Tapeinosperma sp. 1	Dasia	Nat., uncomm.	MT
Myrsinaceae	Tapeinosperma sp. 2	Dasia	Nat., uncomm.	MT
Myrsinaceae	Tapeinosperma sp. 3	Dasia	Nat., uncomm.	MT

Myrsinaceae	Tapeinospermum sp.	Dasia	Nat., uncomm.	13349
Myrtaceae	**Syzygium brackenridgei (A. Gray) C. Muell.	kavika gaga	Nat., uncomm.	13323
Myrtaceae	**Syzygium decussatum* (A.C.Sm.) Biffin & Craven	Yaiyasi	Indg., comm.	SHT
Myrtaceae	^*Syzygium wolfii* (Gillespie) Merr. & Perry	Yasiyasi	End., uncomm.	13166
Myrtaceae	Decaspermum vitiense (A. Gray) Niedenzu	nuqa, nuqanuqa	End., comm.	AW, MT
Myrtaceae	Metrosideros collina (Forst.) A. Gray	Vuga	Ind., loc. comm.	13167
Myrtaceae	Psidium guajava L.	Quava	Exo., loc. comm.	MT
Myrtaceae	Syzygium cf. fijiense Perry	yasiyasi, yasidravu	End., uncomm.	13403
Myrtaceae	*Syzygium effusum* (A. Gray) C. Muell.	yasiyasi, yasivula	End., uncomm.	MT
Myrtaceae	*Syzygium eugenioides* (F.Muell.) Biffin & Craven		End., comm.	SHT
Myrtaceae	*Syzygium gracillipes* (A. Gray) Merr. & Perry	Yasiyasi	End., uncomm.	AW, MT
Myrtaceae	*Syzygium grayi* (Seem.) Merr, & Perry	yasiyasi, yasileba	End., comm.	MT
Myrtaceae	*Syzygium malaccense* (L.) Merr. & Perry	kavika, malay apple	Arb. intrd., comm.	MT
Myrtaceae	*Syzygium quadrangulatum* (A.Gray) Merr. & Perry		Indg., comm.	SHT
Myrtaceae	Syzygium sp.	Yasiyasi	Nat., uncomm.	13388
Nyctaginaceae	*Pisonia umbellifera* (J. R. &G. Forst) Seem.	Roro	Indg., uncomm.	MT
Olacaceae	**Anacolosa lutea Gillespie	kaukau makita	Indg., comm.	13233
Oleaceae	Jasminum didymum Forst.f.		Indg., comm.	MT
Oleaceae	Jasminum simplicifolium Forst.f.		Indg., comm.	MT
Oleaceae	Jasminum sp.		Nat., ucomm.	MT
Onagraceae	Ludwigia octovalvis (Jacq.) Raven		Exo., loc. comm.	MT
Oxalidaceae	Oxalis corniculata L.		Exo., loc. comm.	MT
Passifloraceae	**Passiflora suberosa L.		Exo., loc. comm.	MT
Passifloraceae	Passiflora foetida L.		Exo., loc. comm.	MT
Peperomiaceae	Peperomia cf. ciliifolia Yuncker		End., uncomm.	13398

Peperomiaceae	Peperomia cf. curtispica C. DC.		End., uncomm.	AW
Peperomiaceae	Peperomia cf. falcata Yuncker		End., uncomm.	13287
Peperomiaceae	Peperomia lasiostigma C. DC.		End., comm.	13299
Peperomiaceae	Peperomia sp.		End., comm.	AW
Philesiaceae	*Geitonoplesium cymosum* (R.Br.) A.Cunn. ex R.Br.	wa dakua	Indg., comm.	MT
Phytolaccaceae	**Rivina humilis L.		Indg., comm.	MT
Piperaceae	Piper aduncum L.	Onalulu	Inv., loc comm.	SP, MT
Piperaceae	Piper betle L.	yagoyagona	Arb. intrd., comm.	MT
Piperaceae	Piper insectifugum? C. DC. ex Seem.	wa kawa	End., comm.	AW
Pittosporaceae	Pittosporum arborescens Rich ex A.Gray		Indg., comm.	SHT
Pittosporaceae	Pittosporum cf. pickeringii A. Gray	Duvakalou	End., comm.	13318
Pittosporaceae	Pittosporum cf. rhytidocarpum A. Gray	Duvakalou	End., comm.	13350
Pittosporaceae	Pittosporum spp.		Nat., uncomm.	SHT
Polygalaceae	Polygala paniculata L.		Exo., loc. comm.	AW
Proteaceae	****Turrillia ferruginea* (A.C.Smith) A.C.Smith	kauceuti levu	End., comm.	MT
Proteaceae	****Turrillia vitiensis* (Turrill) A.C.Sm.	Kauceuti	End., comm.	13422
Proteaceae	Turrillia sp.		Nat., uncomm.	13438
Rhamnaceae	**Alphitonia zizyphoides* (Sol. ex Spreng.) A.Gray	Doi	Indg., comm.	MT
Rhamnaceae	Alphitonia franguloides A. Gray	doi damu	End., comm.	13431
Rhamnaceae	Emmenosperma micropetalum (A.C.Sm) M. Johnston	Tomanu	End., uncomm.	MT
Rhamnaceae	Species indet.			13442
Rhizophoraceae	Crossostylis harveyi Benth.	tiri vanua	End., comm.	SHT
Rhizophoraceae	Crossostylis richii (A. Gray) A.C.Sm.	tiri vanua	End., comm.	13192
Rhizophoraceae	Crossostylis sp.		End., comm.	SHT
Rosaceae	Rubus moluccanus L.	wa vuka	Indg., comm.	AW, MT

Rubiaceae	**Calycosia petiolata A.Gray		End., comm.	SHT,MT
Rubiaceae	^^Psychotria st. johnii Fosberg	Deqedeqe	End., uncomm.	AW
Rubiaceae	^Gardenia gordonii Baker	Jale ni veikau	End., comm.	AW
Rubiaceae	Amaracarpus muscifer A.C.Sm.		End., uncomm.	MT
Rubiaceae	Calycosia lageniformis (Gillespie) A.C.Sm		End., uncomm.	MT
Rubiaceae	cf. Gardenia sp.		Nat., uncomm.	13246
Rubiaceae	Coprosma persicifolia A. Gray		End., comm.	13181
Rubiaceae	*Cyclophyllum rectinervium* (A.C.Sm.) A.C.Sm. & S. Darwin		End., loc. comm.	13260
Rubiaceae	Dolicholobium latifolium A. Gray	soso ni ura	End., comm.	MT
Rubiaceae	Dolicholobium macgregorii Horne ex Baker		End., comm.	MT
Rubiaceae	Dolilcholobium cf. oblongifolium A. Gray		End., comm.	13377
Rubiaceae	Gardenia storckii Oliv.		End., uncomm.	13267
Rubiaceae	*Geophila repens* (L.) I. M. Johnston		Indg., comm.	MT
Rubiaceae	Hedstromia latifolia A.C.Sm.	Bulei	End., uncomm.	MT
Rubiaceae	Hedyotis spp.		Nat., comm.	MT
Rubiaceae	Hydnophytum grandiflorum Becc.		End., comm.	MT
Rubiaceae	Hydnophytum longiflorum A. Gray		End., comm.	13272
Rubiaceae	Indet.			MT
Rubiaceae	Indet.			MT
Rubiaceae	Indet.			13252
Rubiaceae	Indet.			13270
Rubiaceae	*Ixora carewii* Horne ex Baker		End., comm.	13395
Rubiaceae	Ixora cf. coronata A.C.Sm.		End., uncomm.	13352
Rubiaceae	*Ixora cf. harveyi* (A. Gray) A.C.Sm.	Tomitomi	End., uncomm.	13240
Rubiaceae	Ixora cf. vitiensis Brownlie	Bulidavui	End., comm.	AW

Rubiaceae	Ixora elegans Gillespie	Motomoto	End., comm.	AW
Rubiaceae	Ixora sp.		Nat., uncomm.	AW
Rubiaceae	Mastixiodendron cf. flavidum (Seem.) A.C.Sm	Reiova	End., uncomm.	13337
Rubiaceae	Mastixiodendron spp.		Nat., comm.	SHT
Rubiaceae	Morinda bucidifolia A. Gray	wa kura	End., comm.	13248
Rubiaceae	Morinda citrifolia L.	Kura	Intrd., comm.	SHT
Rubiaceae	Morinda myrtifolia A. Gray	wa kura	Indg., uncomm.	SHT
Rubiaceae	Mussaenda raiateensis J.W.Moore	Bovo	Indg., comm.	AW, MT
Rubiaceae	*Neonauclea forsteri* (Seem. ex Havil.) Merr.	Vacea	Indg., comm.	AW, MT
Rubiaceae	Ophiorrhiza laxa A. Gray		End., comm.	13241
Rubiaceae	Ophiorrhiza leptantha A. Gray		Indg., comm.	13224
Rubiaceae	Ophiorrhiza peploides A. Gray		End., comm.	13286
Rubiaceae	Psychotria amoena A.C.Sm.	Deqedeqe	End., comm.	AW
Rubiaceae	*Psychotria cf. carnea* (Forst. f.) A.C.Sm.		End., comm.	13269
Rubiaceae	Psychotria confertiloba A.C.Smith	Tabulina	End., comm.	SHT
Rubiaceae	Psychotria parvula A.Gray	Deqedeqe	End., comm.	MT
Rubiaceae	Psychotria sp.	Deqedeqe, tabulina	Nat., uncomm.	13236
Rubiaceae	Psychotria sp. 1	Deqedeqe, tabulina	Nat., uncomm.	13253
Rubiaceae	Psychotria sp. 2	Deqedeqe, tabulina	Nat., uncomm.	13254
Rubiaceae	Psychotria sp. 3	Deqedeqe, tabulina	Nat., uncomm.	13292
Rubiaceae	Psychotria sp. 4	Deqedeqe, tabulina	Nat., uncomm.	13365
Rubiaceae	Psychotria sp. 5	Deqedeqe, tabulina	Nat., uncomm.	AW
Rubiaceae	Psychotria sp. 6	Deqedeqe, tabulina	Nat., uncomm.	13380
Rubiaceae	Psychotria sp. 7	Deqedeqe, tabulina	Nat., uncomm.	13420
Rubiaceae	Psychotria sp. 8	Deqedeqe, tabulina	Nat., uncomm.	13437

Rubiaceae	Psychotria spp.	Deqedeqe, tabulina	Nat., uncomm.	AW
Rubiaceae	Psychotria tephrosantha A.Gray	wa kau	End., ncomm.	13190
Rubiaceae	*Psydrax odorata* (Forst.) A.C.Sm.	nanokonisavu	Indg., comm.	MT
Rubiaceae	Readia membranacea Gillespie	Okeoke	End., comm.	13306
Rubiaceae	*Squamellaria wilsonii* (Horne ex Baker) Becc.	Sekeseke	End., uncomm.	13223
Rubiaceae	*Tarenna sambucina* (Forst.f.) Durand ex Drake	vakarubenidavui	Indg., comm.	MT
Rubiaceae	Timonius cf. affinis A. Gray	dogo ni veikau	Indg., comm.	13199
Rubiaceae	*Xanthophytum calycinum* (A.Gray) Benth. & Hook.f. ex Drake		Indg., comm.	MT
Rutaceae	***Citrus maxima* (Burm.) Osbeck	moli kania	Arb. intrd., comm.	SHT
Rutaceae	*Euodia hortensis* J.R. & G.Forst.	Uci	Arb. intrd., comm.	MT
Rutaceae	Melicope cucullata	drau tolu	End., comm.	13339
Rutaceae	Melicope sp. 1	drau tolu	Nat., uncomm.	13441
Rutaceae	Melicope sp. 2	drau tolu	Nat., uncomm.	13394
Rutaceae	Melicope vitiense	drau tolu	End., ucomm.	AW
Rutaceae	Micromelum minutum (Forst. f.) Seem.	Qiqila	Indg., comm.	AW
Sapindaceae	**Cardiospermum halicacabum L.		Indg., comm.	MT
Sapindaceae	Allophylus sp.		Nat., uncomm.	AW
Sapindaceae	Allophylus timoriensis (DC.) Bl.	kaiga	Indg., uncomm.	AW
Sapindaceae	Dodonaea viscosa (L.) Jacq.		Indg., comm.	MT
Sapindaceae	Elattostachys falcata (A. Gray) Radlk.	Marasa	Indg., comm.	AW, MT
Sapindaceae	Elattostachys venosa A.C.Smith		End., comm.	MT
Sapindaceae	Guioa sp.		Nat., uncomm.	13303
Sapindaceae	Koelreuteria elegans (Seem.) A.C.Smith		End., comm.	MT
Sapindaceae	*Pometia pinnata* J.R. Forst. & G. Forst.	Dawa	Indg., comm.	MT
Sapindaceae	Sapindus vitiensis A.Gray		Indg., comm.	MT

Sapotaceae	**Burckella richii (A.Gray) Lam		Intrd., comm.	MT
Sapotaceae	**Palaquium vitilevuense Gilly ex Royen	bau, bau vudi	End., comm.	MT
Sapotaceae	**Palaquium hornei* (Hartog ex Baker) Dubard	Sacau	End., comm.	AW
Sapotaceae	*Burckella fijiensis* (Hemsl.) A.C.Smith		End., comm.	MT
Sapotaceae	Burckella sp.	Bau	Nat., uncomm.	13322
Sapotaceae	Palaquium fidjiense Pierre ex Dubard	bau , bauvudi	End., uncomm.	13279
Sapotaceae	Palaquium porphyreum A.C.Sm.	bau, bau vudi	End., comm.	13316
Sapotaceae	Palaquium spp.		Nat., uncomm.	AW
Sapotaceae	Planchonella grayana St.John	Galaka	Indg., comm.	MT
Sapotaceae	*Planchonella pyrulifera* (A. Gray) Lam ex van Royen	Sarosaro	End., uncomm.	13258
Sapotaceae	Planchonella spp.	Sasawira	Nat., uncomm.	13344
Sapotaceae	Planchonella vitiensis Gillespie		End., comm.	MT
Saurauiaceae	Saurauria rubicunda (A. Gray) Seem.	Mimila	End., common.	13165
Simaroubaceae	Amaroria soulameoides A.Gray	vasa ni veikau	End., comm.	13189, 13315
Smilacaceae	Smilax vitiensis (Seem.) A. DC	Warusi	Indg., comm.	MT, AW
Solanaceae	**Solanum torvum Sw.	prickly solanum	Inv., comm.	MT
Solanaceae	Solanum americanum Mill.	Boro	Exo., loc comm.	AW
Sterculiaceae	∞Melochia parhamii A.C.Sm.		End., loc. comm.	13207
Sterculiaceae	Firmiana diversifolia A. Gray	Vau ceva	End., comm.	13351
Sterculiaceae	Heritiera ornithocephala Kostermans	rogi, rosarosa	Indg., comm.	AW
Sterculiaceae	Stercula vitiensis Seem.	Waciwaci	End., uncomm.	MT
Symplocaceae	Symplocos leptophylla (Brand) Turrill	molau ni veikau	Indg., uncomm.	AW
Thymelaeaceae	**Wikstroemia foetida L. f.	sinu ni veikau	Indg., comm.	13430
Thymelaeaceae	Phalaria glabra (Turrill) Domke		Indg., uncomm.	13360
Tiliaceae	*Trichospermum richii (A. Gray) Seem.	Mako	Indg., comm.	13384

Tiliaceae	Grewia cf. crenata (Forst.) Schinz & Guillaumin	Siti	Indg., comm.	13232
Tiliaceae	Trichospermum calyculatum (Seem.) Burret	Makoloa	End., comm.	MT
Tiliaceae	Trichospermum spp.		Nat., comm.	MT
Trimeniaceae	Trimenia weinmanniifolia Seem.		Indg., uncomm.	MT
Ulmaceae	Celtis harperi Horne	mala via	Indg., uncomm.	13421
Ulmaceae	Gironniera celtidifolia Gaud.	Sisisi	Indg., comm.	AW, MT
Ulmaceae	Parasponia andersonii (Planch.) Planch.	Drou	Indg., uncomm.	MT
Urticaceae	*Boehmeria virgata* (Forst. f.) Guillemin		Indg., loc. comm.	13221
Urticaceae	Cypholophus macrocephalus Wedd.	Lawa	Indg., uncomm.	MT
Urticaceae	Dendrocnide harveyi (Seem.) Chew	Salato	Indg., loc. comm.	MT
Urticaceae	Elatostema australe (Wedd.) Hall.	Beta	End., uncomm.	MT
Urticaceae	Elatostema cf. vitiense (Wedd.) A.C.Sm.		End., uncomm.	AW
Urticaceae	Elatostema humile A.C.Sm.		End, uncomm.	MT
Urticaceae	Elatostema insulare A.C.Sm		End., uncomm	MT
Urticaceae	Elatostema nemorosum Seem.	Beta	End., uncomm.	13354
Urticaceae	Elatostema seemannianum A.C.Sm.	Beta	End., ucomm.	13211
Urticaceae	Elatostema tenellum A.C.Sm.	Beta	End., uncomm.	13239
Urticaceae	Procris pedunculata (Forst. f.) Wedd.		Indg., loc. comm.	13289
Verbenaceae	**Stachytarpheta cayennensis (Rich.) Vahl		Exo., loc. comm.	AW, SP
Verbenaceae	Faradaya ovalifolia (A. Gray) Seem.	wa vudi	End., comm.	AW, MT
Verbenaceae	Faradaya vitiense Seem.	wa vutu	End., uncomm.	13432
Verbenaceae	Lantana camara L.	Lantana	Exo., loc. comm.	13326
Verbenaceae	Premna serratifolia L.	Yaro	Indg., comm.	13336
Verbenaceae	Stachytarpheta urticifolia (Salisb.) Sims		Inv., comm.	MT
Violaceae	Agatea violaris A. Gray		Exo., loc. comm.	13227

Viscaceae	***Korthalsela platycaula* (van Tieghem) Engl.**	Kabikabi	Indg., uncomm.	13277
Vitaceae	Cayratia seemanniana A.C.Smith		End., comm.	MT
Vitaceae	Cayratia vitiensis (A.Gray) Suess.		End., comm.	MT
Vitaceae	Tetrastigma vitiense A. Gray	wa lisilisi	End., uncomm.	AW

Appendix 2 Checklist of mosses and liverworts

Family	Species Name	Vouchers/Collector's Number
Vouchers: Species recorded and/or collected by SHT (Senilolia H Tuiwawa) or Mereia M. Tabua (MMT)		
MOSSES		
-	Musci – unidentifiable	MMT386, 395, 400, 433, 467, 470, 480, 486, 493,
Calymperaceae	Calymperaceae sp. 1	MMT474
Calymperaceae	Calymperaceae sp. 2	MMT492
Calymperaceae	*Calymperes cf. serratum* A. Braun ex Müll. Hal.	SHT6055.2013; MMT423
Calymperaceae	Calymperes cf. tahitense (Sull.) Mitt.	MMT427, 439
Calymperaceae	Calymperes sp.	MMT389
Calymperaceae	Leucophanes cf. massartii Renauld & Cardot	MMT392, 425, 436, 461
Calymperaceae	Mitthyridium cf. luteum (Mitt.) H. Rob.	MMT452
Calymperaceae	Mitthyridium cf. repens (Harv.) H. Rob.	MMT489
Calymperaceae	Syrrhopodon cf. croceus Mitt.	MMT451, 475
Calymperaceae	*Syrrhopodon cf. muelleri* (Dozy & Molk.) Sande Lac.	MMT450
Calymperaceae	Syrrhopodon cf. vitianus E. B. Bartram	MMT405
Calymperaceae	Syrrhopodon sp. 1	MMT404
Calymperaceae	Syrrhopodon sp. 2	MMT440
Calymperaceae	Syrrhopodon tristichus Nees ex Schwägr.	MMT484
Cyrtopodaceae	*Bescherellia cryphaeiodes* (Mull.Hal.) M. Fleisch.	SHT6012.2013
Dicranaceae	cf. Campylopodium spp.	SHT6038.a.2013
Dicranaceae	cf. Campylopus sp.	MMT405
Dicranaceae	*Leucobryum candidum* (Brid. ex P. Beauv.) Wilson	MMT403
Dicranaceae	*Leucobryum candidum var. pentastichum* (Cardot & Thér.) H.A. Mill., H. Whittier & B. Whittier	SHT6008.a.i.2013
Dicranaceae	Leucobryum cf. aduncum	MMT425
Dicranaceae	Leucobryum cf. glaucum	SHT6002.2013
Dicranaceae	*Leucobryum cf. sanctum* (Nees ex Schwägr.) Hampe	MMT364, 476
Dicranaceae	*Leucobryum sanctum* (Nees ex Schwagrichem) Hampe	SHT6008.a.i.2013
Dicranaceae	*Leucobryum scalare* C.Mull. Hal. ex Fleischer	SHT6038.b.2013
Dicranaceae	Leucobryum sp. 1	MMT469
Dicranaceae	Leucobryum sp. 2	MMT482
Dicranaceae	Leucoloma tenuifolium Mitt.	SHT6021.c.ii.2013, 6025.2013, 6027.a.2013, 6043.2013; MMT376, 420, 459, 461
Fissidentaceae	Fissidens sp. 1	MMT432
Fissidentaceae	Fissidens sp. 2	MMT487
Hookeriaceae	Calyptrochaeta subremotifolia (Broth.) Fife	SHT6041.c.2013
Hookeriaceae	Distichophyllum sp.	MMT434

Family	Species Name	Vouchers/Collector's Number
Vouchers: Species recorded and/or collected by SHT (Senilolia H Tuiwawa) or Mereia M. Tabua (MMT)		
Hookeriaceae	Distichophyllum vitianum (Sull.) Mitt.	MMT430, 438
Hypnaceae	cf. Hypnum sp.	MMT410, 411
Hypnaceae	cf. Isopterygium sp. 1	MMT437, 441
Hypnaceae	Ectropothecium spp.	SHT6024.a.2013, 6032.2013, 6041.b.2013, 6023.2013
Hypnaceae	Hypnaceae sp. 1	MMT417
Hypnaceae	Hypnaceae sp. 2	MMT377
Hypnaceae	Isopterygium cf. minutirameum (Müll. Hal.) A. Jaeger	MMT432
Hypnaceae	Vesicularia cf. inflectens (Brid.) Müll. Hal.	MMT426
Hypnodendraceae	Hypnodendron cf. subspininervium	MMT460, 488
Hypnodendraceae	Hypodendron spp.	SHT6003.2013, 6024.b.2013; MMT418
Hypopterygiaceae	Hypopterygium cf. vriesii Bosch & Sande Lac.	MMT428
Meteoriaceae	Floribundaria aeruginosa (Mitt.) M. Fleisch.	SHT6008.a.iii.2013
Meteoriaceae	Papillaria helictophylla (Mont.) Broth.	SHT6045.2013
Neckeraceae	Homaliodendron flabellatum (Sm.) M. Fleisch.	MMT459, 460, 488
Neckeraceae	Neckeropsis lepineana (Mont.) Fleisch.	MMT381
Neckraceae	*Thamnobruym ellipticum* (Bosch & Sande Lacoste) Niuewland	SHT6034.a.i.2013
Neckraceae	Thamnobruym sublatifolium (Dixon) Schultze-Motel	SHT6034.a.ii.2013
Octoblepharaceae	Octoblepharum albidum Hedw.	MMT445
Orthotrichaceae	Macromitrium angulatum Mitt.	SHT6000.2013, 6008.a.ii.2013, 6018.a.2013, 6018.b.2013, 6018.c.2013, 6014.2013, 6030.e.2013
Orthotrichaceae	Macromitrium cf. incurvifolium (Hook. & Grev.) Schwägr.	SHT6003.2013, 6018.d.i.2013, 6030.b.2013; MMT371, 372, 410, 411, 477
Pilotrichaceae	Callicostella papillata (Mont.) Jaeg.	MMT379, 426
Polytrichaceae	Pogonatum sp.	MMT383
Pterobryaceae	cf. Calyptothecium sp.	MMT378
Pterobryaceae	Garovaglia powellii Mitt.	SHT6010.2013, 6015.2013,6030.c.2013, 6022.2013; MMT366, 411, 422, 468
Pterobryaceae	Symphysodentella cylindracea	SHT6024.b.2013, SHT6026.a.ii.2013
Pterobryaceae	Symphysodon spp.	SHT6007.2013
Rhizogoniaceae	*Hymenodon pilifer* Hook. f. & Wilson	MMT337, 414, 412
Rhizogoniaceae	Pyrrhobryum cf. spiniforme (Hedw.) Mitt.	MMT462
Sematophyllaceae	*Meiothecium hamatum* (Müll. Hal.) Broth.	SHT6027/2013
Spiridentaceae	Spiridens aristifolius Mitt.	SHT6046.2013; MMT415, 460
Thuidiaceae	cf. Thuidium sp. 1	MMT424
Thuidiaceae	cf. Thuidium sp. 2	MMT429
Thuidiaceae	Pelekium velatum Mitt.	MMT442

Family	Species Name	Vouchers/Collector's Number
Vouchers: Species recorded and/or collected by SHT (Senilolia H Tuiwawa) or Mereia M. Tabua (MMT)		
LIVERWORTS		
Acrobolbaceae	Acrobolbus sp.	MMT458
Aneuraceae	Aneuraceae sp. 1	MMT390
Aneuraceae	Aneuraceae sp. 2	MMT426
Lejeuneaceae	Archilejeunea sp. 1	MMT431, 455, 477, 483
Lepidoziaceae	Bazzania cf. trilobata (L.) Gray	MMT464, 472, 476, 489
Lepidoziaceae	Bazzania sp. 1	MMT446, 458
Lepidoziaceae	Bazzania sp. 2	MMT446, 453, 471
Lepidoziaceae	Bazzania sp. 3	MMT448
Lejeuneaceae	Caudalejeunea cf. reniloba (Gottsche) Stephani	MMT436
Lejeuneaceae	Ceratolejeunea sp.	MMT450
Lejeuneaceae	cf. Colura sp.	MMT490
Lejeuneaceae	cf. Lepidolejeunea sp.	MMT454
Frullaniaceae	Frullania sp. 1	MMT394, 410, 485
Frullaniaceae	Frullania sp. 2	MMT408, 411, 365, 385
-	Hepaticae - unidentifiable	MMT368, 369, 374, 375, 387, 388
-	Hepaticae - unidentifiable	MMT396, 402, 407, 409, 416, 419, 421, 466
Herbertaceae	Herbertus sp. 1	MMT367
Geocalycaceae	Heteroscyphus sp. 1	MMT463, 491
Lejeuneaceae	Lejeunea cf. anisophylla Mont.	MMT436, 443, 445
Lejeuneaceae	Lejeunea sp. 1	MMT443
Lejeuneaceae	Lejeunea sp. 2	MMT483
Lejeuneaceae	Lejeunea sp. 3	MMT491
Lejeuneaceae	Lejeuneaceae sp. 1	MMT384
Lejeuneaceae	Lejeuneaceae sp. 2	MMT391
Lejeuneaceae	Lejeuneaceae sp. 3	MMT446
Lejeuneaceae	Lejeuneaceae sp. 4	MMT458
Lejeuneaceae	Lejeuneaceae sp. 4	MMT449
Lejeuneaceae	Lejeuneaceae sp. 5	MMT463
Lejeuneaceae	Lejeuneaceae sp. 6	MMT479
Lejeuneaceae	Lejeuneaceae sp. 7	MMT489
Lepidoziaceae	Lepidoziaceae sp. 1	MMT475
Lepidoziaceae	Lepidoziaceae sp. 2	MMT465
Lejeuneaceae	Lopholejeunea cf. eulopha (Taylor) Schiffner	MMT406, 410, 461, 481,
Lejeuneaceae	Lopholejeunea cf. nigricans (Lindenb.) Stephani	MMT411
Lejeuneaceae	Lopholejeunea cf. subfusca (Nees) Schiffner	MMT464

Family	Species Name	Vouchers/Collector's Number
Vouchers: Species recorded and/or collected by SHT (Senilolia H Tuiwawa) or Mereia M. Tabua (MMT)		
Lejeuneaceae	Lopholejeunea sp. 1	MMT382
Lejeuneaceae	Lopholejeunea subfusca (Nees) Schiffner	MMT393
Lejeuneaceae	Mastigolejeunea sp.	MMT432
Lejeuneaceae	*Metalejeunea cucullata* (Reinw., Blume & Nees) Grolle	MMT450, 461
Metzgeriaceae	Metzgeria sp. 1	MMT458
Metzgeriaceae	Metzgeria sp. 2	MMT490
Pallaviciniaceae	Pallavicinia sp.	MMT457
Pallaviciniaceae	Pallaviciniaceae sp. 1	MMT380
Plagiochilaceae	Plagiochila sp. 1	MMT370, 399
Porellaceae	Porella sp. 1	MMT410, 411, 413, 444, 447, 461,
Radulaceae	Radula cf. retroflexa Taylor	MMT397, 456, 459, 483, 461, 435, 473
Aneuraceae	Riccardia sp.	MMT435
Schistochilaceae	Schistochila sp.	MMT473
Trichocoleaceae	Trichocolea sp.	MMT398

Appendix 3 Summary statistics of vegetation community structure assessment

Plot # Locality	Longitude; Latitude	Principal Veg. Type	Forest / Habitat	# Ind. ≥ 5 cm	# Tree spp.	Most com. spp.	Largest trees	# Ind. ≥ 10 cm	Av. dbh (cm)	Range (cm)	B. area cm^2 (stems ≥ 10cm DBH	Dom. sp.	Rel. Dom. (%)
Delaikoro; 900m a.s.l.; 26.09.13													
T1P1 Del	-16.5867973; 179.314486	Cloud Forest	slope	28	15	Mac_spp.	Gen_spp.; Pan_vit	6	6.8	1-12	393.0	Gen_spp.	20.6
T1P2 Del	-16.5867973; 179.314487	Cloud Forest	slope	33	16	Syz_ spp.	Cro_spp.	12	7.9	3-13	925.0	Syz_ spp.	23.7
T1P3 Del	-16.5867973; 179.314488	Cloud Forest	slope	39	17	Cya_hor	Cya_hor	6	6.8	3-15	352.0	Cya_hor	16.5
T1P4 Del	-16.5867973; 179.314489	Cloud Forest	slope	22	12	Syz_ spp.	Syz_ spp.	5	6.8	3-13	26.7	Syz_ spp.	47.1
T1P5 Del	-16.5867973; 179.314490	Cloud Forest	slope	20	13	Syz_ spp.	Syz_ spp.	5	6.8	3-16	208.3	Syz_ spp.	33.1
T1P6 Del	-16.5867973; 179.314491	Cloud Forest	slope	13	11	Syz_ spp.	Aga_mac	3	7.7	4-20	56.9	Aga_mac	30.7
T1P7 Del	-16.5867973; 179.314492	Cloud Forest	slope	25	16	Cya_hor	Als_spp.	5	7.1	3-15	300.0	Als_ spp.	15.6
T1P8 Del	-16.5867973; 179.314493	Cloud Forest	slope	19	12	Syz_ spp.	Neu_spp.	5	6.9	3-11	259.1	Neu_spp.	14.4
T1P9 Del	-16.5867973; 179.314494	Cloud Forest	slope	21	11	Cya_hor	Elae_spp.	6	6.5	3-13	369.0	Elae_spp.	11.4
T1P10 Del	-16.5867973; 179.314495	Cloud Forest	slope	26	12	Syz_ spp.	Elae_spp.	5	7.6	4-22	375.2	Elae_spp.	23.5
Max				39	1 6	Syz_spp.		12	7.9			Cya _hor	
Min				13					6.5				
Navakuro; 600m a.s.l.; 26.09.13													
T1P1 Nav	-16.60464; 179.37671	Lowland rainforest	slope	21	14	Mac_ spp.	Alp_ spp.	11	9	3-23	831.4	Neu_spp.	27.7
T1P2 Nav	-16.60464; 179.37672	Lowland rainforest	slope	16	13	Cythyx_sp.	Pal_ spp.	10	11.8	4-23	1801.3	Pal_spp.	17.5

Plot # Locality	Longitude; Latitude	Principal Veg. Type	Forest / Habitat	# Ind. ≥ 5 cm	# Tree spp.	Most com. spp.	Largest trees	# Ind. ≥ 10 cm	Av. dbh (cm)	Range (cm)	B. area cm^2 (stems ≥ 10cm DBH	Dom. sp.	Rel. Dom. (%)
T1P3 Nav	-16.60464; 179.37673	Lowland rainforest	slope	24	18	Fic_ful	Dys_ ric	12	13.6	3-55	4677	Dys_ric	33.2
T1P4 Nav	-16.60464; 179.37674	Lowland rainforest	slope	11	11	Cya_spp. End_ spp, Fic_sto	Syz_spp.	7	8.5	3-33.5	1216.0	Syz_ spp.	53
T1P5 Nav	-16.60464; 179.37675	Lowland rainforest	slope	16	16	Gir_cel	Ret_vit	7	11	3-45	2969.0	Ret_vit	48
T1P6 Nav	-16.60464; 179.37676			9	5	Mac_spp.; Cya_spp.	End_mac	4	11.2	3-35	1186.2	End_mac	52
Max				24	18		Dys_ric	12	13.6	3		End_mac	
Min				9	5			4	8.5	55			
Navakuro; 790m a.s.l.; 26.09.13													
T2P1 Nav		Cloud Forest	slope	17	10	Cal_vit; Pom_pin; Syz_spp.	Syz_ spp.	7	8.6	5-13	526	Syz_ spp.	33.2
T2P2 Nav		Cloud Forest	slope	19	10	Syz_ spp.	Syz_ spp.	2	7	5-15	226.9	Syz_ spp.	42.4
T2P3 Nav		Cloud Forest	slope	18	11	Vei_sp., Syz_spp.	Lit_spp.	3	6.8	4-15	333.6	Lit_spp.	23.8
T2P4 Nav		Cloud Forest	slope	14	10	Cyat_spp.	Sau_rub; Syz_ spp.	3	8	5-15	268.5	Sau_rub	25.3
Max				19	11	Syz_spp	Syz_spp	7	8.6				
Min				14	10			2	6.8				
Savusa; 310m a.s.l.; 29.09.13													
T1P1 Sav	-16.6353321; 179.370991	Lowland rainforest	slope	17	5	Gir_cel	Can_spp.	11	15.3	4-40	2534	Can_spp.	37
T1P2 Sav	-16.6353321; 179.370992	Lowland rainforest	slope	25	8	Gir_cel	Myr_cha	16	13	6-41	4306.5	Myr_cha	27.7
T1P3 Sav	-16.6353321; 179.370993	Lowland rainforest	slope	19	6	Gir_cel	autia	13	17.8	5-60	8248.02	autia	33.4

Plot # Locality	Longitude; Latitude	Principal Veg. Type	Forest / Habitat	# Ind. ≥ 5 cm	# Tree spp.	Most com. spp.	Largest trees	# Ind. ≥ 10 cm	Av. dbh (cm)	Range (cm)	B. area cm^2 (stems ≥ 10cm DBH	Dom. sp.	Rel. Dom. (%)
T1P4 Sav	-16.6353321; 179.370994	Lowland rainforest	slope	23	8	Gir_cel	Neu_spp.	17	17.8	5-57	6302.8	Neu_spp.	39.3
T1P5 Sav	-16.6353321; 179.370995	Lowland rainforest	slope	12	8	Gir_cel	Pte_oce	8	21.2	7-46	5543.7	Pte_oce	28.9
T1P6 Sav	-16.6353321; 179.370996	Lowland rainforest	slope	7	7	none	Pal_ spp.	6	16	7-24	1528.4	Pal_ spp.	28.9
T2P1 Sav		Lowland rainforest	slope	24	12	Gir_cel	Fic_the	18	14.9	3-33	4393.6	Fic_the	15.5
T2P2 Sav		Lowland rainforest	slope	22	14	Gir_cel	Ret_vit	13	17.7	5-68	4361.5	Ret_vit	36.9
T2P3 Sav		Lowland rainforest	slope	29	17	Cya_ ala; Gir_cel	Ret_vit	17	15.1	5-50	7327.2	Ret_vit	25.2
T2P4 Sav		Lowland rainforest	slope	18	13	Cit_vit; Gir_cel	Myr_cha	12	14.6	5-53	4314	Myr_cha	42.3
T2P5 Sav		Lowland rainforest	slope	21	15	Syz_spp.	Calo_viti	13	20.1	4-73	6110.4	Calo_vit	32.6
Max				29	17	Gir_cel	Calo_vit	18	21.2	5.0-73		Ret_vit	
Min				7	5			6	13			Myr_cha	
T3P1 Sav	-16.6389575; 179.3710532	Lowland rainforest	ridge flat	23	16	Syz_spp.	Syz_spp.	17	18.9	5-70	8489	Syz_spp.	48.7
T3P2 Sav	-16.6389575; 179.3710533	Lowland rainforest	ridge flat	20	14	Myr_cha	Myr_cha	12	23.3	5-70	9240.2	Myr_spp	29.6
T3P3 Sav	-16.6389575; 179.3710534	Lowland rainforest	ridge flat	20	13	Syz_spp.	End_mac	13	24.1	3-80	5473.8	End_mac	41.1
T3P4 Sav	-16.6389575; 179.3710535	Lowland rainforest	ridge flat	22	14	Cya_spp. + End_sp.	Deg_vit	9	16.4	5-82	5357.6	Deg_vit	46.2
T3P5 Sav	-16.6389575; 179.3710536	Lowland rainforest	ridge flat	16	12	Myr_spp	Myr_spp	8	16.2	5-52	6309.8	Myr_spp	32.3
T3P6 Sav	-16.6389575; 179.3710537	Lowland rainforest	ridge flat	17	14	none	Myr_spp	14	26.4	3-81	16481.9	Myr_spp	37.8
T3P7 Sav	-16.6389575; 179.3710538	Lowland rainforest	ridge flat	14	10	Cya_spp.	Par_ins	7	12	5-25	1159.4	Par_ins	21.2

Plot # Locality	Longitude; Latitude	Principal Veg. Type	Forest / Habitat	# Ind. ≥ 5 cm	# Tree spp.	Most com. spp.	Largest trees	# Ind. ≥ 10 cm	Av. dbh (cm)	Range (cm)	B. area cm^2 (stems ≥ 10cm DBH	Dom. sp.	Rel. Dom. (%)
T3P8 Sav	-16.6389575; 179.3710539	Lowland rainforest	ridge flat	17	12	Myr_gra	Syz_spp.	10	21.6	5-65	9588.8	Myr_spp	31.3
T3P9 Sav	-16.6389575; 179.3710510	Lowland rainforest	ridge flat	24	14	Myr_gra	Syz_spp.	18	17.5	5-52	6973.9	Myr_spp	53.2
Max				24	16		Deg_vit	18	26.4	82		Myr_spp	
Min				14	10			7	12	5			
Nukubolu; elevation; 30.09.13													
T1P1 Nuk	-16.63462; 179.36497	Lowland rainforest	slope/ridge	23	14	Myr_spp	Myr_spp	15	17.4	5-42	7651.4	Myr_spp	47.3
T1P2 Nuk	-16.63462; 179.36498	Lowland rainforest	slope/ridge	20	12	Mac_spp	Myr_spp	4	9.2	5-41	1643.8	Myr_spp	59.4
T1P3 Nuk	-16.63462; 179.36499	Lowland rainforest	slope/ridge	18	9	Syz_ spp.	Syz_ spp.	9	13.4	5-31	3215.4	Syz_ spp.	59.2
T1P4 Nuk	-16.63462; 179.36500	Lowland rainforest	slope/ridge	20	15	Syz_ spp.	Myr_spp	11	14.6	5-62	3945.4	Myr_spp.	49.7
T1P5 Nuk	-16.63462; 179.36501	Lowland rainforest	slope/ridge	18	11	Sau_rub	Syz_ spp.	7	9.5	5-28	1310.2	Syz_ spp.	39.9
T1P6 Nuk	-16.63462; 179.36502	Lowland rainforest	slope/ridge	16	11	Als_spp.; Syz_spp	Syz_ spp.	8	12.5	5-32	2493.9	Syz_ spp.	67
T1P7 Nuk	-16.63462; 179.36503	Lowland rainforest	slope/ridge	11	6	Syz_ spp.	Her_oli	9	22	6-65	6247.8	Her_orn	49.6
T1P8 Nuk	-16.63462; 179.36504	Lowland rainforest	slope/ridge	22	11	Syz_ spp.	Syz_ spp.	15	17	5-47	4337.1	Syz_ spp.	39.5
T1P9 Nuk	-16.63462; 179.36505	Lowland rainforest	slope/ridge	21	10	Syz_ spp.	Dys_spp.	11	13	5-34	3552.1	Dys_spp.	23.4
T1P10 Nuk	-16.63462; 179.36506	Lowland rainforest	slope/ridge	18	9	Syz_ spp.	Dys_spp.	10	11.5	5-20	1834.5	Dys_spp.	47.9
Max				23	15	Syz_spp	Syz_spp.	15	17.4	5-65		Syz_ spp.	
Min				11	6			4	9.2				

Appendix 4 Checklist of insects recorded within the Great Delaikoro Area

Order	Family	Scientific name	Delaikoro lowland	Delaikoro upland	Waisali	Sorolevu
Coleoptera	Anthribidae		-	-	4	-
	Lampyridae		-	-	1	1
	Chrysomelidae		-	-	-	2
	Carabidae		-	-	4	6
	Curculionidae		-	-	4	23
	Elateridae		-	-	-	15
	Coccinelidae		-	-	-	1
	Eucnemidae		-	-	-	1
	Lathrididae		-	-	26	6
	Nitidulidae		-	-	-	1
	Passalidae		-	-	-	1
	Platypodidae		-	-	-	1
	Pselaphidae		-	-	51	15
	Scarabaeidae		-	-	-	18
	Scolytidae		-	-	5	4
	Staphylinidae		-	-	23	24
	Tenebrionidae		-	-	-	1
	Zopheridae		-	-	-	1
Diptera	Others		-	-	-	2
Hymenoptera	Formicidae		-	-	21	232
Hemiptera	Cicadidae		-	-	-	1
	Others		-	-	17	3

Order	Family	Scientific name	Delaikoro lowland	Delaikoro upland	Waisali	Sorolevu
Lepidoptera	Yponomeutidae	Atteva aleatrix ***	-	-	3	-
	Uraniidae	Urapteroides anerces *	2	-	2	-
	Sphingidae	Gnathothlibus fijiensis **	1	1	-	-
	Geometridae	Bulonga philipsi *	1	-	4	1
	Geometridae	Agathia pisina	1	-	1	1
	Geometridae	Cleora sp. *	1	-	46	12
	Geometridae	Pyrrhorachis pyrrhogona	-	-	2	-
	Geometridae	Thalassodes chloropis	-	-	21	4
	Geometridae	Thalasodes pilaria	-	1	-	-
	Geometridae	Thalassodes figurata *	-	-	4	-
	Geometridae	Scotocyma miscix *	-	1	1	-
	Geometridae	Casbia aedoe **	1	-	-	-
	Geometridae	Sauris elaica	1	-	1	-
	Geometridae	Scardamia eucampta	-	1	-	-
	Geometridae	Luxiaria sesquilinea **	-	-	3	-
	Geometridae	Petelia aesyla *	-	-	-	3
	Geometridae	Horisme chlorodesma *	-	-	8	-
	Limacodidae	Beggina mediopunctata *	1	-	-	-
	Lymantriidae	Calliteara fidjiensis *	-	3	6	19
	Lymantriidae	Calliteara nandarivatu **	1	-	-	-
	Lymantriidae	Adetoneura lentiginosa *	-	-	1	1
	Noctuidae	Ericaea leichardtii	5	8	1	-
	Noctuidae	Ericaea inangulata	2	-	-	-
	Noctuidae	Hydrillodes surata	25	-	-	-

Order	Family	Scientific name	Delaikoro lowland	Delaikoro upland	Waisali	Sorolevu
	Noctuidae	Mythimna separate	-	1	-	-
	Noctuidae	Hypena rubrescens **	2	-	-	-
	Noctuidae	Mocis frugalis	-	1	-	-
	Noctuidae	Hypocala deflorata	1	-	-	-
	Noctuidae	Daphnis placida	-	-	-	1
	Noctuidae	Achaea robinsoni	1	-	-	-
	Noctuidae	Sasunaga oenistis	2	2	-	-
	Noctuidae	Athetis thoracica	1	3	-	-
	Noctuidae	Aedia sericea	1	-	-	-
	Noctuidae	Dysgonia prisca	1	1	-	1
	Noctuidae	Rusicada vulpina *	-	-	6	1
	Noctuidae	Palaeocoleus sypnoides *	45	-	4	1
	Noctuidae	Tholocoleus astrifer **	3	-	-	-
	Noctuidae	Tiracola plagiata	16	75	4	3
	Noctuidae	Sarbissa bostrychonota *	1	-	-	-
	Noctuidae	Eudocima salaminia	1	-	-	-
	Microlepidoptera	Micro's***	34	5	6-	17
	Pyralidae	Locastra ardua***	7	-	5	4
Lepidoptera	Nymphalidae	Hypolimnas inopinata **	-	-	-	2
		Hypolimnas bolina	-	1	-	-
		Euploea boisduvalli	1	-	-	-
		Junonia villida	1	-	-	-
	Papilionidae	Papilio schmeltzi *	2		1	2
	Satyridae	Xois sesara *	-	1	-	-

Order	Family	Scientific name	Delaikoro lowland	Delaikoro upland	Waisali	Sorolevu
	Pieridae	Eurema hecabe	1	-	-	-
Orthorptera	Tettigonidae		-	-	-	1
	Gryllidae		-	-	-	2
Odonata		Nesobasis spp. **	5	-	-	13
		Melanesobasis spp.	2	-	-	3
Phasmida	Phasmatidae	Phasmatonea inermis**	-	-	-	1
		Cotylosoma dipneusticum**	-	-	1	1
Arachnidae			-	-		13
Opiliones			-	-	22	17
Acari			-	-	13	-

* - endemic, **- Endemic and significant, *** - Not enough information on the species
NB: No leaf litter or light traps for groups other than Macromoths were sampled from Delaikoro.

Appendix 5 Location of terrestrial insect sampling sites

Code	Latitude	Longitude	Elevation	Date	Notes
1	-16.5868	179.3145	958m	26.ix.13	Ridge on Mount Delaikoro; Spotted 5 *Xois sesara* and 2 *Hypolimnas bolina* along the slope leading up to the ridge
2	-16.5994	179.3669	217m	27.ix.13	1 *P.schmeltzi* was spotted while crossing
3	-16.6047	179.3760	469m	27.ix.13	Cicada nymphal shell
4	-16.6052	179.3748	441m	27.ix.13	Termites on dead log
5	-16.6063	179.3834	490m	27.ix.13	LL_1 ; along ridge of Secondary forest
6	-16.6036	179.3701	298m	27.ix.13	1 Junonia villida; 1 Hypolimnas bolina along trek
7	-16.6066	179.3832	622m	27.ix.13	LL2_Start ; Upland secondary forest ridge; 1 scorpion collected
8	-16.6071	179.3836	635m	27.ix.13	LL2_End ; also found stick insect *Cotylosoma dipneusticum* on niuniu plant (*Balaka seemanii*)
9	-16.5998	179.3674	238m	27.ix.13	spotted one *Nesobasis sp* along stream

10	-16.5982	179.3656	230m	27.ix.13	1 Orthoptera
11	-16.6169	179.3887	788m	27.ix.13	LL3_Start; Upland intact forest ridge. Dominant trees ;cevua, vadra, damanu,sole,doi,wame; *Phasmatonea inermis*
12	16.6171	179.3891	786m	27.ix.13	LL3_End; Upland intact forest ridge. Dominant trees ;cevua, vadra, damanu,sole,doi,wame
13	-16.5888	179.3651	171m	27.ix.13	1 Eurema hacabe along trek
14	-16.6511	179.3603	56m	28.ix.13	1 *Junonia villida* along plantation
15	-16.6458	179.3605	67m	28.ix.13	1 *Hypolimnas bolina* along open disturbed area
16	-16.6451	179.3618	75m	28.ix.13	2 *E.boisduvalli* in bamboo area
17	-16.6405	179.3638	100m	28.ix.13	1 Papilio schmeltzi along river
18	-16.6327	179.3688	333m	29.ix.13	Termites collected in dead log on secondary forest floor
19	-16.6353	179.3697	278m	29.ix.13	1 Nesobasis sp. along the trek near stream
20	-16.6349	179.3695	293m	29.ix.13	*Papilio schmeltzi* flying along first waterfall
21	-16.6353	179.3710	327m	29.ix.13	Leaf Litter_4_Start ; Secondary forest on lowland slope
22	-16.6357	179.3711	346m	29.ix.13	Leaf Litter_4_End; Secondary forest on lowland slope
23	-16.6390	179.3711	375m	29.ix.13	Leaf Litter 5_Start ; in Secondary forest lowland ridge with 75% canopy cover
24	-16.6391	179.3707	363m	29.ix.13	Leaf Litter 5_End ; in Secondary forest lowland ridge with 75% canopy cover
25	-16.6334	179.3654	216m	29.ix.13	Savusa LT_1 ; setup in secondary lowland forest ridge, 200m up from base camp
26	-16.6375	179.2123	492m	01.x.13	Waisali Forest Park LT_2
27	-16.6295	179.2083	636m	01.x.13	Waisali Leaf Litter 6_Start ; Montane cloud forest upland slope, with dominant tree species being Sisisi and Yasiyasi
28	-16.6292	179.2083	615m	01.x.13	Waisali Leaf Litter 6_End ; Montane cloud forest upland slope, with dominant tree species being Sisisi and Yasiyasi
29	-16.6287	179.2073	604m	01.x.13	*Cotylosoma dipneusticum* found on bark of dogo ni vanua (*Timonious affinis*) in primary forest
30	-16.6258	179.2072	584m	01.x.13	Waisali Leaf Litter 7_Start ; Upland secondary forest across slope
31	-16.6253	179.2070	576m	01.x.13	Waisali Leaf Litter 7_End ; Upland secondary forest across slope
32	-16.6290	179.2070	610m	01.x.13	Waisali Leaf Litter 8_Start ; Upland secondary forest slope

33	-16.6291	179.2074	628m	01.x.13	Waisali Leaf Litter 8_End ; Upland secondary forest slope
34	-16.5692	179.3188	625m	02.x.13	LT_3 ; Lowland secondary forest near road leading up to Delaikoro Telecom tower
35	-16.5869	179.3154	897m	02.x.13	LT_4 ; Upland primary forest near Telecom tower
36	-16.5593	179.2436	144m	26.ix.13	Nasealevu stream ; sited 3 *Nesobasis spp.*
37	-16.5595	179.2445	162m	26.ix.13	Nasealevu stream ; sited 2 *Nesobasis spp.*
38	-16.5682	179.2727	204m	26.ix.13	Nasealevu stream ; sited 2 *Papilio schmeltzi*
39	-16.5702	179.2734	214m	26.ix.13	Nasealevu stream ; sited 4 *Nesobasis spp.*
40	-16.5648	179.2941	158m	26.ix.13	Upper Dogoru ; sited 1 *Papilio schmeltzi*
41	-16.5632	179.2936	145m	26.ix.13	Upper Dogoru ; sited 1 *Papilio schmeltzi*
42	-16.5615	179.2923	126m	26.ix.13	Upper Dogoru ; spotted 3 *Nesobasis spp*.
43	-16.5611	179.2910	129m	26.ix.13	Upper Dogoru ; 2 Melanesobasis spp.
44	-16.5586	179.2889	106m	26.ix.13	Upper Dogoru ; spotted 2 *Nesobasis spp.*
45	-16.5912	179.3640	186m	27.ix.13	Waicacuru ; spotted 4 *Nesobasis spp*.
46	-16.6009	179.3675	234m	27.ix.13	Waicacuru ; spotted 3 *Melanesobasis spp.*
47	-16.5963	179.3638	196m	27.ix.13	Waicacuru ; sited 2 *Papilio schmeltzi* along stream
48	-16.5979	179.3618	233m	27.ix.13	Waicacuru ; sited 2 *Hypolimnas inopinata* along stream
49	-16.5528	179.3693	46m	27.ix.13	Waicacuru ; sited 2 *Hypolimnas inopinata* along stream
50	-16.6436	179.2345	44m	28.ix.13	Waisali : sited 1 *Papilio schmeltzi*
51	-16.6348	179.3696	320m	29.ix.13	Waisali : spotted 2 *Papilio schmeltzi*

Appendix 6 Avifauna species checklist, status, distribution and abundance

Common name	Scientific Name	Status	Distribution	Abundance (#/ km²)
Barking Pigeon	Ducula latrans		Endemic	182
Blued crested Broadbill	Myiagra azureocapilla castaneigularis		Endemic (subspecies endemic to Vanua Levu and Kabara)	47
Collared Lory	Phigys solitarius	Cites Appendix II	Endemic	5
Fantail Cuckoo	Cacomantis flabelliformis simus		Endemic (subspecies) to Fiji	74
Fiji bush Warbler	Cettia ruficapilla castaneoptera		Endemic to Fiji (subspecies endemic to Vanua Levu)	135
Fiji Goshawk	Accipiter rufitorques	Cites Appendix II	Endemic	3
Fiji Parrotfinch	Erythrura pealii		Endemic	14
Fiji Woodswallow	Artamus mentalis		Endemic	3
Giant forest Honeyeater	Gymnomyza viridis		Endemic	8
Golden Whistler	Pachycephala pectoralis aurantiiventris		Endemic (subspecies) to Vanua Levu	102
Island Thrush	Turdus poliocephalus vitiensis		Endemic (subspecies) to Vanua Levu	22
Lesser Shrikebill	Clytorhynchus vitiensis buensis		Endemic (subspecies) to Vanua Levu and nearby islands	30
Many-coloured fruit Dove	Ptilinopus perousii		Native	3
Orange breasted Myzomela	Myzomela jugularis		Endemic	185
Orange Dove	Ptilinopus victor		Endemic to Vanua Levu & Taveuni	25
Pacific Harrier	Circus approximans	Cites Appendix II	Native	-
Polynesian Starling	Aplonis tabuensis vitiensis		Endemic (subspecies) to Fiji	3
Polynesian Triller	Lalage maculosa woodi		Endemic (subspecies) to Vanua Levu	210
Silvereye	Zosterops lateralis		Native	25
Slaty Monarch	Mayrornis lessoni		Endemic	25
Streaked Fantail	Rhipidura spilodera erythronata		Endemic (subspecies) to Vanua Levu	44
Red Shining parrot	Prosopeia tabuensis atrogularis		Subspecies endemic to Vanua Levu and Kia.	39

Common name	Scientific Name	Status	Distribution	Abundance (#/ km²)
Vanikoro Broadbill	Myiagra vanikoroensis rufiventris		Endemic (subspecies) to parts of Fiji including Vanua Levu	17
Wattled Honeyeater	Foulehaio carunculata		Native	91
White-collared Kingfisher	Todirhamphus chloris vitiensis		Endemic (subspecies) to some islands in Fiji including Vanua Levu	6
White-rumped Swiftlet	Aerodramus spodiopygius		Native	36
White-throated Pigeon	Columba vitiensis vitiensis		Endemic (subspecies) to Fiji	6
Fiji White-eye	Zosterops explorator		Endemic	191
Samoan flying fox	Pteropus samoensis	Cites Appendix I EN	Endemic (subspecies) to Fiji	8
Pacific flying fox	Pteropus tonganus	Cites Appendix I	Native	3
Fijian Blossom Bat	Notopteris macdonaldi	VU	Native	-
Species likely to be present, but not recorded				
Eastern Reef heron	Egretta sacra		Native	
Peregrine falcon	Falco pereginus	AR	Native	
Red throated Lorikeet	Charmosyna amabilis	CR	Endemic	
Long-legged Warbler	Trichocichla rufa	EN	Endemic	
Friendly-ground Dove	Gallicolumba stairi	VU	Native	
Scarlet Robin	Petroica multicolor		Native	
Black-faced Shrikebill	Clytorhynchus nigrogularis	VU	Native	
Barn Owl	Tyto alba		Native	
IUCN Red List: CR=Critically endangered; VU=Vulnerable; EN=Endangered. Fiji threat status: AR, at risk				

Appendix 7 Location of point count stations, habitat and birds recorded

Transect	Station Code	Latitude	Longitude	No. of birds	No. of species	Vegetataion	Habitat	Impact
TD1	D1	179.36603	-16.61359	7	3	Lowland Rain Forest	riparian & slope	3
	D2	179.36710	-16.61524	13	9	Lowland Rain Forest	slope	3
	D3	179.36781	-16.61739	4	3	Lowland Rain Forest	riparian & slope	3
	D4	179.36592	-16.61810	16	8	Lowland Rain Forest	slope	3
	D5	179.36414	-16.61913	13	9	Lowland Rain Forest	slope	3
	D6	179.36330	-16.62219	9	5	Lowland Rain Forest	slope	3
	D7	179.36386	-16.62404	12	8	Lowland Rain Forest	slope	3
	D8	179.36473	-16.62644	8	5	Lowland Rain Forest	slope	3
	D9	179.36440	-16.62917	15	8	Lowland Rain Forest	slope	3
	D10	179.36346	-16.63148	17	11	Lowland Rain Forest	slope	3
TD2	D11	179.36491	-16.63147	14	11	Lowland Rain Forest	slope	1
	D12	179.36670	-16.63291	17	9	Lowland Rain Forest	Ridge	1
	D13	179.36855	-16.63235	17	10	Lowland Rain Forest	Ridge-Slope	1
	D14	179.36975	-16.63078	14	9	Lowland Rain Forest	slope	1
	D15	179.37015	-16.63363	17	12	Lowland Rain Forest	slope	1
	D16	179.37070	-16.63519	11	6	Lowland Rain Forest	slope	1
	D17	179.37166	-16.63709	4	3	Lowland Rain Forest	riparian	1
	D18	179.37093	-16.63867	5	4	Lowland Rain Forest	slope	1
	D19	179.36905	-16.63822	16	9	Lowland Rain Forest	ridge	1
	D20	179.36737	-16.63909	15	11	Lowland Rain Forest	ridge	1
TD3	D21	179.21289	-16.63626	5	3	Upland Rain Forest	slope	1
	D22	179.21508	-16.63601	9	6	Upland Rain Forest	ridge	1

	D23	179.21672	-16.63601	14	8	Upland Rain Forest	riparian	1
	D24	179.21735	-16.63430	8	7	Upland Rain Forest	slope	1
	D25	179.21756	-16.63228	11	7	Upland Rain Forest	ridge	1
	D26	179.21957	-16.63194	13	9	Upland Rain Forest	ridge	1
	D27	179.22110	-16.63335	7	5	Upland Rain Forest	ridge top	1
	D28	179.22231	-16.63525	12	10	Upland Rain Forest	ridge	1
	D29	179.22105	-16.63691	10	7	Upland Rain Forest	slope	1
	D30	179.21982	-16.63894	16	9	Upland Rain Forest	riparian	1
TD 4	D31	179.31506	-16.58745	13	8	Cloud Forest	slope	2
	D32	179.31683	-16.58621	16	10	Cloud Forest	slope	2
	D33	179.31438	-16.58550	14	10	Cloud Forest	slope	2
	D34	179.31494	-16.58361	13	11	Cloud Forest	slope	2
	D35	179.31592	-16.58179	6	3	Upland Rain Forest	slope	2
	D36	179.57982	-16.57982	7	4	Upland Rain Forest	ridge	2
	D37	179.31609	-16.57769	9	6	Upland Rain Forest	ridge	1
	D38	179.31638	-16.57545	11	5	Upland Rain Forest	ridge-slope	1
	D39	179.31822	-16.57515	16	10	Upland Rain Forest	Ridge-Slope	1
	D40	179.31905	-16.57328	9	5	Upland Rain Forest	slope	1
	D41	179.32083	-16.57242	10	6	Upland Rain Forest	slope	1
	D42	179.32121	-16.57063	16	9	Lowland Rain Forest	Ridge-Slope	2
	D43	179.32063	-16.56869	13	8	Lowland Rain Forest	slope	2
	D44	179.31859	-16.56913	8	5	Lowland Rain Forest	Ridge-Slope	2
	D45	179.31653	-16.56861	13	8	Lowland Rain Forest	Ridge-Slope	2
	D46	179.31439	-16.56812	9	5	Lowland Rain Forest	slope	2
	D47	179.31233	-16.56769	14	10	Lowland Rain Forest	slope	2

Appendix 8 Focal avifauna species recorded from the Greater Delaikoro Area

Common name	Scientific name	Status	Abundance (#/km²)
Land birds			
*Black-face Shrikebill	Clytorhynchus nigrogularis	VU	5
Collared Lory	Phigys solitarius simus	CITES Appendix II	21
Fiji Goshawk	Accipiter rufitorques	CITES Appendix II	7
*Friendly ground Dove	Gallicolumba stairi	VU	7
*Long-legged Warbler	Trichocichla rufa rufa	EN	16
Pacific Harrier	Circus approximans	CITES Appendix II	4
Bats			
Samoan flying fox	Pteropus samoensis	NT, CITES Appendix I	15
Tongan flying fox	Pteropus tonganus	CITES Appendix I	2
IUCN Red List: NT=Near Threatened; VU=Vulnerable; EN=Endangered. ***Prevoiusly recorded from the Greater Delaikoro Area but not recorded on this survey.**			

Appendix 9 Herpetofauna suvey sites locations and sampling methods

Date	Survey type	Time start	Time end	Total time (hours)	Waypoint	Species encountered
26/9/2013	Opportunistic	10:00	13:00	3	41	Black ants
	Opportunistic	14:00	16:00	2	41	*Platymantis vitiensis* calls
					42	*Platymantis vitiensis* captured
27/9/2013	Sticky trap	9:31	15:00	5.5	1	*Emoia cyanura*
	Opportunistic	8:30	17:00	7.5	4, 7, 8	*Platymantis vitiensis*
					10	*Lepidodactylus mann*
					9	Cat scat
					3	*Bufo marinus*
28/9/2013	Opportunistic	13:45	15:00	1.8	16	*Emoia cyanura*
						Platymantis vitiensis
	Standard nocturnal	18:00	20:00	2	24	*Platymantis vitianus*
	Sticky trap	16:51	18:30	182.0	17-23	n/a
29/9/2013	Opportunistic	9:32	14:00	4.5		*Platymantis vitiensis*
	Sticky trap	9:32	18:00	8.5	25	*Emoia concolor*
30/9/2013	Opportunistic	10:00	12:00	2	14	*Emoia cyanura*
1/10/2013	Sticky trap	9:32	14:00	4.5	32-33	n/a
	Standard dirunal	10:00	14:00	4	34-37	*Platymantis vitiensis*
2/10/20103	Standard nocturnal	18:09	19:09	1	39	*Platymantis vitiensis*

Appendix 10 Herpetofauna species checklist for Vanua Levu and Delaikoro

Genus	Species	Conservation Status, IUCN (2013) status	Vanua Levu documented	Delaikoro documented	Delaikoro (captured in 2013)	Common name
Order Anura						
Bufo	*Marinus*	Introduced	✓	✓	✓	Cane toad
Platymantis	*Vitianus*	Endemic, Endangered	✓	✓	✓	Fiji tree frog
Platymantis	*Vitiensis*	Endemic, Near Threatened	✓	✓	✓	Fiji ground frog
Family Gekkonidae						
Gehyra	*Mutilate*	Introduced	-	-	-	
Gehyra	*Oceanica*	Native, not assessed	✓	✓	✓	Oceanic gecko
Gehyra	*Vorax*	Native, not assessed	✓	-	-	Giant forest gecko
Hemidactylus	*Frenatus*	Introduced	✓	✓	-	
Hemidactylus	*Garnotti*	Introduced	-	-	-	
Hemidactylus	*Typus*	Native, not assessed	✓	-	-	
Lepidodactylus	*Lugubris*	Introduced	✓	-	-	
Lepidodactylus	*Manni*	Endemic, not assessed	✓	-	✓	Mann's forest gecko
Nactus	*Pelagicus*	Native, not assessed	✓	✓	✓	Skink-toed gecko
Family Skincidae						
Cryptoblepharus	*Eximius*	Endemic, not assessed	✓	-	-	Pygmy snake-eyed skink
Emoia	*caeruleocauda*	Native, not assessed	-	-	-	Pacific blue tailed skink
Emoia	*Campbelli*	Endemic, not assessed	-	-	-	Montane tree skink
Emoia	*Concolor*	Endemic, not assessed	✓	✓	✓	Fijian green tree skink
Emoia	*Cyanura*	Native, not assessed	✓	✓	✓	Brown-tailed copper-striped skink

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Genus	Species	Conservation Status, IUCN (2013) status	Vanua Levu documented	Delaikoro documented	Delaikoro (captured in 2013)	Common name
Emoia	*Impar*	Native, not assessed	✓	-	-	Blue-tailed copper-striped skink
Emoia	*mokosariniveikau*	Endemic, not assessed	✓	✓	-	Fiji forest skink
Emoia	*Nigra*	Native	✓	✓	-	Pacific black skink
Emoia	*Oriva*	Endemic	-	-	-	Rotuman barred tree skink
Emoia	*Parkeri*	Endemic, Vulnerable	-	-	-	Fijian copper-headed skink
Emoia	*sp. Novum*	Endemic, not assessed	-	-	-	
Emoia	*Trossular*	Native, Endangered	-	-	-	Barred tree skink/ Dandy skink
Leiolopisma	*Alazon*	Endemic, Critically endangered	-	-	-	Lauan ground skink
Lipinia	*Noctua*	Native, not assessed	✓	✓	-	Moth skink
Family Iguanidae						
Brachylophus	*Fasciatus*	Native, Endangered	✓	✓	-	Fiji banded iguana
Brachylophus	*Bulabula*	Endemic, Endangered	✓	-	-	Viti banded iguana
Brachylophus	*Vitiensis*	Endemic, Critically endangered	-	-	-	Fiji crested iguana
Iguana	*Iguana*	Introduced	✓	✓	-	
Snakes						
Ogmodon	*Vitianus*	Endemic, Endangered	-	-	-	Fiji burrowing snake
Candoia	*Bibroni*	Native, Least concern	✓	-	-	Pacific boa
Ramphotyphlops	sp.	Endemic	-	-	-	Taveuni blind snake
Ramphotyphlops	*Braminus*	Introduced, not assessed	-	-	-	Flower pot snake

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Appendix 11 Water quality at freshwater fish sampling sites

Sampling Site no.	1	2	3	4	5	6	7	8	9	10	11	12	13
Site name:	Nasealevu Village	Upper Dreketi	Upper Dogoru	Upper Dogoru (2)	Dogoru Village	Qaraloaloa	Waicacuru	Suweni River	Waisali village	Savutagitagi gagone	Camp Site	Camp Site (lower)	Wai Koroalau
Date collected:	9/26/2013	9/26/2013	9/26/2013	9/26/2013	9/26/2013	9/27/2013	9/27/2013	9/27/2013	9/28/2013	9/29/2013	9/29/2013	9/29/2013	9/30/2013
Latitude	-16.55953	-16.568455	-16.563843	-16.5615	-16.55864	-16.60083	-16.59628	-16.55284	-16.6451	-16.634840	-16.635038	-16.651156	-16.63484
Longitude	179.24449	179.27288	179.2939	179.2923	179.28891	179.36748	179.36377	179.36929	179.23613	179.364262	179.359415	179.436598	179.36961
Altitude (m)	151	240	145	127	106	230	196	46	23	320	300	100	320
Temperature (°C)	23.9	23.4	25	25.3	26.4	22.3	22.8	24	22.5	21.2	22.8	23.2	23.2
DO (mg/L)	8.55	8.74	8.34	8.53	8.41	8.74	8.72	8.72	8.97	8.75	8.72	8.24	8.24
Water Turbidity (NTUs)	2.4	0	0	0	0	0.05	0	9	0	0	0	0	0
Conductivity (μS)	1.11	0.103	0.129	0.13	0.118	0.116	0.114	0.114	0.072	0.054	0.114	0.112	0.112
Salinity (ppt)	0	0.05	0	0	0	0	0	0	0	0.02	0	0	0
pH	7.37	7.77	7.9	7.98	8.8	7.74	7.83	7.83	7.32	7.61	7.83	7.34	7.34
TDS (mg/L)	0.2	0.066	0.83	0.084	0.078	0.07	0.074	0.078	0.046	0.034	0.074	0.0057	0.0057

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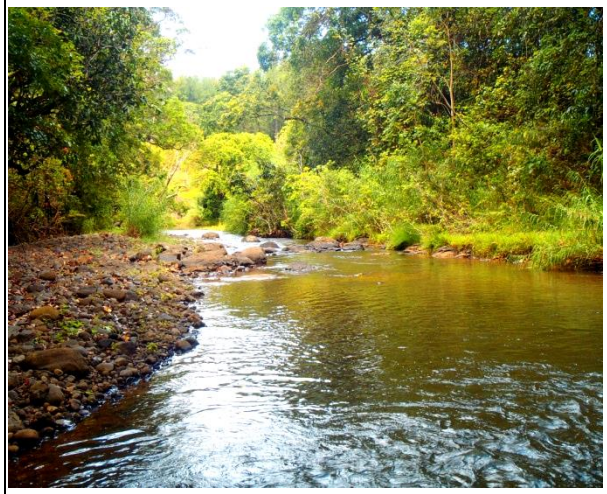
Appendix 12 Habitat characteristics at macroinvertebrate survey sites

VL1



VL2

VL3

VL4

VL5

VL6

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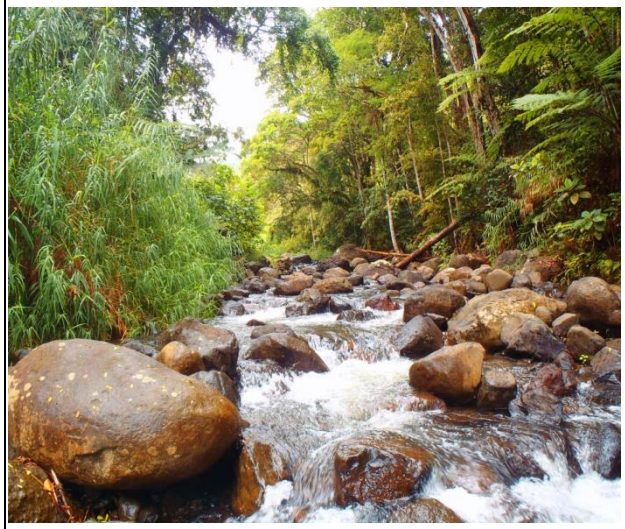
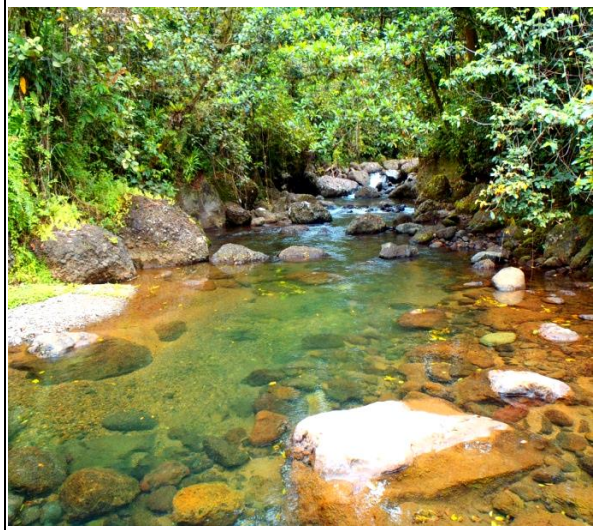
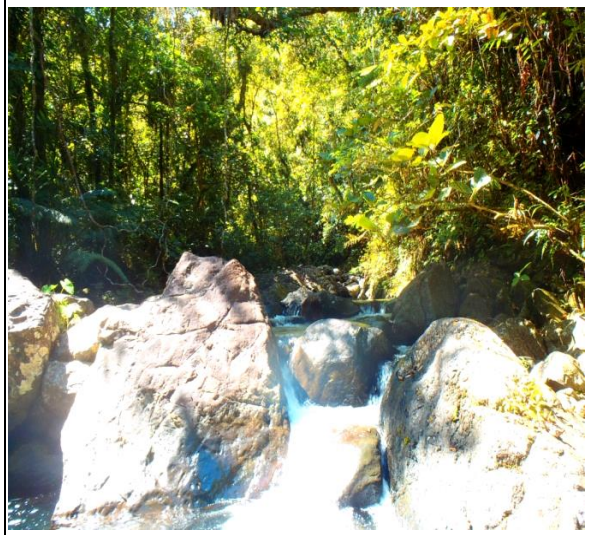
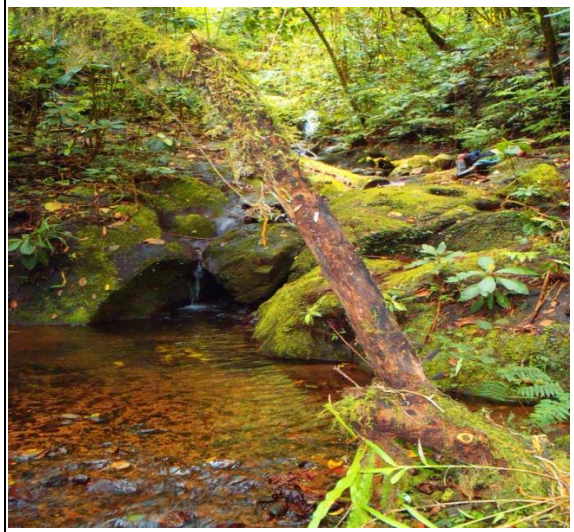
VL7 	**VL8** 	**VL9** 
VL10 	**VL11** 	**VL12** 

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VL13

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Appendix 13 Water quality at freshwater macroinvertebrate sampling stations

Sampling stations	Site Code	Temperature (^{0}C)	DO (mg/L)	Turbidity (NTU)	Conductivity (mS/cm)	Salinity (ppt)	pH	TDS (mg/L)
Nasealevu Village	VL 1	23.9	8.55	2.4	1.110	0	7.37	0.200
Upper Dreketi	VL 2	23.4	8.74	0	0.103	0.05	7.77	0.066
Upper Dogoru	VL 3	25.0	8.34	0	0.129	0	7.90	0.830
Upper Dogoru (2)	VL 4	25.3	8.53	0	0.130	0	7.98	0.084
Dogoru Village	VL 5	26.4	8.41	0	0.118	0	8.80	0.078
Sorolevu-Qaraloaloa	VL6	22.3	8.74	0.05	0.116	0	7.74	0.070
Waicacuru	VL7	22.8	8.72	0	0.114	0	7.83	0.074
Dogoru-Suweni River	VL 8	26.3	8.83	0	0.103	0.05	8.08	0.066
Waisali village	VL 9	22.5	8.97	0	0.072	0	7.32	0.046
Savusa-Savutagitagigagone	VL 10	21.2	8.75	0	0.054	0.02	7.61	0.034
Vunidogoloa-Wai Koroalau	VL 13	23.2	8.24	0	0.112	0	7.34	0.006

Appendix 14 Freshwater macroinvertebrate abundance categories per sampling station

	va = very abundant (>100)
	a = abundant (20-99)
	c = common (5-19)
	f = few (2-4)
	vf = very few (1)

Taxa	VL1	VL2	VL3	VL4	VL5	VL6	VL7	VL8	VL9	VL11	VI10	VL12	VL14	VL13	VL15	VL16
Trichoptera																
Abacaria fijiana	150	200	4	45	510	0	105	22	5	11	7	17	3	2	0	0
Abacaria ruficeps	5	0	0	0	11	0	0	0	0	1	13	2	0	0	0	0
Anisocentropus fijianus	19	137	0	61	15	0	132	0	0	6	1	2	4	0	4	2
Odontoceridae spp.	100	10	1	5	7	1	10	0	4	1	0	2	9	0	0	0
Hydrobiosis sp.	10	9	0	4	5	1	6	0	3	4	0	2	0	0	0	0
Apsilochorema sp.	3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Oxyethira sp. A	6	29	9	1	1	3	30	3	50	0	0	1	0	0	0	0
Oxyethira sp. B.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trianodes fijiana	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Goera fijiana	2	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Unidentifiable species	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Ephemeroptera																
Pseudocloen spp.	17	300	35	78	195	24	61	66	241	30	6	6	0	89	0	1
Cloeon spp.	0	3	0	0	0	0	6	0	2	10	9	2	0	0	0	0
Caenis sp.	42	100	0	18	35	2	15	8	5	5	11	0	0	0	0	0
Pseudocloen sp. A	0	0	0	0	0	1	2	0	0	3	0	0	0	0	0	0
Lepidoptera																

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Nymphula sp.	7	3	0	5	8	0	3	7	4	2	1	1	0	1	0	0
Unidentifiable specie A	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Unidentifiable specie B	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Diptera																
Chironomus sp.	55	34	2	6	25	0	10	3	0	1	2	0	0	7	0	0
Chironomidae sp. B	5	9	0	0	0	0	0	0	0	2	0	0	0	1	0	0
Chironomidae sp. C	0	0	0	15	0	0	1	0	0	0	0	0	0	0	0	0
Chironomidae sp. D	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Simulium jolli		4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Empididae	7	0	0	1	2	0	1	0	0	0	0	0	0	0	0	0
Muscidae	6	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Culicidae	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tipula sp.	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0
Limonia sp.	0	0	0	0	1	1	0	0	3	0	0	0	0	0	0	0
Paralimnophila sp.	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Athericidae	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Psychoda sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Stratiomyidae	0	0	0	0	0	0	0	3	0	0	0	0	5	1	0	0
Odonata																
Corduliidae	5	14	0	2	8	1	11	4	0	0	1	0	0	0	0	0
Dragonfly-Unidentifiable species	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Nesobasis spp.	16	17	0	18	31	0	53	18	2	0	0	0	2	0	2	1
Hemiptera																
Limnogonus sp.	0	8	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Microvelia sp.	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Coleoptera																
Dineutus sp.	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0

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Scirtidae	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Hydraenidae	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0
Oligochaeta (worm)																
Oligochaeta spp.	1	1	0	0	0	0	1	0	1	0	1	0	0	0	0	0
Crustacea																
Atyopsis spinipes	0	0	0	0	5	0	0	0	0	1	1	0	0	0	0	0
Atyoida pilipes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caridina typus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Caridina sp. A	0	0	0	0	0	5	14	0	0	0	0	0	0	0	0	0
Caridina sp. B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caridina longirostris	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Caridina multidentata	1	11	0	10	14	1	9	5	0	0	1	0	0	0	0	0
Caridina grandirostris	0	0	0	0	0	0	1	2	2	0	0	0	0	1	0	0
Caridina leucosticta	0	1	0	0	0	0	8	0	0	0	0	0	0	0	0	0
Caridina weberi	0	4	0	0	0	7	1	0	0	1	0	0	1	0	0	0
Macrobrachium sp. A	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Macrobrachium sp. B	0	0	1	0	0	1	0	0	0	0	1	0	0	0	0	0
Macrobrachium lar	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Macrobrachium equidens	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Mollusca																
Ferrissia sp.	1	0	0	3	0	0	0	2	0	1	0	0	0	0	0	0
Neritina pulligera	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Melanoides tuberculata	4	6	0	1	4	3	0	17	0	1	0	0	1	0	0	0
Melanoides lutosa	0	4	0	0	0	0	0	0	0	0	4	1	0	0	0	1
Fluviopupa spp.	0	0	34	0	51	0	2	0	2	1	8	0	51	0	0	0
Physastra nasuta	0	0	5	7	0	0	10	0	0	0	0	0	0	0	6	0
Taxa number	26	23	9	17	20	15	26	14	14	21	16	13	10	9	4	5

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Appendix 15 Freshwater macroinvertebrates abundance (Surber sampling)

	Nasealevu village	Waisali village
	VL1	VL9
Trichoptera		
Abacaria fijiana	3050	517
Abacaria ruficeps	137	0
Anisocentropus fijianus	17	27
Odontoceridae (case)	10	0
Hydrobiosis sp.	143	33
Apsilochorema sp.	0	0
Oxyethira sp. A	0	273
Oxyethira sp. B.	0	0
Trianodes fijiana	3	0
Goera fijiana	27	0
Unidentifiable species	0	3
Ephemeroptera		
Pseudocloen spp.	567	1500
Cloeon spp.	0	33
Caenis sp.	143	77
Pseudocloen sp. A	0	0
Lepidoptera		
Nymphula spp.	147	130
Unidentifiable specie A	0	0
Unidentifiable specie B	0	0
Diptera		
Chironomus sp.	277	83
Chironomidae sp. B	3	23
Chironomidae sp. C	0	0
Chironomidae sp. D	0	0
Simulium jolli	0	0
Empididae	10	7
Muscidae	7	0
Culicidae	3	0
Tipula sp.	0	0
Limonia sp.	0	13
Paralimnophila sp.	0	0
Athericidae	0	0
Psychoda sp.	0	0
Stratiomyidae	0	0

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Odonata		
Corduliidae	0	0
Unidentifiable species	0	0
Nesobasis spp.	7	3
Hemiptera		
Limnogonus sp.	0	0
Microvelia sp.	0	0
Coleoptera		
Dineutus sp.	0	0
Scirtidae	0	0
Hydraenidae	0	0
Oligochaeta (worm)		
Oligochaeta spp.	0	3
Crustacea		
Atyopsis spinipes	0	0
Atyoida pilipes	0	0
Caridina typus	0	0
Caridina sp. A	0	0
Caridina sp. B	0	0
Caridina longirostris	0	0
Caridina multidentata	0	0
Caridina grandirostris	0	0
Caridina leucosticta	0	0
Caridina weberi	0	0
Macrobrachium sp. A	0	0
Macrobrachium sp. B	0	0
Macrobrachium lar	0	0
Macrobrachium equidens	0	0
Mollusca		
Ferrissia sp.	0	0
Neritina pulligera	0	0
Melanoides tuberculata	0	3
Fluviopupa spp.	0	0
Physastra nasuta	0	0
Taxa number	16	16
Total Abundance	4550	2730

Appendix 16 Freshwater macroinvertebrate abundance (kick-net and hand-picking)

(Note: Only sites VL12, VL14, VL15 & VL16 were hand-picked)

Kick-net & Hand-picked	Nasealevu village VL1	Upper Dreketi VL2	Upper Doguru VL3	Upper Doguru 2 VL4	Doguru village VL5	Sorolevu/qaraloaloa VL6	Waicacuru VL7	Doguru/Suweni Rv. VL8	Waisali village VL9	Waisali River upper VL11	Savusa-Savutagitagigagone VI10	Savusa-tributary VL12	Spring-Savusa VL14	Vunidogoloa VL13	Mt. Delaikoro VL15	Tabia-Savusavu VL16
Trichoptera																
Abacaria fijiana	150	200	4	45	510	0	105	22	5	11	7	17	3	2	0	0
Abacaria ruficeps	5	0	0	0	11	0	0	0	0	1	13	2	0	0	0	0
Anisocentropus fijianus	19	137	0	61	15	0	132	0	0	6	1	2	4	0	4	2
Odontoceridae spp.	100	10	1	5	7	1	10	0	4	1	0	2	9	0	0	0
Hydrobiosis sp.	10	9	0	4	5	1	6	0	3	4	0	2	0	0	0	0
Apsilochorema sp.	3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Oxyethira sp. A	6	29	9	1	1	3	30	3	50	0	0	1	0	0	0	0
Oxyethira sp. B	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trianodes fijiana	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Goera fijiana	2	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Unidentifiable species	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Ephemeroptera																
Pseudocloen spp.	17	300	35	78	195	24	61	66	241	30	6	6	0	89	0	1
Cloeon spp.	0	3	0	0	0	0	6	0	2	10	9	2	0	0	0	0
Caenis sp.	42	100	0	18	35	2	15	8	5	5	11	0	0	0	0	0
Pseudocloen sp. A	0	0	0	0	0	1	2	0	0	3	0	0	0	0	0	0
Lepidoptera																

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Nymphula sp.	7	3	0	5	8	0	3	7	4	2	1	1	0	1	0	0
Unidentifiable specie A	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Unidentifiable specie B	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Diptera																
Chironomus sp.	55	34	2	6	25	0	10	3	0	1	2	0	0	7	0	0
Chironomidae sp. B	5	9	0	0	0	0	0	0	0	2	0	0	0	1	0	0
Chironomidae sp. C	0	0	0	15	0	0	1	0	0	0	0	0	0	0	0	0
Chironomidae sp. D	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Simulium jolli		4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Empididae	7	0	0	1	2	0	1	0	0	0	0	0	0	0	0	0
Muscidae	6	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Culicidae	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tipula sp.	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0
Limonia sp.	0	0	0	0	1	1	0	0	3	0	0	0	0	0	0	0
Paralimnophila sp.	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Athericidae	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Psychoda sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Stratiomyidae	0	0	0	0	0	0	0	3	0	0	0	0	5	1	0	0
Odonata																
Corduliidae	5	14	0	2	8	1	11	4	0	0	1	0	0	0	0	0
Unidentifiable species (dragonfly)	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Nesobasis spp.	16	17	0	18	31	0	53	18	2	0	0	0	2	0	2	1
Hemiptera																
Limnogonus sp.	0	8	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Microvelia sp.	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Coleoptera																
Dineutus sp.	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Scirtidae	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Hydraenidae	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0
Oligochaeta (worm)																
Oligochaeta spp.	1	1	0	0	0	0	1	0	1	0	1	0	0	0	0	0

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Crustacea																
Atyopsis spinipes	0	0	0	0	5	0	0	0	0	1	1	0	0	0	0	0
Atyoida pilipes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caridina typus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Caridina sp. A	0	0	0	0	0	5	14	0	0	0	0	0	0	0	0	0
Caridina sp. B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caridina longirostris	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Caridina multidentata	1	11	0	10	14	1	9	5	0	0	1	0	0	0	0	0
Caridina grandirostris	0	0	0	0	0	0	1	2	2	0	0	0	0	1	0	0
Caridina leucosticta	0	1	0	0	0	0	8	0	0	0	0	0	0	0	0	0
Caridina weberi	0	4	0	0	0	7	1	0	0	1	0	0	1	0	0	0
Macrobrachium sp. A	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Macrobrachium sp. B	0	0	1	0	0	1	0	0	0	0	1	0	0	0	0	0
Macrobrachium lar	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Macrobrachium equidens	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Mollusca																
Ferrissia sp.	1	0	0	3	0	0	0	2	0	1	0	0	0	0	0	0
Neritina pulligera	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Melanoides tuberculata	4	6	0	1	4	3	0	17	0	1	0	0	1	0	0	0
Melanoides lutosa	0	4	0	0	0	0	0	0	0	0	4	1	0	0	0	1
Fluviopupa spp.	0	0	34	0	51	0	2	0	2	1	8	0	51	0	0	0
Physastra nasuta	0	0	5	7	0	0	10	0	0	0	0	0	0	0	6	0
Taxa number	26	23	9	17	20	15	26	14	14	21	16	13	10	9	4	5
Abundance	477	907	92	280	930	53	495	161	326	85	68	39	79	104	13	6

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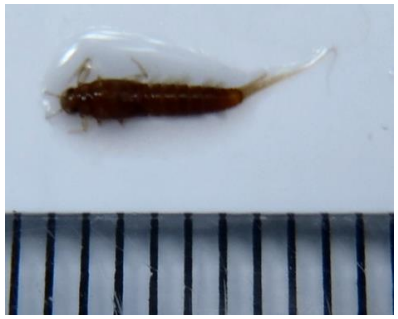
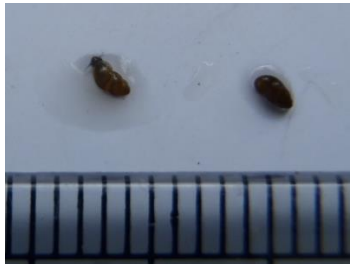
Appendix 17 Freshwater macroinvertebrate taxa of interest

***Pseudocloeon* sp.** 	***Cloeon* sp. A** 	***Cloeon* sp. B** 	***Caenis* sp.** 
***Apsilochorema* sp.** 	***Hydrobiosis* sp.** 	***Tipula* sp.** 	***Fluviopupa* spp.** 
***Nesobasis* sp. W** 	***Nesobasis* sp. X** 	***Nesobasis* sp.Y** 	***Nesobasis* sp. Z** 

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Appendix 18 List of invasive plant species documented

Scientific name	Common name	Family	Invasion category (Meyer, 2000)
1. *Arundo donax*	giant reed	Poaceae	Moderate
2. *Clidemia hirta*	Koster's curse	Melastomataceae	Dominant
3. *Cyperus rotundus*	nut sedge	Cyperaceae	Moderate
4. *Dissotis rotundifolia*	pink lady	Melastomataceae	Potential
5. *Eichhornia crassipes*	water hyacinth	Pontederiaceae	Dominant
6. *Hedychium coronarium*	white ginger	Zingiberaceae	Moderate
7. *Lantana camara*	lantana	Verbenaceae	Dominant
8. *Leucaena leucocephala*	wild tamarind	Mimosaceae	Dominant
9. *Merremia peltata*	merremia	Convolvulaceae	Dominant
10. *Mikania micrantha*	mile-a-minute	Asteraceae	Dominant
11. *Mimosa invisa*	giant sensitive grass	Fabaceae	Moderate
12. *Pennisetum polystachion*	mission grass	Poaceae	Dominant
13. *Piper aduncum*	false kava	Piperaceae	Dominant
14. *Psidium guajava*	guava	Myrtaceae	Moderate
15. *Rubus moluccanus*	wild rasberry	Rosaceae	Dominant
16. *Samanea saman*	rain tree	Fabaceae	Moderate
17. *Solanum torvum*	prickly solanum	Solanaceae	Moderate
18. *Spathodea campanulata*	African tulip	Bignoniaceae	Dominant
19. *Sphagneticola trilobata*	Singapore daisy	Asteraceae	Dominant
20. *Stachytarpheta urticifolia*	blue rats tail	Verbenaceae	Moderate
21. *Urena lobata*	hibiscus burr	Malvaceae	Moderate

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Appendix 19 List of invasive animal species documented

Scientific Name	Common Name	Group
1. *Mus musculus*	house mouse	Mammals
2. *Rattus cf. exulans*	Pacific rat	
3. *Rattus cf. rattus*	black rat, ship rat	
4. *Rattus cf.norvegicus*	Norway rat	
5. *Felis catus*	cat	
6. *Sus scrofa*	pig	
7. *Equus caballus*	horse	
8. *Canis lupus familiaris*	dog	
9. *Herpestes cf. fuscus*	Indian brown mongoose	
10. *Herpestes cf. auropunctatus*	small Indian mongoose	
11. *Pycnonotus cafer*	bulbul	Birds
12. *Acridotheres tristis*	mynah	
13. *Bufo marinus*	cane toad	Amphibian

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Appendix 20 Household survey questionnaire

This survey is part of a baseline study conducted in areas within the Delaikoro, Delaisatulaki etc region. It is a collaborative study between the Forestry Department and the University of the South Pacific with the aim of identifying key ecosystem sites which are worth protecting for improved ecosystem services such as water protection. Our survey will take approximately 40 minutes and please let me know if you are not sure of any questions or if you are reluctant to answer.

Date	
Interviewer	
Village	
Name of Household	
Interviewee	
Who owns this house? **(please select one)**	**Owned by HH as newly constructed** **Owned by HH through inheritance** **Owned by HH as given by a relative** **Living but owned by a relative/someone else**
Name of the head of the household	
Age	
Highest level of education	
Original village	
How long he/she been living in this village?	
Religion	

SECTION 1: POPULATION, EDUCATION AND HOUSING									
Apart from the head of household, complete list of all the people who normally live and eat their meals together in this household beginning with your immediate family and then the extended family									
1.Name	2.Sex Male/ Female	4.Age Age	5. Religion Methodist/ Catholic/ AOG/ F/ A/Nation/ Pentecost/ SDA/ Others	6.Original village (if from study site go to 8) Study site/ Within the same district/ Other district, same province/ Other province in Vanua Levu/ Other province in Viti Levu	7.Reason for residing here Married here/ Vasu/ Friend's village/ Employment/ Other (specify)	8. Suffering from any illness? None/ High BP/ Diabetes/ Respiratory/ Heart / Other (specify)	9. Attending school now? Yes/ No	10. Highest level of education attained. No education/ Primary/ Secondary/ Tertiary	11. Why no education at all No fee/ Against religion/ Against culture/ Family not interested/ Disabled from birth

Interviewer: Record the main material of the walls and important livelihood component of the house. Please circle only one choice						
12. Wall type	13.Roof type	14. Toilet type	15. Water source	16. Waste management	17. Lighting source	18. Main Cooking practice
Bamboo Corrugated iron Wood Brick/cement Other (specify..)	Thatched/leaves Corrugated Concrete and tiles Other, specify….	No toilet Pit toilet Water seal Flush for exclusive use of HH Flush shared with other HH Other, specify…	Village water system Settlement water system Own water system Rivers and Creeks Spring Rainwater Well Other (specify)	Village dump HH dump Village boundary area Rivers/creek Burning of papers Burying of glass Compost Other (specify…)	Village generator Own generator Kerosene lamp Benzene lantern Battery lantern Solar panel Solar lantern Other (specify..)	Open fire Smokeless stove Kerosene stove Gas stove Other (specify…)

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SECTION 2: DURABLE ASSETS			
19a. Do you or any members of your family owe the following assets in your household?	**Yes=1 (go to 19b and 19c) No=2 (go to next item)**	**19b If Yes, how many do you own?**	**19c. What is the value of one of these in its current state?**
a. Kitchen stove			
b. Sitting room sofa			
a. Kitchen stove			
d. Mobile telephone			
e. Radio/stereo			
f. TV			
g. DVD player			
h. SKY Pacific			
i. Generator			
j. Chainsaw			
k. Brushcutter			

SECTION 3: LIVELIHOOD AND FOOD SECURITY (INCOME AND RESOURCE USE PATTERN)		
20 Is this a source of income for your household?	**1=Yes 0=No**	**Cash income generated for the household ($ per month)**
Farming yaqona		
Farming root crops (dalo etc)		
Farming vegetables		
Canteen business (groceries, kava, cigarette etc.)		
Livestock		
Freshwater finfish fishing (grass carp, tilapia etc.)		
Freshwater non-finfish fishing (prawns, eels etc.)		
Carrier/land transport operation		
Beekeeping		
Logging royalty		
Land lease		
Selling timber		
Handicraft / basket weaving		
Pension		
Remittances		
Social welfare		
Employment		
Odd paid labor work		
Other income sources, specify …		
21 Is this an item of expenditure for your household?	**1=Yes 0=No**	**Cash spent (FJD/month)**
Food and household daily needs		
School kids expenses		
Medical		
Farming inputs		
Transport		
Clothes		
Hire of labour		
Church obligation		
Village development obligation		
Mataqali development obligation		
Vanua obligation		
Soqo		
Others (please specify..)		

22. In what ways does your family use timber/wood forest products?					
Use	Does your family use trees for this? 1= Yes, 2= No	Frequency of harvest? 1=weekly 2=Monthly 3=Every 6 month 4=Yearly 5=After every 5 years	Amount per harvest (number of units)	Distance of harvesting area from village 1=1-4km 2=5-10 km 3=>10km	Harvesting method (select one) 1=knife/axe 2=chainsaw
Subsistence firewood			____ bundles		
Selling firewood			____bundles		
House construction			____big trees		
House post			____post		
Fencing post			____post		
Markings			____plants		
Furniture			____trees		
Other uses (specify)					
23. Do members of your household consider sustainable approaches when cutting down trees for the above uses? Yes – go to Q24, No – got to Q25					
24. If Yes, select all that is applicable: Do not cut trees on very steep slope Random cutting rather than concentrating on a particular area Do not cut trees on the edge of a river/creek Ensure less damage to trees nearby when cutting a large tree					
22. In what ways does your family use non-timber/wood forest products?					
Use	Does your family the forest for this? 1= Yes, 2= No	Frequency of harvest? 1=weekly 2=Monthly 3=Every 6 month 4=Yearly 5=After every 5 years	Amount per harvest (number of units)	Distance of harvesting area from village 1=1-4km 2=5-10 km 3=>10km	Harvesting method (select one) 1=knife/axe 2=chainsaw
Herbal medicine			____ plants		
Wild ferns			____bundles		
Wild pigs			____individuals		
Other uses (specify)					

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26. Please indicate some of the AGRICULTURE PRACTICES that your household members are involved in?							
Crop	Does your household grow this crop? Yes/No	If yes, is it grown for selling or for subsistence?	If grown for selling, where is the main market? Labasa market/ Savusavu market/ Viti Levu market/ Middlemen agent/ Within the village	Of all the crops your household grow, indicate the 3 most important crops.	Current size of farm for the 3 crops? Garden/ Less than ¼ acre/ ¼- ½ acre/ More than ½ acre	Did you purchase farming items in 2012 in order to grow each of the 3 crops? Yes/No	What is the total amount of money your household used in 2012 for each crop?
Yaqona							
Dalo							
Cassava							
Kumala							
Uvi							
Dalo ni tana							
Via							
Tivoli							
Bele							
Tubua							
Watermelon							
Cucumber							
Pawpaw							
Sugarcane							
Chilies							
Eggplant							
Others (specify….)							

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27. Do members of your household consider and implement sustainable agricultural practices when farming the above crops? **Yes – go to Q28, No – got to Q29**
24. If Yes, select all that is applicable: **Do not farm on very steep slope** **Do not farm very close to riverbanks** **Encourage farming on used areas rather than untouched areas** **Intercropping** **Contour farming in slopes** **Controlled burning of farming areas** **Proper usage of weedicide and pesticide chemicals** **Others (please specify…)**
29. How do you get professional information on farming? **None** **Visit by Agr. Extension Officer** **Visit to nearby Agr. Office** **Media awareness**

30. LIVESTOCK

Livestock	Do you have the following?	If yes, how many does the household own?	Value of one animal	Main use (select one only) Food Transportation Land cultivation Moving heavy items Producing milk Traditional gift Other (specify)	How do you get professional information on raising your livestock? None Visit by Agr. Extension Officer Visit to nearby Agr. Office Media awareness
Cattle					
Pig					
Goat					
Horse					
Chicken					
Duck					
Other (specify)					

SECTION 4: LAND ACCESS AND FINANCIAL SAVINGS	
31. How much land does your household have access to for farming and livestock? (1 acre=1 rugby field)	
32. Please indicate the type of land your household has access to? (Choose only one)	**Freehold** **Mataqali land** **Leased *mataqali* land** **Other mataqali's land** **Leased land on other *mataqali*** **Leased crown land**
33. Which of the institutions below does members of your household feel at times that they encroached on the piece of land the household have access to? (Choose only one)	**None** **Fellow mataqali members** **Other mataqali members** **Landowners if HH on lease land** **Others (please specify)**
34a. Does any members of your household have cash savings?	**Yes/No**
34b. If above answer is YES, where is the savings held?	**Commercial bank** **Community cooperative** **Financial investment institution** **Others (specify)**
35a. Does any members of your household currently have a loan?	**Yes/No**
35b. If above answer is YES, which institution the household borrowed from?	**Commercial bank** **Community cooperative** **Financial investment institution** **Relatives or business individual** **Others (please specify)**

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Appendix 21 Focus group discussion and key informant interview questions

Date:	
Village:	
Which primary schools do children from the village go to?	
Distance from village to school?	
Which secondary schools do children from this village go to?	
Distance from village to school?	
Available village Committee (circle all applicable)	**Development committee** **Health committee** **Environment committee** **Crime committee** **Women's Group** **Youth Group** **School committee** **Religious group committee** **Others (specify…)**
Where do villagers go to for medical assistance?	
Distance from village to Health/Nursing Center	
What's the main mode of transportation in the village?	
Farming:	
Other villages within the district:	
Urban centers:	
What are some main infrastructural and economic development in the village?	

HISTORICAL TIMELINE	
Yabaki	**Veika lelevu e yaco kina**

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SEASONAL CALENDAR												
Activity	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Teitei												
Vaqarai lavo												
Cakacaka (dovu, were pine)												
Qaravi soqo/oga												
Levu na veitosoyaki												
Veisiko mai na veitabana												

PERCEPTIONS OF ENVIRONMENT MANAGEMENT
Please indicate on the scale 1-100 your stand on the statements below. (1= totally disagree, 50= neutral, 100= totally agree)

STATEMENT	**Score 1-100**
E sega soti sara ni bibi na kena taqomaki se maroroi na veikau kei na veikabula era tu kina vaka na manumanu vuka, kau etc.	
Ni caka na musu kau (logging) e bibi taudua nai lavo e rawa mai kina ka sega soti ni yaga me da kila nai walewale se vakarau ni kena musu na veikau.	
Kevaka e maroroi e dua na tiki ni neitou qele/veikau me kakua ni tarai, keitou sa na leqa saraga vakavuvale se vakamataqali	
E taucoko tu na cakacaka vata kei na veilomani ena koro oqo	
E dau rogoci na domoi keimami kece, wili kina na marama kei na tabagone ena so na vei	