Terrestrial and Archaeological Surveys of the Kilaka Forest Conservation Area

Citation: Kirmani SN, Brehme C, Cakacaka T, Dulunaqio S, Fisher R, Hathaway S, Koroi I, Loganimoce E, O'Brien M, Masibalavu V, Naikatini A, Segaidina M, Thomas N, Tikoca S, Tubuitamana P, Tuiwawa M, Vido S, Mangubhai S (2018) Terrestrial and Archaeological Surveys of Kilaka Forest Conservation Area. Wildlife Conservation Society. Report Report No. 04/18. Suva, Fiji. 59 pp.

ISBN-13: 978-0-9903852-3-3

Photograph (front cover): A freshwater creek in the Kilaka Forest Conservation Area. ©Sahar N Kirmani/WCS

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Acknowledgements*:* Firstly, we would like to thank the community of Kilaka for supporting these surveys, providing both guides and forest wardens. We are grateful for the opportunity for bringing together so many experts from the Wildlife Conservation Society, BirdLife International, University of the South Pacific, NatureFiji-MareqetiViti and the United States Geological Survey. This work would not have been possible without the generous support of the John D. and Catherine T. MacArthur Foundation (grant #17-1706-152078-CSD).

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EXECUTIVE SUMMARY

Protected under a 99-year conservation lease between the Wildlife Conservation Society and *mataqali* Nadicake, the Kilaka Forest Conservation Area in Kubulau District, Vanua Levu, boasts a diversity of native, endemic and endangered flora and fauna. Herpetofauna, birds, bats and invasive mammal surveys were conducted between 12–16 February, 2018 and vegetation, flora and archaeological surveys were done on 28 April, 2018. This report presents the findings of terrestrial and archaeological baseline surveys conducted in the Kilaka Forest Conservation Area by experts from BirdLife International, NatureFiji-MareqetiViti, University of the South Pacific and the United States Geological Survey.

A total of 245 taxa of higher vascular plants were recorded during the survey, including 196 angiosperms, 44 ferns and fern allies, and 5 gymnosperm taxa. Endemism was 35% (87 species) for all higher vascular plants. The higher plants comprised of 100 families, 188 genera, and 214 species. The largest family was Rubiaceae (16 taxa), Orchidaceae (15 taxa), Euphorbiaceae (13 taxa). The largest genus was *Ficus* with 8 species in the Moraceae family, followed by Syzygium with 6 taxa in the Myrtaceae family, Cyathea in the Cyatheaceae family, and Asplenium in the Aspleniaceae family. Lowland rainforest was the principal vegetation or forest type in the Kilaka Forest Conservation Area. Three exotic plant species (1%) were recorded.

A total of 25 species of birds were recorded, of which 15 species are endemic to Fiji including the vulnerable shy ground-dove. The bird community in Kilaka Forest is indicative of a large island native forest community with species composition similar to Natewa on Vanua Levu. The near threatened Samoan flying-fox and the vulnerable Fijian blossom bat were recorded from diurnal surveys. Eleven of the the 21 known herpetofauna species on Vanua Levu were recorded, including 2 species of native frogs, 5 species of native skinks (1 potentially new species undergoing further analysis), 3 species of native geckos and the invasive toad. A combination of three different trapping techniques was used to identify the presence of 5 invasive mammals in or along the boundary of the area. These include rats, mongoose, cats, pigs and cows.

Lepidoptera or moths were the only group of terrestrial invertebrates surveyed and experts found 27 species belonging to 7 families over the 4 nights of sampling. This represents 25% of the known species for Vanua Levu and a high rate (48%) of endemism. Four new moth species were found for Vanua Levu: *Adetoneura lentigiginosa* (Erebidae), *Thalassodes fiona* (Geometridae), *Aeolopetra palaeanthes* (Crambidae) and *Locastra ardua* (Pyralidae).

In addition to biodiversity surveys, two archaeological sites, an old village and house foundation, were mapped, documented and placed on Fiji's National Register.

Although short in duration, these surveys revealed a relatively high percentage of endemic or native flora and fauna, providing a baseline for further longterm research. Experts made a number of specific recommendations:

- conducting longer surveys over different seasons to capture and map a greater diversity of species;
- demarcating vegetation plots for longterm monitoring and research;
- investigate interactions between native herpetofauna and introduced mammalian predators to devise conservation and management strategies;
- include more terrestrial invertebrate taxa surveys; and
- conduct proper documentation of archaeological sites, including oral history.

1 INTRODUCTION

The Kilaka Forest Conservation Area (KFCA) is is close to Kilaka Village and is located on the southern coast of Fiji's second largest island, Vanua Levu, in Kubulau District, Bua Province (Fig. 1). The Conservation Area is just 6 km south west of the western perimeter of the Wailevu/Dreketi Highlands International Bird and Biodiversity Area/Key Biodiversity Area (IBA/KBA)[1], an area of primarily native forest covering some 720 km^2 of southern/central Vanua Levu (BirdLife International 2018), and has been identified as a national priority by the National Protected Areas Committee.

The KFCA and lies on land belonging to land owning unit or clan (*mataqali*) Nadicake. Recognising the value of the forest, its biological diversity and important catchment area, *mataqali* Nadicake has been protecting the forested area from logging, informally, since 2006, and formally, through a 99-year conservation lease with Wildlife Conservation Society (WCS), since June, 2017. The KFCA has a management plan (WCS 2016) which sits under the Kubulau Ecosystem-Based Management (EBM) Plan (WCS, 2012). One of the objectives of the Kubulau EBM plan is to "*protect and provide good habitats for endemic forest species*", some of which have been identified opportunistically (NatureFiji-MareqetiViti unpublished data, O'Brien unpublished report) or through formal surveys (Keppel 2005, Jupiter et al. 2012).

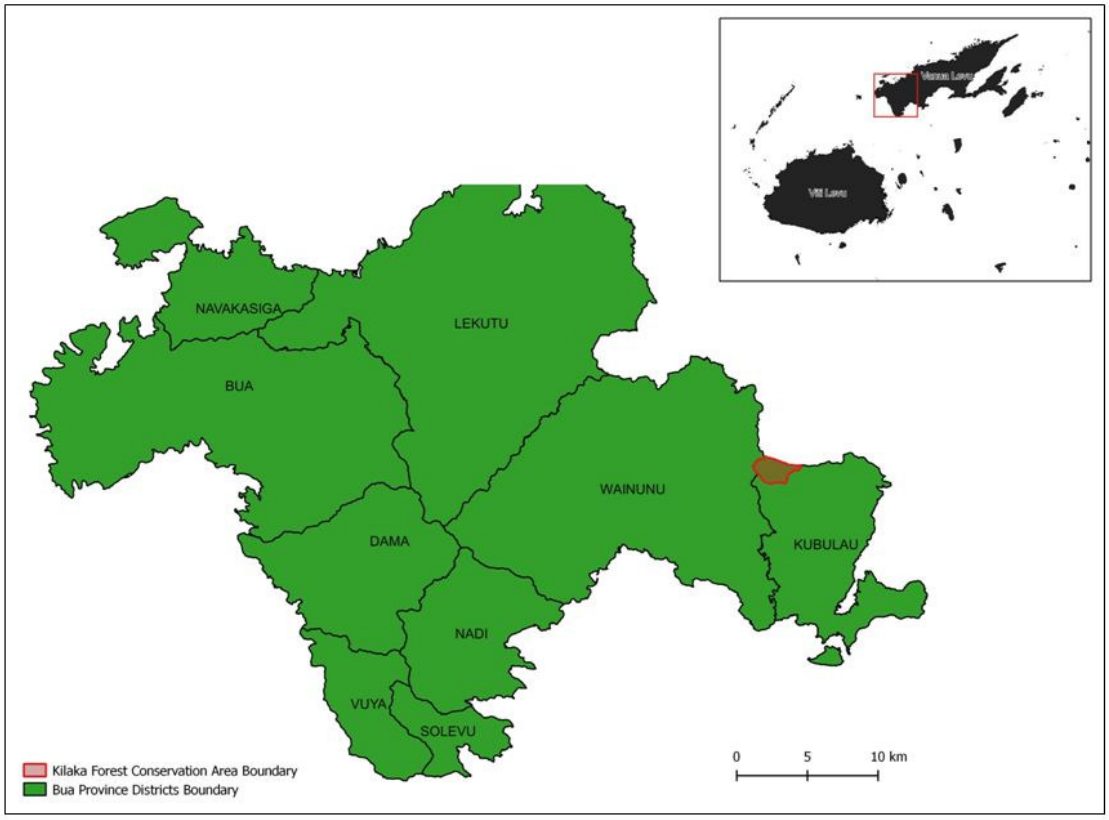


Figure 1. Kilaka Forest Conservation Area in Kubulau District, Bua Province

[1] This IBA has all (but one) endemic birds of Vanua Levu, including the endangered subspecies of Long-legged thicketbird (*Megalurulus rufus)* (BirdLife International 2018), last recorded in Vanua Levu in 1974 (Kinsky 1975).

The KFCA comprises 402 ha of one of Fiji's last native rainforests with 98% of primary habitat that is mostly unlogged (Ministry of Forests 2016). The area is part of a contiguous forested zone that covers the southern half of Vanua Levu. Vegetation and botanical surveys of KFCA, conducted almost 15 years ago, identified the primary vegetation type as lowland tropical rainforest dominated by the flowering plants *Myristica gillespieana*, *Parinari insularum* and *Calophyllum vitiense*, a conifer *Retrophyllum vitiense* and the tree species *Gironniera celtidifolia*. Keppel (2005) recorded 319 species of flora belonging to 99 families and 223 genera, of which nearly 40% were endemic to Fiji, and 5% of plants found only on Vanua Levu. Additionally, 2 tree species listed as Endangered on the IUCN Red-List, Fijian Kauri Pine (*Agathis macrophylla*), and a native tree known locally as *vo'a* (*Geissois imthurnii*), and one Critically Endangered tree species previously only found from Mt. Kasi (*Astronidium kasiens*), were recorded. The 2005 survey also provided the second-ever recording of a small endemic tree in the citrus family (*Zanthoxylum myrianthum*), seen for the first time in more than 50 years, and documented a species of *Terminalia* believed to be new to science.

Along with this high diversity of flora, the area also contains a variety of native animal life including birds, bats, herpetofauna, invertebrates and fish species. A rapid bird assessment of KFCA in May 2016 identified at least 13 bird species found only in Fiji, including the orange fruit dove (*Chrysoena victor*) and maroon shining parrot (*Prosopeia tabuensis*) (M. O'Brien unpublished report). In 2016, a bat survey carried out in KFCA by NatureFiji-MareqetiViti (NFMV), Bat Conservational International, BirdLife International and the University of the South Pacific (USP) confirmed the presence of echolocating microbats *Chaerephon bregullae,* only known from one other roosting and nursing cave, Nakanacagi Cave in Dreketi, Vanua Levu (NFMV, unpublished data).

Along with the diversity of fauna and flora that exists within the KFCA, an old village site with foundations of houses marked with stones and rocks was noted along the south-eastern boundary (WCS 2016), although there has been no archaeological assessment in the area. There are very few archaeological studies within Bua Province and the work of Fiji Museum lacks coverage of the province. Recently, the Fiji Museum has received several request letters from the communities in Bua Province seeking assistance to document and protect their cultural heritage spaces.

Given the high floristic endemism, the wide diversity of native animals and the identification of a number of rare and threatened species that may be susceptible to invasive or introduced species within Kilaka Forest, the aim of this study was to collect terrestrial baseline data for longterm monitoring of the conservation area.

Given the local expertise available in Fiji, the study aimed to cover a wide range of objectives:

- Identify rare and threatened native species, especially the endemic taxa;
- Conduct detailed quantitative analysis of the main forest types;
- Assess the extent to which the avifauna at Wailevi/Dreketi IBA was found at KFCA;
- Determine whether the bird population at KFCA justifies including the site as a KBA under the new criteria[2];
- Provide a checklist of all bat species present;
- Identification of herpetofauna to add to or expand distribution maps on Vanua Levu;
- Establish a baseline of macro-moth assemblages;
- Record the presence and distribution of introduced invasive mammalian predators; and
- Document any cultural or archaeological sites.

[2] IUCN (2016)

2 METHODS

All surveys were conducted within the KFCA or along its boundary between 12 February to 28 April, 2018 (Fig. 2). Seven types of surveys were conducted:

a) Vegetation and flora, led by local experts and the Ministry of Forests;
b) Birds, led by BirdLife International;
c) Bats, led by NatureFiji-MareqetiViti;
d) Herpetofauna, led by NatureFiji-MareqetiViti and the United States Geological Survey;
e) Invertebrates, led by NatureFiji-MareqetiViti;
f) Invasive mammals, led by NatureFiji-MareqetiViti and the United States Geological Survey; and
g) Archelogical surveys, led by the Fiji Museum.

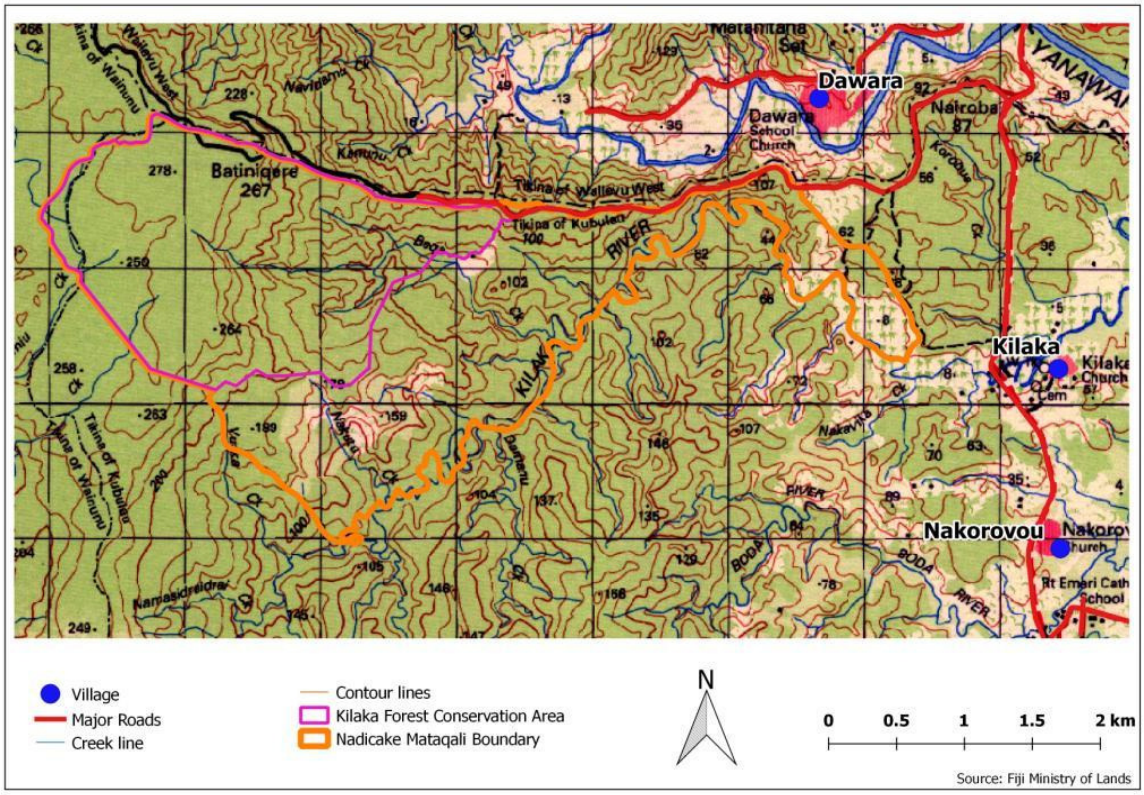


Figure 2. Kilaka Forest Conservation Area study site

2.1 Vegetation and Flora

An initial desktop assessment of the study area was done using maps provided by WCS, satellite imagery and Fiji 1:50000 topographic maps. It was noted that "forested areas" in the conservation area appeared intact accept for the forest edges next to the road that runs along the north-east edge and the south west edge of the KFCA, with the later appearing to be an old garden or grazing site. Due to time constraints, vegetation transects and flora surveys were carried out where access was most efficient (Fig. 3). Assuming that exotic species gain access from roads, the proximity of these surveys towards the road and KFCA boundary would also allow the team to assess the incursion of exotic invasive species into KFCA.

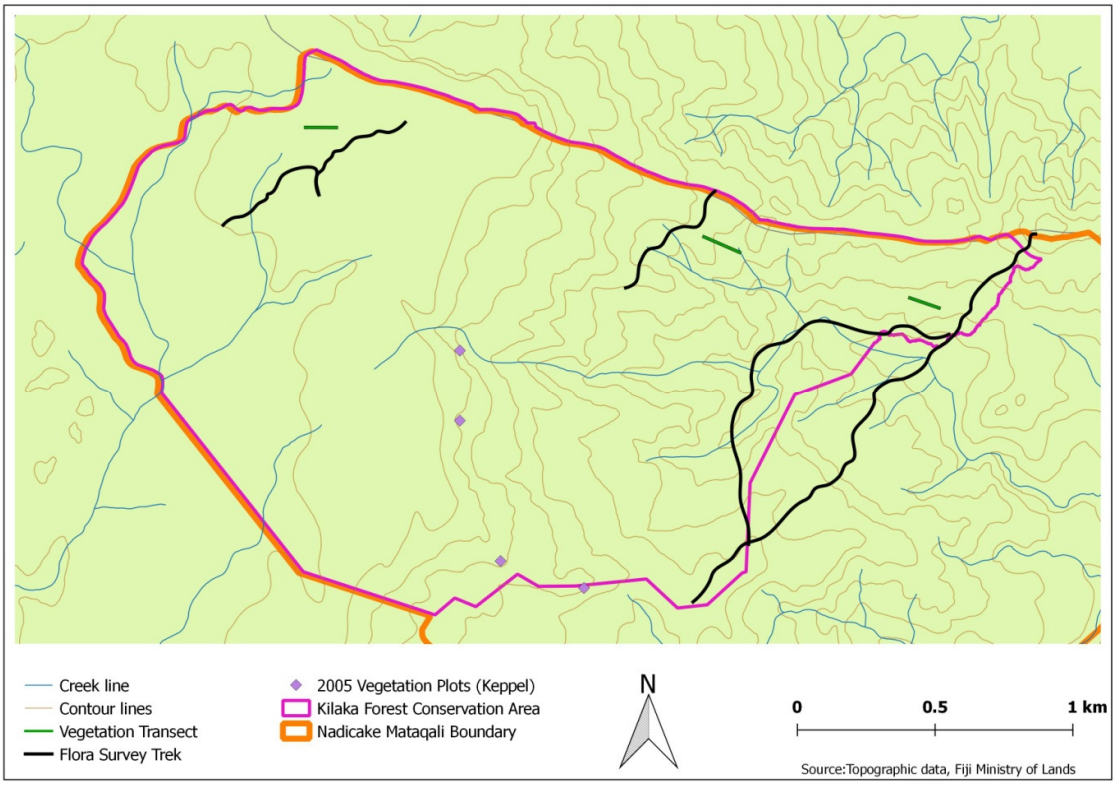


Figure 3. Location of vegetation and flora surveys in the Kilaka Forest Conservation Area.

The field work assessment took place on 28th April 2018, and involved trekking through the various forest types based on the topography of this lowland rainforest. Field observations and opportunistic collection of vascular plants were done, particularly of rare and threatened endemic species. Belt transects were used to quantify plant density, distribution and diversity within the different forest types. An annotated checklist was prepared with special interest in the floristic composition and distribution of plants particularly the focal species listed in the IUCN Red List, Endangered and Protected Species Act for Fiji (2001) and CITES Appendices (2014). Where feasible, specimens were collected and and their marked using a Global Position Satellite (GPS).

Specimens collected were deposited at the South Pacific Regional Herbarium (SPRH) where identification was carried out. Unidentified or unverified species in the field were collected for later taxonomic work at the herbarium. Plants with undetermined taxa were

cross-referenced to herbarium vouchers, documented flora by Smith (1979, 1981, 1985, 1988, 1991), Brownlie (1977) and Brownsey and Perrie (2011). These also involved the field collection, preparation and annotation of specimens as permanent records. The distributions of taxa within the area surveyed were indicated and recommendations to their protection highlighted.

Quantitative assessment of the communities in different forest types were carried out using 10 m x 10 m plots along an 80 m transect. A modified and similar methodology (use of a 100 m transect) was 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 within each principal vegetation type; and
- 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 in addition, the epiphytic flora recorded. Where feasible, GPS locations and photographs of the vegetation were taken for record.

2.2 Birds

A five-minute point count survey technique was used to estimate the number of birds in the KFCA from 12–16 February 2018, to enable a comparision to other sites. Tracks, previously established by the herpetofauna team, were used as transects at this site (Fig. 4). Point counts were taken at approximately 200 m intervals along these tracks (transects 1–4 and the boundary road, Fig. 2) using the survey methods by Schuster et al. (1999). Generally, a set of 10 point counts, with the first one starting within an hour of sunrise, can be completed in 3 hours. Bird song, and so detectability, declines as the day progresses so all quantitative data was collected in the early morning, leaving the rest of the day to search for and count those species not amenable to point counts (e.g. species which call infrequently or are scarce in the study area).

All bird species seen or heard during a 5-minute period at the point were recorded. The number of individuals of each species was estimated based on the variation in the distance and direction of the various calls. A short, 5-minute period is used to minimise the likelihood that individual birds will move from one singing post to another, within the survey period. This short time period means that some birds present at the site may not be recorded as they do not call within the timeframe. Estimating distance to birds is too inaccurate to be of any use when undertaking general surveys of forest birds in Fiji. Distance-sampling methods (e.g. Buckland et al. 2001), and so estimates of density, require measurements to be exact; therefore, the approach used was to collect information on all birds and compare within species frequency at a range of sites, on the assumption that variation in detectability between these sites is minimal. A detailed survey, perhaps using an array of sound recorders to estimate the detectability of individual species (e.g. Dawson and Efford 2009) would be a useful study to consider in the future.

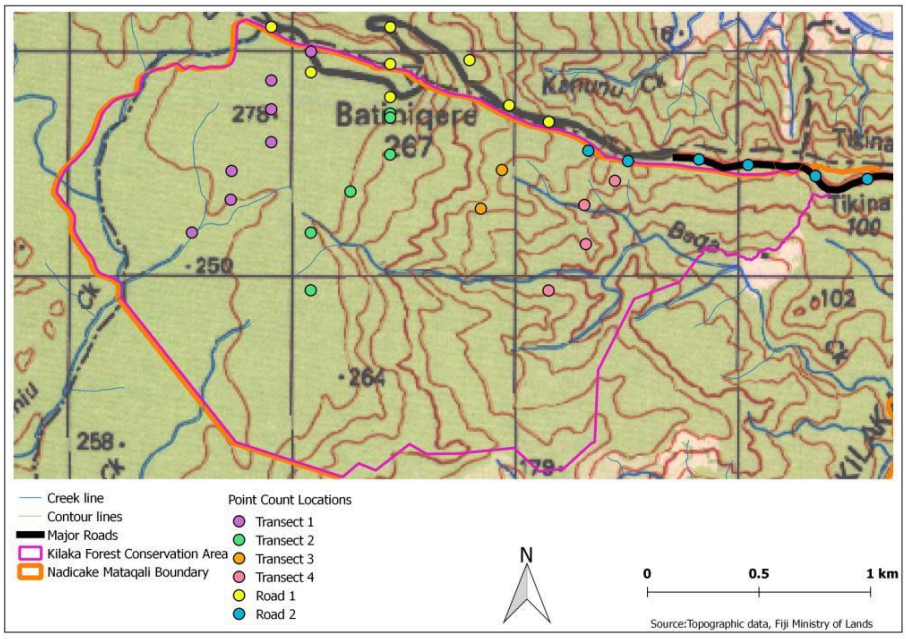


Figure 4. Point count locations in KFCA and along the boundary road.

Conducting surveys along the boundary road at KFCA. ©Sahar N Kirmani

It is assumed that the large number of point counts at a site will capture/detect most, or all, the bird species present, and will provide information on the relative frequency of birds at each of the sites. A limitation of this method is that information obtained while moving between the point counts, i.e. as surveyors walk from point to point, is ignored. This is remedied by maintaining a total species list for that site, which combines birds recorded on point counts with any other species present.

The estimates of bird numbers per point count cannot be compared between species, as different species have different detectability, but can be compared between sites of similar habitat. We assume that where habitats are sufficiently similar the detectability of an individual species is unlikely to vary. We can compare forest bird numbers in KFCA

with similar surveys undertaken between 2010 and 2015 in Fiji (Mark O'Brien unpublished data), where a series of point counts, each of 5-minute duration, were undertaken. Where the species present in a particular island group of Fiji is different from the species present in Kilaka, but where a similar species occurs we provide the data for the related species. Examples of this are:

- Masked shining parrot on Viti Levu replaces maroon shining parrot on Vanua Levu. These species are from the same family, Prosopeia, and appear to occupy the same ecological niche (Watling and Talbot-Kelly 2004).

- Kikau (or Western) wattled honeyeater on Viti Levu and Eastern (or Polynesian) wattled honeyeater on Northern Lau replaces Fiji (or Northern) wattled honeyeater. All 3 species are from the same family, Foulehiau, and were only considered to be separate species following a recent systematic review (Andersen et al, 2014, del Hoyo et al. 2016).

- Golden dove on Viti Levu replaces the orange dove found on Vanua Levu and Taveuni. These species are from the same family, Chrysoena, and appear to occupy a similar ecological niche (Watling and Talbot-Kelly 2004).

- Giant honeyeater on Viti Levu replaces the yellow-billed honeyeater on Vanua Levu and Taveuni. These species were only considered separate species following a recent systematic review (Andersen et al. 2014, del Hoyo et al. 2016). Detectability of these species varies markedly – the Viti Levu bird has a distinctive, and loud 'car alarm' yodelling song that is a feature of forested areas on the island. The yellow-billed honeyeater is less vocal with a less distinct song. Even given these differences it appears that the latter is noticeably less common than its congener.

While it is unwise to directly compare the results of a series of point counts with the results of walking transects, and recording all birds seen, both methods rely on the sight and sound of birds. A previous study (O'Brien 2016) compares observations of a range of bird species on point counts (the method used in the current survey) with observations of the same species on line-transects at the same sites (line transects were the method used to assess IBAs across Fiji), and so provide a dataset from over 10 years (Masibalavu and Dutson 2006). Although using the same method for both surveys is more reliable for comparisons, point counts of short (5 minute) duration lend themselves better to longterm monitoring of sites.

Finally, we can use the bird data to assess whether the site might qualify as a KBA in its own right, under the new criteria (IUCN 2016). Sites qualify as global KBAs if they meet one or more of 11 criteria, clustered into 5 categories: threatened biodiversity; geographically restricted biodiversity; ecological integrity; biological processes; and, irreplaceability.

For the purposes of assessing bird populations at KFCA we will consider two of these criteria.

(1) Threatened Biodiversity/Species of Global Conservation Concern:
- ≥0.5% of the global population size and ≥5 reproductive units of a critical (CR) or endangered (EN) species;
- ≥0.1% of the global population size and ≥5 reproductive units of a species assessed as CR or EN due only to population size reduction in the past or present;

Effectively the entire global population size of a CR or EN species.
- ≥1% of the global population size and ≥10 reproductive units of a vulnerable (VU) species;
- ≥0.2% of the global population size and ≥10 reproductive units of a species assessed as VU due only to population size reduction in the past or present;

(2) Geographically Restricted Biodiversity/Restricted Range Species:
- Site regularly holds ≥10% of the global population size AND ≥10 reproductive units of a species.
- Site regularly holds at least 1% of the global population of each of at least 2 restricted-range bird species.

The KBA criteria have quantitative thresholds to ensure that site identification is transparent, objective and repeatable. It is important to compile the best available data for KBA identification, but the availability of high quality data differs significantly between different taxonomic groups. Hence, for some of the population size-related criteria there is a range of metrics that can be used to estimate or infer whether a site holds a threshold proportion of a species' global population size, including number of mature individuals, area of occupancy, extent of suitable habitat, range, number of localities, and distinct genetic diversity. We will analyse the available data, and identified how we might extrapolate the available data in order to use the information from KFCA to assess its suitability as a KBA for birds.

2.3 Bats

Observations were conducted during the day and night to confirm presence of bats within the KFCA. Diurnal observations were carried out while conducting the bird surveys along several points within the area. In addition to the visual survey, a wildlife acoustic song meter (model: SM4) or bat detector was set up and secured on a tree using cable ties. The bat detector was programmed to automatically start recording at dusk (6.30 pm) and stop at dawn (4.30 am). It was left out for two nights, once at transect 3 and once at transect 1 (14–15 February, 2018) (Fig. 5). The bat detector was collected on the following morning of each deployment (Table 1). Acoustic data recorded during the 2 nights were downloaded, and shared with collaborating partners, for further analysis to determine presence and activity of Fiji's echo-locating and endangered microbats in the area.

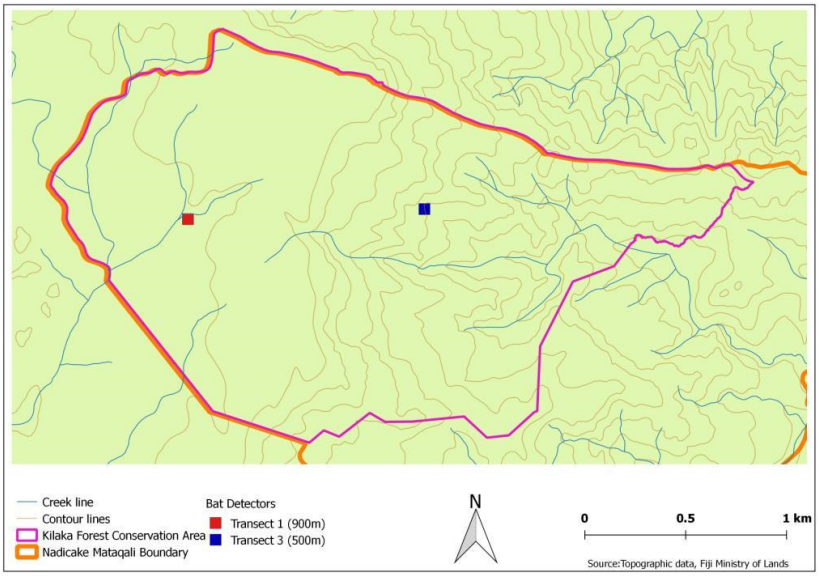


Figure 5. Location of acoustic bat detectors in the Kilaka Forest Conservation Area.

Table 1. Acoustic song meter deployment stations within riparian vegetation in the Kilaka Forest Conservation Area from 7:00 pm to 4:40 am.

Transect	Date	Transect point (m)	Forest cover (%)	Avg. air temp (°C)
3	14/02/18	500	100	26.3
1	15/02/18	900	85	26.5

2.4 Herpetofauna

There are several accepted methods for herpetofauna surveys that generally fall under two categories: opportunistic diurnal and nocturnal searches and trapping, and standardised nocturnal and diurnal searches and trapping. Herpetofauna long term monitoring transects that exist for Fiji are restricted to frogs (Sovi Basin Conservation Area, Wabu Forest Reserve), and crested iguanas (Yadua Taba Iguana Sanctuary, Monuriki Island). 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, to document the presence/absence of herpetofauna. For the KFCA, two methods under the standardised nocturnal and diurnal category were employed: sticky trap stations and nocturnal visual surveys along 3 x 1 km transects from 12–16 February, 2018.

2.4.1 Sticky Traps

Sticky trap stations were set up whereby sticky mouse traps (Masterline®) were laid out at intervals along a transect line. Each station was designated a station number with a cluster of three traps per station for three placements to represent local habitat structure at each location (Tree, Log and Ground), to capture terrestrial and arboreal herpetofauna, and rats. Previous surveys have employed the use of sticky traps in two ways:

a) Because of the low capture rates of herpetofauna within high island rain forest, sticky traps have been placed opportunistically at identified ideal habitats e.g.

ridge tops and along river banks/ riparian vegetation (e.g. Sovi Basin Conservation Area, Proposed Greater Delaikoro Protected Area).

b) Sticky traps have been placed along a 1 km transect, at 50 m intervals (e.g. Southern Lau, Vatuvara Island).

For the KFCA, the method was modified to increase the sampling effort. Sticky trap stations were clustered with 10 stations at 250 m intervals along transects 1, 2 and 4. The stations (three sticky traps per station: Tree, Log and Ground) were placed at 10 m intervals and left for a minimum of 24 hours before collection, allowing the capture of nocturnal and diurnal species. This modified method intensified sampling from one trap station per 50 m to five trap stations per 50 m. In total, 450 sticky traps were laid out at 150 trap stations along transects T1, T2 and T4 (50 trap stations per transect). See Figure 2.6.

2.4.2 Nocturnal Visual Encounters

Nocturnal visual encounter surveys were used to survey iguanas (which are more visible at night) and nocturnal herpetofauna such as frogs, geckoes and snakes (active and more visible at night). These surveys were conducted with a minimum of two searchers per night, following a 1 km transect for reptiles and for 2 hours for frogs. For the KFCA, nocturnal surveys along transects 1, 2 and 4 and a 2-hour frog survey was conducted within transect 2 (Fig. 6). Environmental variables were recorded at the start and end of each survey: cloud cover, air temperature, rain (last 12 hours and 24 hours). All captured individuals from the sticky trap stations and the nocturnal visual surveys were identified and recorded; a select few were processed and retained as specimens. The liver and tail of specimens were retained for further DNA analysis.

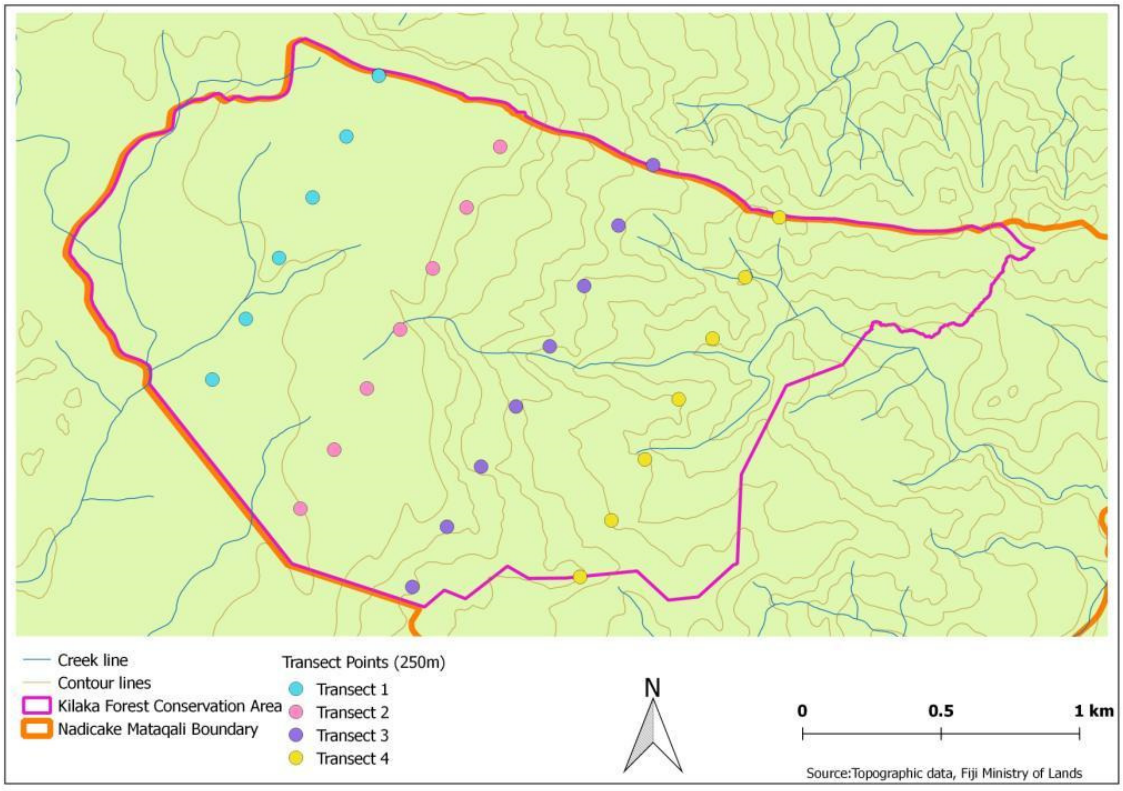


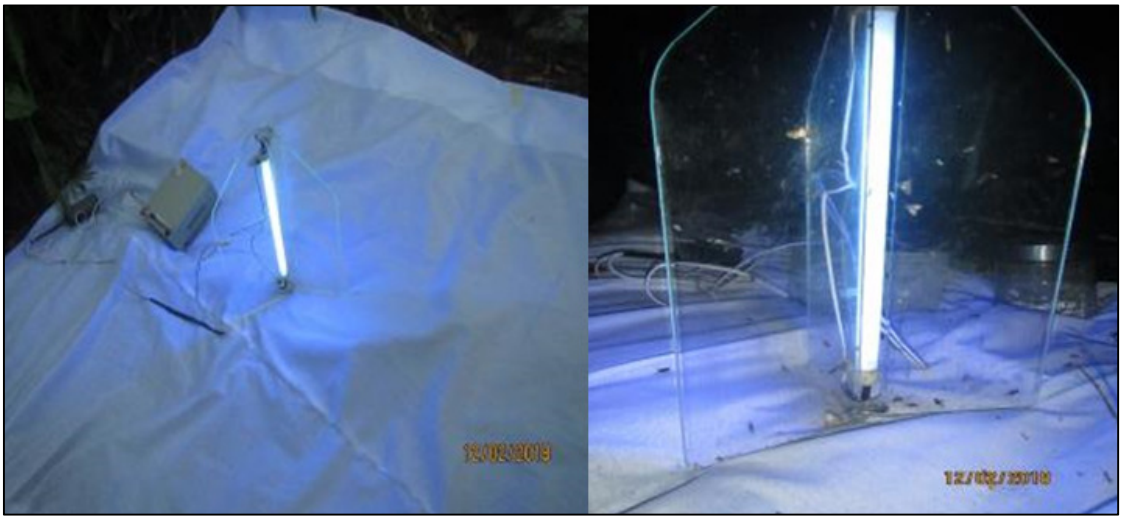
Figure 6. Location of the 250 m stations along each transect in Kilaka Forest Conservation Area.

2.5 Terrestrial Invertebrates

Moth surveys using light traps were carried out from 12–16 February 2018, while an opportunistic collection of insects of interest encountered during the vegetation surveys was to be conducted in April 2018. Unfortunately, the weather did not permit the latter insect surveys to be carried out.

Previous research comparing light trap efficiency at Colo-i-Suva Forest Reserve, Fiji indicated that at least 4 nights of sampling is required to obtain a good proportion (approximately 80%) of the estimated total number of moth species present (Tikoca et al. 2016). This applies specifically to manual collection using a powerful light; mercury vapour light. Despite its efficiency to collect representative samples with fewer sampling nights, there are several disadvantages of using this light trapping method. These include the need for a generator to power it; more man power needed to transport and run the generator as well as safety concerns and considerations (while transporting and operating it, particularly under bad weather conditions). Due to these considerations, an ultra violet (UV) light traps was used instead.

Traditional UV light traps are designed as automatic bucket light traps that can be set up and left over night for collection in the early hours of the morning. These traps have proven to be inefficient for tropical countries like Fiji, where one night of sampling can collect individuals as low as two and made up of only one species (Tikoca et al. 2016). Therefore, to effectively sample moths, the light trapping method employed during this survey was a combination of the two mentioned methods where a UV light source was used with a 2 m x 2 m white sheet and macro-moth samples were manually collected off the white sheet with killing jars charged with ethyl acetate for three hours after dusk (see photo below). Light trapping was carried out for four nights along the 500 m mark of the 1 km transect lines running through the conservation forest. The first transect (T1) was sampled twice to ensure that habitats sampled were consistent along all transects. Habitat type, forest cover, air temperature, and start times and finishing times were recorded for each site.



UV light trap powered by a 12V portable battery and set up on a 2 m x 2 m white sheet.

Sorting and identification of specimens was done in reference to Robinson (1975), CSIRO (2011), Evenhuis (2013) and Clayton (2004). For this study specifically, macro-moths collected and recorded also included some species that belong to the Pyralidae family. These were then checked across the Global Name Resolver[3] database to ensure that the latest accepted scientific names were recorded. In order to assess the levels of endemism of the moths in each forest type, species were classified as endemic based on currently available distribution records. Individuals of the large genus Cleora were not identified to species level, therefore, '*Cleora* sp.' was treated as a single taxon. Of the 10 species belonging to the genus Cleora in Fiji, *C. injectaria* and *C. samoana*, are not endemic. Neither of these species was recorded and therefore *Cleora* sp. was considered an endemic taxonomic unit for the purposes of this study.

2.6 Invasive Mammals

Several passive tools were used to survey for the presence of mammals in the KFCA: Infrared cameras, bait and track tunnels for invasive mammals, and snap traps and bait for rats. During the set-up of these methods, signs of mammal presence were noted: tracks, scat, and evidence of digging or foraging. The Infrared cameras, track tunnels and snap traps were placed with the herpetofauna sticky trap stations at 250 m intervals (see Figure 2.6 in section 2.4.1) along transects 1, 2, 3 and 4 (T1, T2, T3, T4) from 12th – 16th February, 2018.

2.6.1 Infrared Cameras

Passive infrared (PIR) wildlife cameras are triggered by a combination of heat and motion. A total of 24 passive cameras were set up on T1, T2, T3 and T4 at distances of 0, 125, 250, 500, 750, and 1000 m to target small mammals and run for a total of three nights (Table 2). The cameras were attached to tree trunks at a height of approximately 20 cm above the ground targeting 0–2 m of forest floor (see photos below). At the 0 m roadside transects, cameras were set to face the forest edge and/or road with a field of view of approximately 1–10 m. For all cameras, low vegetation was cleared from the field of view to prevent excessive false triggers from moving vegetation. At least one track tunnel was in the field of view for all cameras. Bushnell Trophy HD Cameras were set to normal sensitivity motion detection with video. Reconyx PC800 HyperFire Professional Semi-Covert IR cameras were set to medium sensitivity for motion detection and automatic time-lapse photo captures every one minute.

Table 2. Passive infrared camera survey times and settings in the Kilaka Forest Conservation Area.

Transect	Date Set	Date Removed	Camera Type	Sensitivity Setting	Data Capture
1	12/2/2018	15/2/2018	Bushnell Trophy HD	High (0m); Medium (125–1000 m)	3 photos, 6 s video
2	12/2/2018	15/2/2018	Bushnell Trophy HD	High (0m); Medium (125–1000 m)	3 photos, 6 s video
3	13/2/2018	16/2/2018	Bushnell Trophy HD	High (0m); Medium (125–1000 m)	3 photos, 6 s video
4	14/2/2018	16/2/2018	Reconyx PC800 HyperFire	High (0m); Medium (125–1000 m)	3 photos*

* No video option

[3] https://resolver.globalnames.org/

(a) (b)

Wildlife camera traps in (a) interior and (b) edge habitat.

2.6.2 Track Tunnels

Tracking tunnels are used to survey for small mammals by attracting them with bait and recording their foot prints. Tunnels with pre-inked tracking cards (Black Trakka, Gotcha Traps Ltd; 10 cm x 10 cm x 50 cm) were used to target small mammal sizes ranging from mongoose to rats (see photos below). Track tunnels were set and removed at the same transect locations and times as the PIR cameras (Table 2). For setting, three tunnels were placed in an array at each sampling location and baited with a tablespoon of tuna, roasted coconut, or peanut butter placed in the centre of the card (one bait type per tunnel). After collecting all tracking cards from the tunnels, individual tracks were identified and measured (forefoot width) in the lab.

Images show the track tunnels laid down.

2.6.3 Rat Snap Traps

Rat trapping using snap traps was carried out over three consecutive nights from the 13–15 February, 2018. The rat traps were deployed on transects 1, 2 and 4, along with the herpetofauna sticky traps and Infrared cameras and tunnels, at 250 m intervals. Each transect had six stations and there were two traps deployed per station. Each trap was given a trap number which was marked on a pink flagging tape and tied to a nearby tree branch so that it was visible. The snap traps were set up and baited with roasted coconut at 6 pm on the 12, 13 and 14 February 2018, and checked and collected at 6 am on the 13, 14 and 15 of February, 2018.

Trap rebaiting was only done in the evenings (6 pm) to minimise the capture of non-target species during the day. Body measurements of all rats caught were recorded to help confirm species identification. These body measurements included weight, head-body length, tail length, length right ear, length right foot, length skull, length from anus to urethra. For females, additional measurements and observations were made including, length from vagina to urethra, observations of the vagina (open or closed), and number of nipples.

2.7 Archaeology

The Fiji Museum's assessment of the archaeological/cultural sites in the KFCA was identified initially from the KFCA Management Plan and later confirmed by local guides' knowledge of the sites. The sites were mapped using a mobile phone application called Avenza[4]. Site notation was carried out and photographic documentation of sites was made with a camera (Canon EOS 700D). Due to time constraints and a death in Kilaka Village, the team chose to identify and demarcate the two archaeological sites, and thus were not able to record oral narratives on the ancient occupation, events and migration of the ancestors of the surrounding communities.

[4] https://www.avenzamaps.com/

3 RESULTS

3.1 Vegetation and Flora

3.1.1 Floristic Diversity

A total of 245 taxa of higher vascular plants were recorded during the one day KFCA survey (Appendix 1). For these plants there were 196 angiosperms (159 dicots and 37 monocots), 44 ferns and fern allies, and 5 gymnosperm taxa. For the 44 fern and fern allies, 80% (35 species) of the fern flora are indigenous and 14% (6 species) are endemic to Fiji. All 5 gymnosperm species are indigenous. For the angiosperms (flowering plants) documented, 47% (92 species) are indigenous, 41% (81 species) are endemic species, 2% (3 species) exotic and 2.5% (5 species) aboriginal introductions. The remaining 7.5% (14 taxa) are native most likely to be either indigenous or endemic.

From the angiosperms, only 13 taxa were identified at the generic level and another 7 were allotted specific species that they resembled. This latter group did not have fertile features (flowers and or fruits) that could be used to verify their true identity. The higher plants comprised 100 families, 188 genera, 214 species and 8 other (varieties, subspecies) taxa. It is to be noted that only 16 taxa were identified at the generic level and another nine were allotted specific species that they resembled. The 6 largest families were Rubiaceae with 16 taxa followed by Orchidaceae with 15 taxa, Euphorbiaceae with 13 taxa, and then Moraceae, Myrtaceae and Cyatheaceae with 9, 8 and 7 taxa, respectively. The speciose genera included Ficus with 8 taxa in the Moraceae family followed by Syzygium with 6 taxa in the Myrtaceae family and Cyathea with 5 taxa in the Cyatheaceae family. Of the 3 introduced species or exotics species recorded during the survey, all are recognised invasive species and include *Clidemia hirta, Mikania micrantha* and *Solanum torvum*. Only 6 species encountered (Table 3) could be considered important due to their rarity (known from at least three or less collection localities according to Smith 1985), listing on the IUCN Red List (2012), CITES Appendices (2014), and Fiji Endangered and Protected Species (Amended) Act 2017 schedules.

Table 3. Plants with conservation status formally determined, considered rare or have limited distribution, especially in Fiji.

Species name	Status
Medinilla kambikambi A.C.Sm.	Endemic and known only from Vanua Levu
Podocarpus neriifolius D.Don	Least Concern but on CITES Appendix III
Crossostylis harveyi	Endemic to Viti Levu and rare on Vanua Levu
Macaranga vitiensis	Endemic, supposed rare on Vanua Levu
Trichospermum calyculatum (Seem.) Burret	New record from Vanua Levu
Amaracarpus muscifer A.C.Sm.	Endemic to moist forests of Vanua Levu

3.1.2 Community Structure

A noticeable feature observed whilst driving along the KFCA boundary was the old logging tracks that run into the forest. This indicated that the area had been previously logged (over 25 years ago) and the forest appeared to have recovered. Of the 9 principal vegetation types recorded for Fiji (Mueller-Dombois and Fosberg 1998), only 1 was observed in the KFCA - lowland rain forest vegetation. Keppel (2005) also recorded this principle vegetation type and was referring to it as "rain forest". Within this principle vegetation type, two forest types based on the dominant or more prominent topographical feature were selected to quantitatively assess the plant community within. These were the forest on slopes (with gradients ranging from 10° to 40°) or flats hence

forthwith being referred to as the Lowland Slope Forest Type (LSFT) and the Lowland Flat Forest Type (LFFT), respectively. Since more than 75% of the KFCA is made up of LSFT, two transects, each with eight plots, were used to assess this forest type and one transect with eight plots used to assess the LFFT forest type. The summarised results of the quantitative assessment of plots within the lowland rain forest vegetation type are given in Appendix 2. In total, 24 plots along three transects were used to assess this vegetation type.

Lowland Slope Forest Type

Most of the forested area in KFCA is on slopes. Sixteen plots along two transects were used to quantitatively assess this forest type. The transects were placed to run parallel with the slope and one ran across a dry creek. On average 17 (range 9 to 30) trees per plot with an average of 12 (range 7 to 19) species per plot was recorded. The most common species was *Syzygium* spp. (*yasiyasi*), which was present in three plots, followed by *Gironniera celtidifolia*, *Haplolobus floribundus* and *Retrophyllum vitiensis,* present in two plots. Other common tree species recorded included *Cyathea* spp., *Psychotria* spp. and the palm *Veitchia filifera,* which were the most common in single plots in this forest type.

The five largest trees measured were *Endiandra s*p. (*kabi*) with a dbh of 85.5 cm followed by *Cynometra insularis* (*moivi*) with a dbh of 80 cm, *Cryptocarya* sp. (*lidi*) with 68 cm and 2 *Retrophyllum vitiensis* (*dakua salusalu*) trees with dbh of 64.6 cm and 62.5 cm. It is interesting to note that there were only two other trees that had dbh greater than 50 cm. The average tree dbh per plot was 23 cm, for trees with dbh that were greater than 10 cm, with a range of (10 cm to 85.5 cm). There are no overall single dominant species for this forest type but the four species with some of the largest trees recorded like *Retrophyllum vitiensis*, *Syzygium* spp., *Haplolobus floribundus* and *Myristica castaneifolia* had a combined relative dominance of 53% representing half the tree biomass in this forest type.

Lowland Flat Forest Type

Eight plots along one transect were used to quantitatively assess this forest type. There was an average of 16 (range 9 to 19) trees per plot and an average of 10 (range 6 to 12) species per plot. There was no overall "most common" tree species for plots in the transect but each plot had a dominant species, including species like *Girroniera celtidifolia, Macaranga membranacea, Trichospermum richii, Endospermum macrophyllum, Cryptocarya* sp., *Myristica gillespieana* and *M. castaneifolia*. The 5 largest trees measured included *Cryptocarya sp*. (*lidi*) with a dbh of 68 cm, *Parinari insularum* with a dbh of 59 cm, and *Heritiera ornithocephala* and *Mastixiodendron robustum* (*yatuvu*) with a dbh of 51.8 cm. For trees with a dbh greater than 10 cm, the average dbh per plot was 25 cm with a range of 13.6 cm to 85.5 cm. The dominant species for this forest type is *Parinari insularum* (sea) with 78% relative dominance.

Other Vegetation and Forest Types

Other forest types found in or next to the KFCA that were not visited due to time and logistical constraints, were the riparian or creek system, most likely found on the south west of the KFCA. Similarly, disturbed vegetation or anthropogenic forest(s) were restricted to areas closer to human habitation or where roads are accessible to vehicles. It is also likely that no rare or threatened species would be observed or encountered in these disturbed areas.

3.2 Birds

Over four consecutive mornings, 39 point counts along the transects (Appendix 3) equated to 3 hours and 15 minutes of data collection and approximately 16 hours in the field. In addition, specific habitats were visited to search for any signs of the globally threatened long-legged thicketbird (*Megalurulus rufus*). A total of 25 species of bird were recorded, 15 of which are endemic to Fiji (Table). Four of these species were recorded on more than 50% of the point counts surveyed: Fiji bush-warbler (*Horornis ruficapilla*), Polynesian triller (*Lalage maculosa*), barking pigeon (*Ducula latrans*) and maroon shining-parrot (*Prosopeia tabuensis*). Fiji white-eye (*Zosterops exploratory)* and Fiji whistler (*Pachycephala vitiensis*), when recorded on a point count, were present in higher numbers than other species. For the Fiji white-eye, this reflects the fact that most birds are reported in small, rapidly dispersing flocks, so when recorded there will tend to be several individuals. For the Fiji whistler, this might reflect time of survey – the birds tend to call, and so be easily detectible, for a short period at dawn. Alternatively, Fiji whistlers may be restricted to a certain type of habitat within the area – but, are at relatively high densities in that habitat.

Table 4. Bird species recorded at KFCA with total number of individuals, the number recorded per hour of survey, and the percent of point counts at which the bird was recorded. LC – least concern, VU – Vulnerable, RR – Restricted Range

Common Name	Latin name	TOTAL	Birds/hr	P/A
Fiji White-eye	*Zosterops exploratory* [LC, RR]	76	23.4	41%
Fiji Bush-warbler	*Horornis ruficapilla*[LC,RR]	69	21.2	67%
Polynesian triller	*Lalage maculosa*[LC]	64	19.7	54%
Barking imperial-pigeon	*Ducula latrans*[LC, RR]	52	16.0	67%
Fiji whistler	*Pachycephala vitiensis* [LC, RR]	52	16.0	46%
Maroon shining-parrot	*Prosopeia tabuensis*[LC,RR]	49	15.1	56%
Orange-breasted Myzomela	*Myzomela jugularis* [LC, RR]	40	12.3	41%
White-rumped swiftlet	*Aerodramus spodiopygius* [LC]	37	11.4	26%
Fiji wattled honeyeater	*Foulehaio taviunensis* [LC, RR]	30	9.2	36%
Slaty monarch	*Mayrornis lessoni* [LC, RR]	24	7.4	41%
Fiji streaked fantail	*Rhipidura layardi* [LC, RR]	18	5.5	21%
Chestnut-throated flycatcher	*Myiagra castaneigularis* [LC, RR]	17	5.2	26%
Fiji parrotfinch	*Erythrura pealii* [LC, RR]	12	3.7	13%
Island thrush	*Turdus poliocephalus* [LC]	9	2.8	13%
Collared kingfisher	*Todiramphus chloris* [LC]	6	1.8	10%
Fiji shrikebill	*Clytorhynchus vitiensis* [LC]	6	1.8	10%
Orange dove	*Chrysoena victor* [LC, RR]	6	1.8	8%
Pacific robin	*Petroica pusilla* [LC]	6	1.8	8%
Vanikoro flycatcher	*Myiagra vanikorensis* [LC]	3	0.9	5%
Metallic pigeon	*Columba vitiensis* [LC]	3	0.9	3%
Collared lory	*Phigys solitaries* [LC, RR]	3	0.9	3%
Fiji woodswallow	*Artamus mentalis* [LC, RR]	3	0.9	3%
Fiji goshawk	*Accipiter rufitorques* [LC, RR]	2	0.6	5%
Shy ground dove	*Alopecoenas stairi* [VU]	2	0.6	5%
Shrikebill spp.	*Clytorhynchus spp*[LC]	1	0.3	3%
Yellow-billed honeyeater	*Gymnomyza viridis* [LC, RR]	1	0.3	3%

Looking at data from point count surveys across Fiji (Table 5) indicates clearly that the Kilaka bird community is indicative of a large Fijian island native forest community. The species composition and relative frequencies are similar to Natewa, also on Vanua Levu, and to forested areas on Viti Levu. By comparison, the information from the two Fiji island bird communities, while still in native forest patches, reflect the relatively small number of species present in these areas. This summary indeed, reduces the effect – each individual island is unlikely to have all, or even the majority of species, credited to Fiji island sites.

Table 5. Birds/hour of survey data in Kilaka compared to other point count surveys in Fiji (all surveys were based on 5 minute counts, except for Fiji Islands which used 15-minute point counts).

Species	Kilaka	Natewa[1]	Viti Levu[2]	Northern Lau[3]	Fiji Islands[4]
Fiji white-eye	23.4	0.3	9.0	0.0	0.0
Fiji bush-warbler	21.2	9.2	14.5	0.0	0.0
Polynesian triller	19.7	6.4	7.4	0.0	4.0
Barking Imperial-pigeon	16.0	31.5	15.3	10.6	4.6
Fiji whistler	16.0	16.1	6.7	0.0	1.7
Maroon shining-parrot	15.1	9.2	10*	0.0	1.8
Orange-breasted Myzomela	12.3	8.3	6.0	5.2	4.5
White-rumped swiftlet	11.4	1.1	2.2	8.3	4.9
Fiji wattled honeyeater	9.2	0.5	6.7*	17.8*	2.0
Slaty monarch	7.4	0.5	2.4	2.0	6.4
Fiji streaked fantail	5.5	0.8	1.7	0.0	0.4
Chestnut-throated flycatcher	5.2	0	3.1	0.0	0.0
Fiji parrotfinch	3.7	0.1	2.8	0.0	1.2
Island thrush	2.8	0.1	3.1	0.0	0.0
Collared kingfisher	1.8	0.1	1.9	3.5	1.8
Fiji shrikebill	1.8	1.8	2.4	0.7	1.8
Orange dove	1.8	3.6	7.6*	0.0	0.3
Pacific Robin	1.8	1.2	0.7	0.0	0.0
Vanikoro flycatcher	0.9	0.9	3.8	8.3	5.5
Metallic pigeon	0.9	0.8	0.5	0.7	4.5
Collared lory	0.9	0.6	1.4	3.7	0.4
Fiji woodswallow	0.9	0.3	0	0.0	1.0
Fiji goshawk	0.6	0.3	0.5	0.9	0.9
Shy ground dove	0.6	0.0	0.2	0.2	0.0
Yellow-billed honeyeater	0.3	0.0	21.6*	0.0	0.0

1 Operation Wallacea, Joe England pers info. Unpublished point counts from the Operation Wallacea project undertaken at Natewa in June/July 2017. Information available on eBird.
2 O'Brien (2016)
3 O'Brien (2013)
4 Morley and Winder (2013)
* Information based on surveys of different, but closely related, species (see methods for details)

Comparing data from KFCA with IBA data for forested areas in the Northern Division makes most logical sense. However, different survey methods were used – making direct comparisons difficult. A preferred option may be to compare ranks of the two sets of groups and look for species that are markedly different. Looking at the rank order of species, by density, in the Vanua Levu/Taveuni sites, there appears to be a good fit with the order of species, based on species index, at Kilaka (Table). The most notable differences occur for Orange Dove, Collared Lory and Vanikoro Flycatcher, which appear to be ranked higher on the Vanua Levu/Taveuni sites than at Kilaka Forest.

Table 6. Comparison of point count data (birds/hr) at KFCA with transect survey data from all forest areas on Vanua Levu and Taveuni (note the different methods of count).

Species	Kilaka Point Count	Vanua Levu and Taveuni Transect Count	Vanua Levu and Taveuni Rank Order by Index
Fiji white-eye	23.4	3.4	1
Fiji bush-warbler	21.2	1.7	5
Polynesian triller	19.7	1.8	4
Barking imperial-pigeon	16.0	3.1	2
Fiji whistler	16.0	1.6	6
Maroon shining-parrot	15.1	1.5	7=
Orange-breasted Myzomela	12.3	2.0	3
White-rumped swiftlet	11.4	0.99	12=
Fiji wattled honeyeater	9.2	1.0	11
Slaty monarch	7.4	1.3	10
Fiji streaked fantail	5.5	1.5	7=
Chestnut-throated flycatcher	5.2	0.99	12=
Fiji parrotfinch	3.7	0.47	17
Island thrush	2.8	0.32	19
Collared kingfisher	1.8	0.36	18
Fiji shrikebill	1.8	0.49	16
Orange dove	1.8	1.7	7=
Pacific robin	1.8	0.68	15
Vanikoro flycatcher	0.9	0.83	13
Metallic pigeon	0.9	0.16	21
Collared lory	0.9	0.76	14
Fiji woodswallow	0.9	0.19	20
Fiji goshawk	0.6	0.13	24
Shy ground dove	0.6	0.14	23
Yellow-billed honeyeater	0.3	0.15	22

3.2.1 Red-listed and Restricted Range Species

Of the 25 species of birds recorded on these point counts, all are classed as Least Concern in the IUCN Red list, except for the shy ground-dove, currently listed as Vulnerable (Table 4). It was heard on two occasions, once along the boundary road, and the second time while on transect 3. Shy ground-doves tend to be a rarely detected species, with a scattered distribution from Fiji eastwards to American Samoa. Personal observations (M. O'Brien) indicated that intensive surveys at a particular site failed to locate any birds for months at a time yet ring/recapture observations indicated that birds were present but difficult to detect.

There were 16 species of birds recorded that are considered to be restricted range species (Table). For birds, a restricted range species is one for which the global range is less than 50,000 km^2 (Stattersfield et al. 1998) (see Table 7). For a restricted range species to represent a 'trigger' species for a KBA, the site needs to hold 1% or more of the global population of at least two species. Four of these species are restricted to Vanua Levu and Taveuni and so occupy just 2,850 km^2 of forested habitat. Of these 4 species only the yellow-billed honeyeater (*Gymnomyza viridis*) is considered to be highly dependent on native forest habitats. The Fiji wattled-honeyeater (*Foulehaio taviunensis*) is considered highly dependent in Taveuni but information from Vanua Levu is less conclusive. The other 2 species, orange dove (*Chrysoena victor*) and maroon shining-parrot are less clearly restricted to forested habitats and can be found in farm woodlands and many areas of bush within non-forested areas. Of these four species, the Orange Dove is less frequently recorded at KFCA than in forested areas in Vanua Levu and Taveuni, while the maroon shining-parrot was more frequently recorded at Kilaka (Table 6). The other two species appear to be at similar densities.

Maroon shining-parrot densities were 50% higher at Kilaka than at Natewa (using the same survey methods) and also 50% greater at Kilaka than the masked shining-parrot densities recorded on Viti Levu (although a different species, the masked shining-parrot on Viti Levu is considered to occupy the same ecological niche). If we assume that the total extent of forest on Vanua Levu and Taveuni is 2,850 km^2 with birds at 1 unit per km^2 here, while in the 4 km^2 of Kilaka the birds are at 1.5 units per km^2 then the Kilaka population will represent 0.2% of the total population of maroon shining-parrot. Conversely, the Kilaka population would need to be over 7 times the average population density of a species that was restricted to Vanua Levu and Taveuni forests. The individual site of Kilaka, as represented by the current survey, would not qualify as a globally important site for birds – using current KBA indicators.

Table 7. The range (or extent of occurrence), by area and extent of island occupancy for each species with an assessment of the extent to which the species is dependent on native forests.

Common Name	Extent of Occurrence (km^2)	Distribution in Fiji[1]	Forest Dependency[2]
Fiji White-eye	51,700	ViL, VaL, Ta	Medium
Fiji Bush-warbler	55,600	ViL, VaL, Ta	Medium
Polynesian Triller	2,100,000	ViL, VaL, Ta	Medium
Barking Imperial-pigeon	125,000	ViL, VaL, Ta	High
Fiji Whistler	174,000	ViL, VaL, Ta	Low
Maroon Shining-parrot	23,800	VaL, Ta	Medium
Orange-breasted Myzomela	174,000	ViL, VaL, Ta	Low
White-rumped Swiftlet	5,430,000	ViL, VaL, Ta	Low
Fiji Wattled Honeyeater	19,500	VaL, Ta	Medium/High[3]
Slaty Monarch	174,000	ViL, VaL, Ta	Medium
Fiji Streaked Fantail	33,600	ViL, VaL	Medium
Chestnut-throated Flycatcher	29,800	ViL, VaL	High
Fiji Parrotfinch	65,200	ViL, VaL, Ta	Low
Island Thrush	21,900,000	ViL, VaL, Ta	High
Collared Kingfisher	55,200,000	ViL, VaL, Ta	Medium
Fiji Shrikebill	912,000	ViL, VaL, Ta	Medium
Orange Dove	13,200	VaL, Ta	Medium
Pacific Robin	2,630,000	ViL, VaL, Ta	Medium
Vanikoro Flycatcher	451,000	ViL, VaL, Ta	Medium
Metallic Pigeon	18,200,000	ViL, VaL, Ta	Medium
Collared Lory	128,000	ViL, VaL, Ta	Medium
Fiji Woodswallow	80,900	ViL, VaL, Ta	Low
Fiji Goshawk	82,000	ViL, VaL, Ta	Medium
Shy Ground Dove	731,000	ViL, VaL, Ta	High
Yellow-billed Honeyeater	12,100	VaL, Ta	High

1 ViL – Viti Levu, VaL – Vanua Levu, Ta – Taveuni
Extent of forest on each island (assumed to be 47% of total area of island) is 4,880km^2 on Viti Levu, 2,625 km^2 on Vanua Levu and 227 km^2 on Taveuni.

2 Tracewski *et al.* (2016)

3 The Fiji Wattled honeyeater is a recently split species restricted to Vanua Levu and Taveuni on Fiji. It is known that birds on Taveuni are restricted to forests – but there has been no comment on whether this applies to the same species in Vanua Levu.

3.3 Bats

Two species of bats were recorded within the KFCA in this survey, the Samoan flying-fox (*Pteropus samoensis*), and the Fijian blossom bat (*Notopteris macdonaldi*) (Table 8). The Samoan flying-fox is listed on the IUCN Red List as Near Threatened (Brooke and Wiles, 2008) and Fijian blossom bat as Vulnerable (Palmeirim 2008). Data from the acoustic detector is currently being analysed by partners, Bat Conservation International. Results from this analysis will be able to confirm findings from the 2016 acoustic survey in KFCA (Appendix 4).

Table 8. List of bat species recorded in the Kilaka Forest Conservation Area.

Scientific name	Common name	Local name	IUCN RedList status
Notopteris macdolandii	Fijian blossom bat	Manumanu vakabuina	Vulnerable
Pteropus samoensis	Samoan flying-fox	Beka lulu	Near threatened

The most common bat species, the Pacific flying-fox (*P. tonganus)* was not encountered in this survey and no roost was observed in the study area. Comparatively, the Samoan flying-fox was encountered along three of the four transects (1, 2 and 4) as well as the road leading to and from the base camp. This was expected as the Samoan flying-fox is known to be more dependent on good forests rather than *P. tonganus*, which are more commonly found around gardens and plantations (Palmeirim et al. 2007). Preliminary analysis of acoustic data collected by the NFMV and Bat Conservation International from KFCA in 2016 confirmed the presence of one of Fiji's endangered microbats, the Fijian Free-tailed bat (*Chaerephon bregullae*). This species is only known from one roosting and nursing cave globally, the Nakanacagi cave in Dreketio on the island of Vanua Levu. Appendix 4 lists all bat species historically known from Vanua Levu, significant finds from the survey as well as notes on conservation status and threats to each of the five species.

Fijian Free-tailed bat, *Chaerephon bregullae*, from Nakanacagi bat cave in Dreketi © NFMV

3.4 Herpetofauna

The weather from 12–16 February, 2018 was favourable for sticky traps and nocturnal surveys. Air temperature at night ranged from 23^0 C–30.5^0 C at the start of the survey to 23.8^0 C–26.5^0 C at the end of the survey. Of the 21 terrestrial herpetofauna known for Vanua Levu (Appendix 5), 11 species were encountered using the two different methods employed (Table 9). Of these 11 species, one is possibly a new species, *Emoia* sp.aff. *parkeri,* previously observed on Vanua Levu but is yet to be described. The *E.* sp. aff. *parkeri* specimen encountered appears to be different from the Viti Levu skink (*E. parkeri)* and further investigation will confirm its relation to other Emoia species in Fiji.

Table 9. Herpetofauna species and numbers of individuals of each species observed within the KFCA on sticky traps (S) and during the night survey (N).

Species	Transect 1	Transect 2	Transect 4	Total # of individuals
Cornufer vitiensis	N (6)	N (6)	N (7)	19
Cornufer vitianus	N (1)		N (2)	3
Emoia cyanura	S (1)	S (2)	S (2)	5
Emoia mokosariniveikau	S (4)	S (1)	S (1)	6
Emoia sp. aff. *parkeri*	S (3)			3
Emoia trossula	S (2)			2
Gehyra oceanic		N (1)	S (1)	2
Gehyra vorax	N (1)	N (1)		2
Lipinia noctua	S (2)	S (1)		3
Nactus pelagicus	N (3)	N (8)	N (5), S (1)	17
Rhinella marinus	N (1)		N (2)	3
Total # species	**10**	**7**	**6**	
Total # sticky trap hours	**1228**	**1437**	**1356**	**4021**
Total # man-hours (night survey)				**117**
Number of frogs per hour				**0.2**

3.4.1 Nocturnal visual encounters

After 117 man-hours of nocturnal visual encounter surveys along T1, T2 and T4, six species of herpetofauna were encountered (Table 9): *Cornufer vitianus* (3 individuals), *C. vitiensis* (19 individuals), *Gehyra oceanica* (2 individuals), *G. vorax* (2 individuals), *Nactus pelagicus* (16 individuals), *Rhinella marinus* (3 individuals). Other species encountered included rats (18 individuals) and sleeping birds (3 occasions).

The frog survey (4 man-hours) yielded only one species of *C. vitiensis*. Frog snout-vent length ranged from 35.0–44.0 mm for *C. vitianus*; and from 28.0–53.5 mm for *C. vitiensis*. Frog weights ranged from 2.9–7.9 g for *C. vitianus* and from 0.3–8.6 g for *C. vitiensis*. Consistent with observations of frogs in other sites in Fiji, individuals of the two native species of frogs (*C. vitiensis* and *C. vitianus*) encountered were found on a substrate at some height off the ground, with height above ground-height ranging from 0.2–2 m. Rats were observed along tree trunks and on the ground. The frog encounter rate for *C. vitiensis* in KFCA (0.15 frogs per hour) was less than that of the Proposed Greater Delaikoro Protected Area of 0.2 frogs per hour. Frog (*C. vitiensis*) encounter

rates in other sites range from 0.1 (Nakauvadra Forest – 11,387 ha) to 2.0 (sites within the Namosi Province, Viti Levu).

3.4.2 Sticky Traps

After 4,021 hours of sticky traps, 5 species of native skinks (one island endemic, one Fiji endemic and three native), 2 species of native geckoes, and rat activity were recorded on 39 sticky traps across the three transects. Transect 1 had the most herpetofauna and rat encounters with 24 rat occurrences and 12 herpetofauna (Table 10).

Table 10. Species encountered and trap activity on sticky traps (G = ground, L = log, T = tree) along transects 1, 2 and 4 in the Kilaka Forest Conservation Area.

Species	Transect 1 (trap number)	Transect 2 (trap number)	Transect 4 (trap number)	Total #traps with activity
Emoia cyanura	405L	276G, 277L	354L, 371L	**5**
Emoia mokosariniveikau	416L, 420L,431L, 445T	326L	354L	**6**
Emoia sp. aff. *parkeri*	412L, 431L			**2**
Emoia trossula	417L, 422T			**2**
Gehyra oceanic			387T	**1**
Lipinia noctua	406L, 413T	304G		**3**
Nactus pelagicus			376G	**1**
Skink tail	404T			**1**
Unknown young skink	402T			**1**
Rat fur	401L, 404T, 405T,410L, 411L, 411G, 413L, 414L, 414G, 415G, 418L, 421L, 422G, 423L, 424G, 427G, 435G, 436G, 437G, 439L, 445L, 446G, 449L	278G, 279L, 284G, 279G, 288G, 292L	356L, 358G, 370G, 374L, 378L, 385T, 385L, 389L, 395G, 396L	**39**
Rat fur and tail		278L		**1**
Rat (whole)	442L	299G		**2**
Total #traps with activity	**37**	**12**	**15**	**64**

3.5 Terrestrial Invertebrates (Lepidoptera)

A total of 177 moth individuals belonging to 7 families and consisting of 27 species were collected over the four nights of sampling at KFCA. The moth assemblages varied in abundance and diversity across the sites. This may not be a reflection of diversity at those specific sites but rather how species use different parts of the forest during the night. The sites that recorded the highest number of species were transects 1 (slope) and 3 followed by transects 2 and 1 (flat).

A total of 108 macro-moth species belonging to 9 families (excluding the Pyralidae and Crambidae families) are known to occur in Vanua Levu (Robinson, 1975). Of these, a total of 7 species are documented to occur only in Vanua Levu. Recent surveys in Delaikoro, Vanua Levu (FPAM 2014) yielded two new records of macro-moths including *Luxiaria sesquilinea* and *Hypena rubrescens*, both from the Noctuidae family. These new records were not observed in KFCA in this survey. Moths collected from only four nights of sampling represent 25% of the known species for Vanua Levu and also includes one species that is known only from Vanua Levu, *Beggina minima* (see photo below). This species belongs to a genus that has a very high species radiation; in Fiji all species within this genus are endemic (Table 11). The rate of endemism at the site is high (48%) with a total of 13 out of the 27 moth species collected being endemic. A detailed checklist and abundance of moths collected during the survey is presented in Appendix 6.

This survey documents 4 new records of moth species for Vanua Levu: *Adetoneura lentigiginosa* (Erebidae), *Thalassodes fiona* (Geometridae), *Aeolopetra palaeanthes* (Crambidae) and *Locastra ardua* (Pyralidae) (Figure 3.3). Most of these species have only been recorded from Viti Levu (Appendix 6).

Beggina minima, a species collected from within the Kilaka Forest Conservation Area and is endemic to Vanua Levu © Clayton

Table 11. Summary of the moth data including abundance of moths caught, number of macro-moth families and species all per site, from the four nocturnal surveys (19:00-22:00) in the Kilaka Forest Conservation Area.

Transect	Date	Distance (m)	Habitat	Forest cover (%)	Mean air temp (°C)	# moths caught/ site	# macro-moth families/ site	# macro-moth species/ site
1	12/02/18	500	Forest edge (on a flat)	75	25.1	42	4	7
2	13/02/18	900	Forest Edge - Riparian vegetation	100	23.5	50	7	17
3	14/02/18	500	Riparian vegetation	100	26.25	37	4	7
1 (900m)	15/02/18	900	Riparian vegetation	85	26.5	48	5	17
Total						**177**	**7**	**27**

Four moth species found for the first time in Vanua Levu in the Kilaka Forest Conservation Area (top left: *Adetoneura lentiginosa*, top right: *Thalossodes fiona*, bottom left: *Aeoloptera palaeanthes*, bottom right: *Locastra ardua*) © Clayton

3.6 Invasive Mammals

A number of invasive mammal species were documented in the KFCA: rats (*Rattus rattus*), small Indian mongoose (*Herpestes auropunctatus*), domestic cat (*Felis catus*), domestic pigs (*Sus scrofa domesticus*), and cows (*Bos primigenius*). Infrared cameras captured images of rats, mongoose, cats, and cows. Tracking tunnels recorded tracks of mongoose and rats. Snap traps captured rats. Evidence of pig presence (pig wallows, rooting areas, and tracks) was documented throughout the forest. Cats were only detected on the Infrared cameras on T2, T3 and T4. Cows were detected on the Infrared camera and by cow dung at the start of T1 and T2, and by the boundary road end of the transects. Pigs were only detected by pig wallows in all four transects. The mongoose was detected by the infrared camera and track tunnel at all stations throughout T1, T2, T3 and T4. Rats were detected in all four transects, but only at some stations. A summary of animal presence by all techniques is presented in Table 12. Example images of wildlife camera photos, tracks, and animal sign are presented in Table 13.

Table 12. Mammals (cat, cow, pig, mongoose and rat) detected in the Kilaka Forest Conservation Area by location and method (C=camera, T=track tunnel, S=animal signs, R=rat snap trap with each R representing one individual count).

Transect	Distance (m)	Cat	Cow	Pig	Mongoose	Rat
1	0		S		C,T	
	125			S	C	C,R
	250			S	C,T	C,T
	500			S	C,T	C,T,R,R
	750			S	T	C,T,R
	1000				C,T	C,T
2	0	C	C,S		C,T	
	125				T	C,T,R
	250			S	C,T	C,T,R
	500				C,T	C,R,R
	750				T	C,T
	1000				C,T	C,T
3	0	C			C,T	
	125	C		S	C,T	C
	250	C		S	C,T	T
	500			S	C,T	T
	750			S	C,T	C,T
	1000				C,T	C,T
4	0				T	
	125				T	C,T,R
	250				T	T,R
	500	C		S	T	T
	750			S	T	
	1000				T	

Ten rats were captured and measured after three nights of 12-hour trapping along T1, T2 and T4 in the KFCA. Body measurements confirmed the species to be the black/ship rat (*Rattus rattus*). Nine individuals were adults, of which 3 were female and 6 males, with body weight ranging from 115–200 g (for 8 individuals); and head-body length ranging from 315–468 mm (Table 14). One young male individual was also caught with a body weight of 60 g and head-body length of 290 mm.

Table 13. Examples of wildlife camera trap images, track tunnel prints and animal signs of animals detected in Kilaka Forest Conservation Area.

Species	Wildlife camera images, tracks, and signs
Cow (left), Cat (right)	 
Mongoose and their prints on tracking card (range of forefoot widths = 10-20 mm)	 
Rat (on track tunnel), and Rattus spp. prints on tracking card (range of forefoot widths = 7-14.5 mm)	 
Signs of pig rooting (left) and pig wallow (right)	 

Table 14. Body measurements of rats caught, killed and processed at the Kilaka Forest Conservation Area.

Specimen	Date deployed	Date retrieved	Weight (g)	Head-body length (mm)	Sex	Maturity
1	12-02-18	13-02-18	180	410	Female	Adult
2	12-02-18	13-02-18	60	290	Male	Young
3	12-02-18	13-02-18	115	375	Male	Adult
4	12-02-18	13-02-18	160	355	Male	Adult
5	13-02-18	14-02-18	160	385	Male	Adult
6	13-02-18	14-02-18	200	425	Female	Adult
7	13-02-18	14-02-18	160	350	Male	Adult
8	13-02-18	14-02-18	160	315	Female	Adult
9	14-02-18	15-02-18	Unknown	468	Male	Adult
10	14-02-18	15-02-18	Unknown	409	Male	Adult

3.7 Archaeology

During the course of the survey, an annotated field map of the two cultural sites was produced (Fig. 7). Site P24/00001 refers to the archaeological structure currently used as a boundary marker located on the south-eastern end of the conservation area (see photo below). The site is an old village setup which contains several ancient house foundations. Located at the crossroads of development, the site is overgrown and heavily disturbed by bulldozer tracks on both sides. The entire length of the remnants of the old village is 32 meters. This includes three possible house foundations. There is evidence of a house foundation aligned with river boulders. Unfortunately, the western side of this structure was destroyed by the bulldozer. Other evidence of the ancient village includes anthropogenic plant indicators such as sacasaca (*Codiaeum variegatum*), vasili (*Cordyline terminalis*) and koka (*Bischofia javanica*).

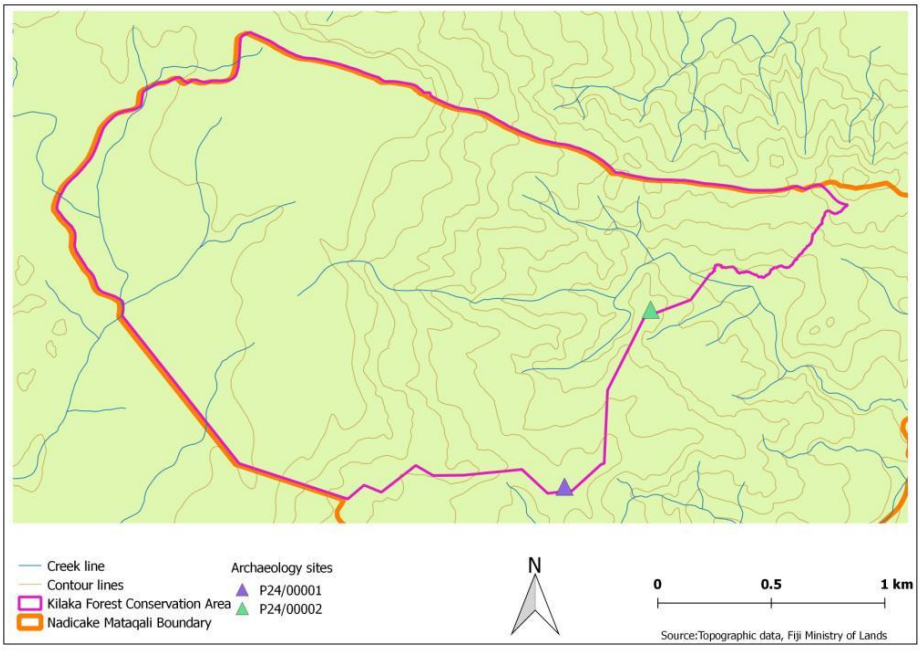


Figure 7. Location of archaeology sites in the Kilaka Forest Conservation Area.

Forest Warden sitting on the stone alignment at site P24/00001

Site P24/00002 is a single ancient house foundation (see photo below) situated along the boundary heading towards P24/00001. About 5 x 4 m in size, the structure contains visible stone alignment but many stones have been displaced due to erosion and humans frequenting the forest. The site has been cleared of vegetative cover and clearly visible to forest users.

Field guide at site P24/00002

4 CONCLUSION

4.1 Vegetation and Flora

The key findings from this one-day survey include the relatively high percentage of endemism, 37%, for the study area with only a few areas in Fiji of mid to lower altitude (<350 m) in close proximity to the coast registering such high percentages. No unique (or rare) plant species or forest and habitat types were observed during the short survey. This could be due to the overall size of the KFCA and its proximity to roads and human settlement. However, Keppel's (2005) surveys covering a one hectare and placed further in from the road did note some rare and threatened species. The study area is indeed a botanical diversity hotspot given the increasing threat from agricultural activities (the key threat, especially commercial), logging, plantations (mahogany and pine) and even road work development in and around the area. The surveyed area on the outskirts of the KFCA, is still recovering from the impact of logging that had taken place some decades ago. The old logging roads leading into the KFCA are still very much visible and more importantly the species composition and tree sizes (dbh) from the plot data analysis are typical of re-growth sites from logging.

Six native species were considered important due to their rarity, listings on the IUCN Red List (2013), CITES Appendices (2014), and Fiji's Endangered and Protected Species (amended) Act (2013). However, based on recent work in other parts of Vanua Levu and Fiji, the conservation status of these 6 species listed in Table **3**3 should be amended, as these plants are neither rare nor threatened since they have been recorded elsewhere in Fiji. The only principle vegetation type observed and assessed in the KFCA was the Lowland Rainforest vegetation type and two forest types namely the Lowland Slope and Lowland Flat forest type. This forest system would be very common and widespread throughout Vanua Levu, especially in Cakaudrove.

The average dbh of trees recorded from all plots was very low at 16 cm (average range of 5–85 cm) and when the dbh was limited to 10 cm and above, the average dbh was 23 cm (average range 10–85cm). For a "good" forest, the average dbh would be around 35 cm or more. The low dbh records for KFCA is typically indicative of a forest system that is (regularly) logged selectively (small scale) over a long period. Another indication of this is the absence of some important (high value) timber tree species from the area assessed like *Dacrydium nidulum* (yaka), *Agathis macrophylla* (dakua makadre), *Neonauclea fosteri* (vacea) and *Fagraea gracillipes* (buabua). However, some of these species were recorded with very large dbh by Keppel (2005) so it would be worth increasing the coverage of the area surveyed to include these previous plots.

4.2 Birds

The detailed bird survey found 25 species in a survey of 39 point counts from within the KFCA. From these, 15 are endemic to Fiji, although all of these are considered of Least Concern from an IUCN Red-list perspective. The shy ground-dove, with two calling birds were recorded during this survey, is considered to be a globally threatened species and occurs from Fiji eastwards to American Samoa. Detailed surveys of the ground-dove at an individual site, known to contain small numbers of this species, found that detectability is low. The birds do not call for many weeks/months at a time while sightings have been almost non-existent in three years of monitoring, even though birds are present (having been caught in mist nets). Accordingly, more intensive survey work at KFCA with regular surveys through the year may find this species to be more common than the two individuals recognised in this survey. The global population of the ground-dove is estimated to be between 2,500 to 9,999 mature individuals (BirdLife International 2018). Kilaka Forest is unlikely to have 25 or more birds, and so unlikely to have more than 1% of the global population.

There were no signs of two of the rarest birds on Vanua Levu: Red-throated lorikeet (*Charmosyna amabilis*) and long-legged thicketbird (*Megalurulus rufus*). Neither of these species have been seen for over 30 years on Vanua Levu, although the island is relatively poorly covered by bird surveyors. On Viti Levu, the Thicketbird is strongly associated with native forest, fast-flowing streams, waterfalls and/or cliff slopes. Afternoon surveys targeting these habitats within the KFCA were undertaken but with no success. It should be noted that the 'type habitat' for the subspecies of long-legged thicketbird described from Vanua Levu does not accord with this specific habitat type (Kinsky 1975). Similarly, we found no sign of the black-faced shrikebill (*Clytorhynchus nigrogularis*), and just one sighting of the yellow-billed honeyeater (*Gymnomyza viridis*). The Shrikebill is a notoriously difficult bird to detect outside of its breeding season. October is generally considered to be the most reliable month for locating breeding birds.

One of the gaps of knowledge in the distribution of birds in forests in Fiji is the lack of an analysis associating bird species, or communities, with any particular forest type. The method used to capture information on birds in the current study lends itself well to this kind of analysis as point counts are focussed on a particular location within the forest, thus, allowing the species present to be associated with the associated forest communities. Previous analyses of bird distribution within forested areas indicates that geography (altitude, latitude, longitude, etc.) and tree species identification tends to be more important than physical measures of individual trees (such as size, height) (Lee and Marsden 2008).

None of the bird species are present at KFCA in numbers that are sufficient to raise the importance of the site, from a bird perspective, to global importance. Consequently, the bird information would suggest a "Site of National Significance". Kilaka Forest is just 6 km south west of the western perimeter of the Wailevu/Dreketi Highlands IBA/KBA – an area of primarily native forest covering some 720 km^2 of southern/central Vanua Levu. Investigating whether there would be logic in extending the KBA boundary westwards to encompass this area would be one suggestion for raising the conservation profile of the site for birds. There appears to be reasonably continuous forest between the site and the KBA (Global Forest Watch, 2014).

4.3 Bats, Herpetofauna, Terrestrial Invertebrates

The four days of opportunistic surveys and two days of acoustic data collection yielded a preliminary species list of bats in the KFCA. This included the near threatened Samoan flying-fox, and the vulnerable Fijian blossom-bat, in addition to the endangered Fijian free-tailed bat (*Chaerephon bregullae*) recorded in May 2016.

The results from this survey contributes to the little known terrestrial herpetofauna in Vanua Levu, and raises more questions on the persistence of endemic and endangered herpetofauna despite the presence of introduced mammalian predators (cats, mongoose and rats) on the island. From the 11 species recorded, four ground-nesting and semi-arboreal herpetofauna are of particular interest because of their vulnerability to introduced mammalian predators: the Fiji ground frog (*Cornufer vitiensis),* Viti banded iguana (*Brachylophus bulabula*) and Emoia species of skinks (*E. trossula, E. nigra* and *E.* sp. aff. *parkeri*).

The moth surveys recorded 27 species from seven families, representing 25% of the known species for Vanua Levu. The site had a high percentage of endemism, 48%, and recorded four new species of moths for Vanua Levu. The survey collections yielded a good diversity of moths, particularly those that depend on good secondary or primary forest, suggesting that the Kilaka Forest system is intact. Variation in the moth assemblages across transects reflect moth habitat use and the importance of having

multiple habitat types and terrains. The survey collection, collectively, makes up the moth assemblage of the KFCA.

4.4 Invasive Mammals

This is the first documentation of the combined use of infrared cameras, track tunnels, and snap traps for introduced mammalian surveys in Fiji. The results confirm that a combination of these methods, in a standardised manner is useful for the purposes of monitoring biodiversity within a forest ecosystem. Five introduced, invasive mammalian predators were observed throughout the KFCA: cats, cows, mongoose, pigs and rats. It is interesting to note that despite this widespread occurrence, special species of herpetofauna (terrestrial, arboreal and semi-arboreal) with documented vulnerability to introduced invasive mammalian predators continue to persist within the KFCA.

4.5 Archaeology

Two archaeological features were recorded and placed on the national register. Despite time constraints, an old site was highlighted as a boundary marker in the south-eastern periphery and the team was able to ascertain the layout of the archaeological structure. Similarly, a house mound, which is located along the eastern boundary, indicates that human occupation was widespread in the area and there is a possibility of other archaeological foot prints in the study area.

The study of the cultural footprints within the KFCA 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. Despite the lack of coverage, 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. Hence, the sites may include one of these values while some may incorporate all, however absent values do not lessen the significance of a site as it holds the ancestral history of the hill tribes of Fiji.

5 RECOMMENDATIONS

5.1 Vegetation and Flora

(1) **Vegetation monitoring:** Given that the equivalent of a whole day was spent in the KFCA to carry out the survey, the findings obtained supported the surveyed areas to have high botanical prospects for future research on forest dynamics. With the unexpected high number of floristic datasets, continued work with longer periods to the centre and surrounding vicinities of the study areas must be considered to better understand the vegetation and ecology of the area for better management. An ideal way to monitor vegetation long term would be to put permanent markers (corner posts) on the ground for these plots and Keppel's (2005) larger plots.

(2) **Fencing**: Additionally, the edge of the forest adjacent to the dirt road should be fenced to prevent cattle and horses from getting into the protected area. A buffer composed of mixed exotic and aboriginal tree crop species can be introduced between the dirt road and the protected area. By planting high value commodities, pressure will be reduced from logging high value trees within the KFCA.

(3) **Extension of boundary**: Extending the boundary towards the nearby headwaters for the creek that runs along the KFCA and across the creek (near a high elevation system) should be seriously considered as these will add to protecting the ecosystem processes that maintains the quality and integrity of the area and further downstream systems.

5.2 Birds

(4) **Future surveys**: The timing of these surveys (February) falls outside the main breeding season. It is the month that most birds are in primary (wing) moult, are most likely to remain hidden, and so, are less detectible (Langham 1987, Naikatini 2009). Most birds are easier to locate during the peak of the breeding season, from July to October in Fiji. This is also a time when they are most attached to a particular location (ie their nesting site) within the site (Watling 2004, Naikatini 2009). A future survey, at the start of the breeding season, may find higher numbers of individuals and species at the site.

Species-specific recommendations for the shy ground-dove include more intensive survey work at KFCA with regular surveys throughout the year, which may find this species to be more common than the two individuals recognised in this survey. During this survey, it was unclear whether at least one shrikebill recorded was a Fiji rather than a Black-faced Shrikebill. This would be worth following up, as the latter is a Fiji endemic, and considered to be a near threatened species. The yellow-billed honeyeater is a little-known, newly-split species that appears to be much less commonly encountered than its congener on Viti Levu. The best-known location for observing this species is on the upper slopes of Des Veoux Peak, on Taveuni. No reliable recordings from other sites exist. Any further information on the numbers, distribution and habitat use of this species in the KFCA would be of great interest.

5.3 Bats

(5) **More comprehensive surveys**: The bat survey was not extensive due to time constraints and a more comprehensive bat survey is needed for the future in this area, to mark out roosting areas for these bat species. This would be very important information to obtain for effective management of these threatened bat species within this conservation area.

5.4 Herpetofauna

(6) **More comprehensive surveys:** The presence of the Fiji ground frog, and skinks *E. trossula* and *E.* sp. aff. *parkeri* within the KFCA is of particular conservation interest and highlights the need for more research and monitoring. There is opportunity for research within the KFCA to contribute towards the little known ecology, phenology and distribution of herpetofauna in Vanua Levu. An investigation of the interactions between introduced mammalian predators and herpetofauna populations to devise invasive species management regimes within the KFCA will contribute to the value of the conservation area.

5.5 Terrestrial Invertebrates

(7) **More comprehensive surveys and long-term monitoring:** Increased and seasonal sampling efforts within the KFCA will ascertain the true status of the forest health and its composition. Because of the high rate of moth endemism within the Kilaka FCA, long term monitoring and research to determine host and feeding plants of the endemic moths will be most useful and contribute to the ecological knowledge of Fiji's endemic moths. Surveys are also needed of a wider range of taxa, especially anthropods.

5.6 Invasive Mammals

(8) **Removal of cattle**: The presence of cattle at the periphery of the KFCA is of concern (see section 5.1), and must be addressed immediately amongst stakeholders. The impact of free-roaming cattle on forest biomass in Fiji has not been studied, but their presence in other forests of conservation interests such as the Garrick reserve in the Namosi Province and the Nakorotubu Forest in Ra Province have raised concerns on their potential long term impact.

(9) **Research on invasives**: There is opportunity for monitoring and research on the impacts of invasive mammalian predators on the native flora and fauna of the KFCA, and their management to ensure the integrity of the habitats for Fiji's biodiversity.

5.7 Archaeology

(10) **Protection of archaeological sites:** It is important that Fiji's archaeological sites be well maintained due to their ancient, complex and unique cultural heritage. They also form an important resource for education, science, recreation and tourism. Disturbance from human activities, including current and planned land development, are a great threat to the remaining sites, and may alter important aspects of material history of the *vanua* of Kilaka. Both the sites identified are protected in Fiji under the Preservation of Objects of Archaeological and Palaeontological Interest Act (1940).

(11) **Documentation of traditional knowledge**: It is recommended that proper documentation of the assessment and oral history be completed to avoid the loss of traditional knowledge and history of the study area. The Fiji Museum Archaeology Department should be included in any future surveys to capture overlooked areas in the KFCA with a presentation of significant findings be done to raise awareness in the region.

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7 APPENDICES

Appendix 1. Flora checklist of Kilaka Forest Conservation Area

The following checklist of native and naturalised vascular plants is based upon collections made during the present survey. The checklist is divided into Dicotyledon, Monocotyledon, Gymnosperms, Ferns, and Fern Allies, in that order. Within each group the species are listed in their alphabetically arranged families, and alphabetically within each of the families. Key: (1) Under "Distribution or Origin," Abo = ancient/aboriginal introduction, End = endemic, Ind = Indigenous, but not endemic, Ntv = Native, can either be indigenous or endemic, Ex = exotic, not native, and Inv = Invasive, not weeds; (2) Under "Life Form," E = epiphyte, H = terrestrial herb, L = liana (woody climber), S = shrub, T = tree, V = herbaceous vine, and G = grass where a = annuals and p = perennial; (3) Under "Source," 2006 depicts records by GK = Gunnar Keppel and, 2018 records by MT = Tuiwawa with collection number where applicable respectively.

Gymnosperm						
Family	**Botanical name**	**Common / Local Name**	**Life form**	**Distribution**	***Source***	
					2006	***2018***
Gnetaceae	*Gnetum gnemon*	Sukau/bele sukau	T	Ind	GK	MT
Podocarpaceae	*Dacrycarpus imbricatus var. patulus*	amunu	T	Ind		MT
Podocarpaceae	*Podocarpus neriifolius*	kuasi/buawaka	T	Ind	GK	MT
Podocarpaceae	*Retrophyllum vitiensis*	dakua salusalu/dahua salusalu	T	Ind	GK	MT
Podocarpaceae	*Dacrydium nidulum*	yaka	T	Ind	GK	MT

Angiosperms						
Family	**Botanical name**	**Common / Local Name**	**Life form**	**Distribution**	***Source***	
					2006	***2018***
Melastomaceae	*Medinella cf. kabikabi*		L	End	GK	MT
Acanthaceae	*Graptophyllum insularum*		S	Ind		MT
Alangiaceae	*Alangium vitiense*	dokonisau	T	Ind	GK	MT
Anacardiaceae	*Semecarpus vitiensis*	malawaci/kaukaro	T	Ind	GK	MT
Annonaceae	*Cyathocalyx suaveolens*	makosoi ni veikau? Mn ni veihacuhacu	T	End	GK	MT
Annonaceae	*Xylopia pacifica*	oto/ dulewa	T	End	GK	MT
Apiaceae	*Geophila repens*		H	Ind		MT
Apocynaceae	*Alstonia pacifica*	Sorua/drega mei ralago	T	Ind	GK	MT
Apocynaceae	*Alyxia bracteolosa var. macrocarpa*	vono	V	Ind		MT
Apocynaceae	*Pagiantha thurstonii*	tadalo	T	End	GK	MT
Apocynaceae	*Ervatamia obtusiuscula*	Vueti naitasiri	T	Ind	GK	MT
Araliaceae	*Plerandra pickeringii*	sole	T	End		MT
Araliaceae	*Plerandra sp.*	sole	T	Ntv		MT
Araliaceae	*Polyscias multijuga*	danidani	T	Ind	GK	MT
Araliaceae	*Schefflera vitiensis*	sole	T	End	GK	MT
Asclepiadeceae	*Hoya australis*	wa bi/wa bibi	V	Ind	GK	MT

Asteraceae	*Mikania micrantha*	wabosucu	V	Ex/Inv	GK	MT
Barringtoniaceae	*Barringtonia cf. seaturae*	Vutu ni veikau	T	End		MT
Burseraceae	*Canarium harveyi*	Kaunigai/titi vula	T	Ind	GK	MT
Burseraceae	*Haplolobus floribundus*	Kaunicina/titi	T	Ind	GK	MT
Caesalpiniaceae	*Cynometra insularis*	Moivi/cibicibi	T	End	GK	MT
Caesalpiniaceae	*Kingiodendron platycarpum*	moivi levu	T	Ind	GK	MT
Casuarinaceae	*Gymnostoma vitiense*	Velau/caukuro	T	End	GK	MT
Chrysobalanaceae	*Atuna racemosa*	makita	T	Ind	GK	MT
Chrysobalanaceae	*Parinari insularum*	sea, sa	T	Ind	GK	MT
Clusiaceae	*Calophyllum cerasiferum*	damanu dilo/tamanu drau lailai	T	End	GK	MT
Clusiaceae	*Calophyllum vitiensis*	Damanu/tamanu drau levu	T	Ind	GK	MT
Clusiaceae	*Garcinia myrtifolia*	Laubu/raubu	T	Ind	GK	MT
Clusiaceae	*Garcinia pseudoguttifera*	bulu m/burau, vusavusa	T	Ind	GK	MT
Clusiaceae	*Garcinia sessilis*	bulu wai		End	GK	MT
Combretaceae	*Terminalia sp*	Tivi/tavola ni veikau	T	Ind		MT
Connaraceae	*Connarus pickeringii*	Wa masimasi	L	End	GK	MT
Convolulaceae	*Merremia peltata*	wa bula/viliyawa	V	Ind	GK	MT
Convolulaceae	*Operculina turpethum*		V	Ind		MT
Cunoniaceae	*Geissois ternata var. glabrior*	vure/va'o	T	End	GK	MT
Dilleniaceae	*Dillenia biflora*	kuluva/kulukulu	T	Ind	GK	MT
Dioscoreaceae	*Dioscorea bulbifera*	kaile gaga	H	Abo		MT
Ebenaceae	*Diospyros samoensis*	kauloa	T	Ind		MT
Elaeocarpaceae	*Elaeocarpus sp.*	Kabi/malamala?	T	Nvt	GK	MT
Euphorbiaceae	*Acalypha repanda*	kalabuci	S	Ind	GK	MT
Euphorbiaceae	*Baccaurea stylaris*	midra/roro damu	T	Ind	GK	MT
Euphorbiaceae	*Bischofia javanica*	koka	T	Abo	GK	MT
Euphorbiaceae	*Codium variegatum*	sacasaca	T	Abo		MT
Euphorbiaceae	*Endospermum macrophyllum*	kauvula/vulavula	T	End	GK	MT
Euphorbiaceae	*Endospermum robbianum*	kauvula/vulavula	T	End	GK	MT
Euphorbiaceae	*Glochidion ramiflorum?*	molau	T	Ind		MT
Euphorbiaceae	*Glochidion vitiense*	molau tagane	T	End		MT
Euphorbiaceae	*Homalium sp.*	molaca	T	Ntv		MT
Euphorbiaceae	*Macaranga graffaeana*	gadoa	T	Ind		MT
Euphorbiaceae	*Macaranga magna*	gadoa levu	T	End		MT
Euphorbiaceae	*Macaranga membranacea*	mama	T	End	GK	MT
Euphorbiaceae	*Macaranga vitiensis*	mavu	T	End		MT
Euphorbiaceae	*Omalanthus nutans*	tadano	T	Ind		MT

Goodeniaceae	*Scaevola floribunda*		T/S	End	GK	MT
Herdnandiaceae	*Hernandia ovalicea*	dalovoci	T	End	GK	MT
Icacinaceae	*Medusanthera vitiensis*		T	End	GK	MT
Lauraceae	*Cryptocarya sp. 1*	Diriniu/vorovoro	T	Ntv		MT
Lauraceae	*Endiandra sp.*	Damabi	T	Ntv		MT
Lauraceae	*Litsea sp.*	lidi/titi	T	Ntv		MT
Lecythcidaceae	*Barringtonia edulis*	vutukana/vutu ni vanua	T	Ind		MT
Leeaceae	*Leea indica*			Ind	GK	MT
Loganiaceae	*Fagraea berteroana*	bua ni viti/buabua	T	Ind	GK	MT
Loganiaceae	*Geniostoma rupestre*	boiboida	T	End		MT
loganiaceae	*Geniostoma macrophyllum*		T	End	GK	MT
Loganiaceae	*Neuburgia corynocarpa*	bo	T	Ind	GK	MT
Loganiaceae	*Neuburgia macroloba*	bo	T	End		MT
Malvaceae	*Hibiscus tilaceus*	vau, beach hibiscus	T	Ind	GK	MT
Melastomataceae	*Melastoma denticulatum*		S	Ind	GK	MT
Melastomataceae	*Astronidium cf. parviflorum*		T	End		MT
Melastomataceae	*Astronidium sp.*		T	Ntv		MT
Melastomataceae	*Clidemia hirta*	Korster's curse	S	Ex/Inv	GK	MT
Melastomataceae	*Medinilla kambikambi*		L	End	GK	MT
Meliaceae	*Aglaia elagans*	kautoa	T	Ind		MT
Meliaceae	*Aglaia vitiensis*	kautoa/waicavucavu	T	End	GK	MT
Meliaceae	*Dysoxylum richii*	tarawau kei rakaka/tk soqe	T	End	GK	MT
Meliaceae	*Dysoxylum sp.*	malamala	T	Ntv		MT
Meliaceae	*Vavaea amicorum*	cevua	T	Ind	GK	MT
Meliaceae	*Vavaea harveyi*	cevua	T	End	GK	MT
Mimosaceae	*Acacia richii*	qumu	T	End	GK	MT
Mimosaceae	*Entada phaseoloides*	walai	L	Ind	GK	MT
Monimiaceae	*Hedycarya dorstenoides*		T/S	Ind	GK	MT
Moraceae	*Ficus barclayana*	ai masi	T/S	End	GK	MT
Moraceae	*Ficus fulvo-pilosa*	ai masi	T	Ind	GK	MT
Moraceae	*Ficus masonii*	nunu	T	End		MT
Moraceae	*Ficus obliqua*	baka ni veikau	L	Ind	GK	MT
Moraceae	*Ficus smithii var. robusta*	losilosi/nunu ke	T	Ind	GK	MT
Moraceae	*Ficus storckii*	nunu	T	End	GK	MT
Moraceae	*Ficus theophrastoides*		T	End	GK	MT
Moraceae	*Ficus vitiensis*	Lololo/lolo	T	End	GK	MT
Moraceae	*Malaisia scandens*	aumica	L	Ind	GK	MT
Myrisinaceae	*Maesa insularis*	kutumirase	S	End		MT

Myrisinaceae	*Maesa sp.*		T/S	Ntv		MT
Myrisinaceae	*Tapeinosperma capitatum*	dasia	T	End		MT
Myristicaceae	*Myristica chartacea*	Kaudamu lailai	T	End	GK	MT
Myristicaceae	*Myristica gillespieana*	male	T	End	GK	MT
Myristicaceae	*Myristica macrantha*	male	T	End	GK	MT
Myrsinaceae	*Rapanea myricifolia*	sagale ni vanua	T/S	Ind	GK	MT
Myrsinaceae	*Tapeinosperma capitatum*	dasia	T/S	End	GK	MT
Myrtaceae	*Decaspermum vitiense*	nuqanuqa	T	End		MT
Myrtaceae	*Metrosideros collina*	vuga	T	Ind		MT
Myrtaceae	*Syzygium corynocarpum*		T	Ind	GK	MT
Myrtaceae	*Syzygium fijiense*	yasiyasi	T	End	GK	MT
Myrtaceae	*Syzygium gracillipes*	yasiyasi	t/s	End.		MT
Myrtaceae	*Syzygium malacense*	Kavika, malay apple	T	Abo	GK	MT
Myrtaceae	*Syzygium quadrangulatum*	yasiyasi	T	Ind		MT
Myrtaceae	*Syzygium sp.*		T	Ntv		MT
Nyctaginaceae	*Pisonia umbellifera*	roro	T	Ind		MT
Phytolaccaceae	*Rivina humulis*		H	Ind		MT
Piperaceae	*Macropiper puberulum*		V	Ind	GK	MT
Piperaceae	*Macropiper vitiense*		S	End		MT
Piperaceae	*Piper betel*		V	Ind		MT
Piperaceae	*Piper insectifugum*	yaqoyaqona	V	End		MT
Pittosporaceae	*Pittosporum arborescens*		T	Ind		MT
Pittosporaceae	*Pittosporum rhytidocarpum*	duva ni veikau	T	End		MT
Proteaceae	*Turrillia feruginea*	kauceuti	T	End		MT
Proteaceae	*Turrillia vitiense*	kauceuti	t	End	GK	MT
Rhamnaceae	*Alphitonia zizyphoides*	doi	T	Ind	GK	MT
Rhamnaceae	*Ventilago vitiensis*		V	Ind	GK	MT
Rhizophoraceae	*Crossostylis harveyi*	tirivanua	T	End	GK	MT
Rosaceae	*Rubus moluccanus var. austropacificus*	Wavuka/soni	V	Ind	GK	MT
Rubiaceae	*Amaracarpus muscifer A*	baka ni Viti??	H	End	GK	MT
Rubiaceae	*Dolicholobium latifolium*	soso ni ura	T	End	GK	MT
Rubiaceae	*Geophila repens*		H	Ind	GK	MT
Rubiaceae	*Hedstromia latifolia*	drumadruma	T	End	GK	MT
Rubiaceae	*Ixora cf. pubiflora*		T/S	End	GK	MT
Rubiaceae	*Mastixiodendron robustum*	yatuvu	T	End	GK	MT
Rubiaceae	*Morinda citrifolia*	Kura	V	Ind	GK	MT
Rubiaceae	*Mussaenda raiateensis*	Vobo/ vobo damu	T	Ind	GK	MT
Rubiaceae	*Neonauclea forsteri*	Vacea/vacea ni wailevu	T	Ind	GK	MT
Rubiaceae	*Ophiorrhiza leptantha*	Lewa nini	H	Ind	GK	MT
Rubiaceae	*Psychotria confertiloba*	deqedeqe	T	End		MT
Rubiaceae	*Psychotria spp*		T	Ntv		MT

Rubiaceae	*Psychotria tephrosantha*		V	End		MT
Rubiaceae	*Readea membranacea*		T	End	GK	MT
Rubiaceae	*Squamellaria major*	sekeseke	E	End		MT
Rubiaceae	*Squamellaria wilsonii*	sekeseke	E	End		MT
Rubiaceae	*Tarenna sambucina*	vakaceretabua	T	Ntv	GK	MT
Rubiaceae	*Timonius affinis*	dogo ni vanua	T	Ind	GK	MT
Rutaceae	*Melicope cucullata var. cucullata*	drautolu	T	End	GK	MT
Sapindaceae	*Elattostachys falcata*	Marasa/drausasa	T	Ind	GK	MT
Sapindaceae	*Pometia pinnata*	dawa	T	Ind	GK	MT
Sapotaceae	*Burckella fijiensis*	Bau loa	T	End	GK	MT
Sapotaceae	*Planchonella grayana*	bau	T	Ind		MT
Sapotaceae	*Planchonella umbonata*	Bau/celavia	T	End	GK	MT
Sauriaceae	*Saurauia rubicunda*	Mimila	T	End	GK	MT
Simaurabaceae	*Amaroria soulameiodes*	Vasa ni veikau/korara	T	End	GK	MT
Solanaceae	*Solanum torvum*	Prickly solanum, kosipeli	T/S	Ex		MT
Sterculiaceae	*Commersonia bartramia*	Sama/sea	T	Ind	GK	MT
Sterculiaceae	*Heritiera ornithocephala*	rogi/savai	T	Ind	GK	MT
Sterculiaceae	*Sterculia vitiensis*	waciwaci	T	End	GK	MT
Sterculiaceae	*Melochia vitiensis*	iviloa	T	End		MT
Tiliaceae	*Grewia crenata*	siti	T	Ind		MT
Tiliaceae	*Trichospermum richii*	mako	T	Ind	GK	MT
Tiliaceae	*Trichospermum calyculatum*	Mako loa	T	End		MT
Ulmaceae	*Gironniera celtidifolia*	Sisisi/masivau	T	Ind	GK	MT
Urticaceae	*Boehmeria virgata*	kaulolo	T/S	Ind		
Urticaceae	*Cypholophus macrocephalus var. mollis*	lawa	H	Ind		
Urticaceae	*Dendrocnide harveyi*	salato	T	Ind	GK	MT
Urticaceae	*Elatostema australe*	beta	H	End		MT
Urticaceae	*Elatostema humile*		H	End		MT
Verbenaceae	*Faradaya ovalifolia*	wavudi	L	End	GK	MT
Verbenaceae	*Premna protusa*	yaro loa	T	End	GK	MT

Monocotyledons						
Family	**Botanical name**	**Common / Local Name**	**Life form**	**Distribution**	**Source**	
					2006	**2018**
Agavaceae	*Cordyline terminalis*	qai, vasili	S	Abo	GK	MT
Araceae	*Epipremnum pinnatum*	yalu	V	Ind	GK	MT
Arecaceae	*Balaka seemannii*	balaka	T	End	GK	MT
Arecaceae	*Physokentia thurstonii*	niuniu	T	End	GK	MT
Arecaceae	*Veitchia filifera*	niuniu	T	End	GK	MT
Commelinaceae	*Aneilema vitiense*	Cobula, luna	H	Ind		MT
Flagellariaceae	*Flagellaria indica*	wa ulo; wa laki	L	Ind	GK	MT
Flagellariaceae	*Flagellaria neo-caledonica*	Wa ulo lailai	L	Ind		MT
Heliconiaceae	*Heliconia paka*	Paka	S	End		MT
Joinvilleaceae	*Joinvillea plicata*	gasau ni veikau	S	Ind	GK	MT
Liliaceae	*Collospermum montanum*		E	End		MT
Orchidaceae	*Appendicula pendula*		E	Ind		MT
Orchidaceae	*Appendicula reflexa*		E	Ind	GK	MT
Orchidaceae	*Bulbophyllum cf. longiscapum*		E	Ind		MT
Orchidaceae	*Calanthe triplicata*	varavara	H	Ind		MT
Orchidaceae	*Calanthe ventilabrum*	varavara	H	Ind	GK	MT
Orchidaceae	*Coelogyne macdonaldii*		H	Ind		MT
Orchidaceae	*Dendrobium mohlianum*	Tokai lailai	E	Ind		MT
Orchidaceae	*Dendrobium sp.*		E	Ntv		MT
Orchidaceae	*Eria rostriflora*		E	Ind		MT
Orchidaceae	*Glomera emarginata*		E	End		MT
Orchidaceae	*Malaxis cf. vitiensis*		H	End		MT
Orchidaceae	*Oberonia equitans*		E	Ind		MT
Orchidaceae	*Oberonia heliophila*		E	Ind	GK	MT
Orchidaceae	*Pseuderia platyphylla*		E	End		MT
Orchidaceae	*Spathoglottis pacifica*	varavara	H	Ind	GK	MT
Pandanaceae	*Freycinetia caudata*	wa me; wa vuka	L	End	GK	MT
Pandanaceae	*Freycinetia cf. vitiensis*	wa me	L	End		MT
Pandanaceae	*Freycinetia storckii*	wa me	L	Ind		
Philesiaceae	*Geitonoplesium cymosum*	wa dakua	V	Ind		MT
Poaceae	*Centotheca lappacea*		Gp	Ind	GK	MT
Poaceae	*Miscanthus floridulus*	gasau	S	Ind		MT
Smilacaceae	*Smilax vitiensis*	warusi	V	Ind	GK	MT
Taccaceae	*Tacca leontopetaloides*	yabia	H	Ind		MT
Zingiberaceae	*Alpinia boia*	boia, vava	H	End	GK	MT
Zingiberaceae	*Alpinia parksii*	locoloco	H	End	GK	MT
Zingiberaceae	*Zingiber zerumbet*	lalaya	H	Abo		MT

Pteridophytes						
Family	**Botanical name**	**Common/Local Name**	**Life form**	**Distribution**	**Source**	
					2006	**2018**
Adiantaceae	*Stenochlaena palustris*	Wa midri	V	Ind	GK	MT
Aspidiaceae	*Tectaria decurrens*		H	Ind		MT
Aspidiaceae	*Tectaria latifolia*	Ota loa	H	Ind		MT
Aspleniaceae	*Asplenium amboinense*		E	Ind	GK	MT
Aspleniaceae	*Asplenium australasicum*	Sova ni gata	E	Ind	GK	MT
Aspleniaceae	*Asplenium bipinnatifidum*		E	Ind	GK	MT
Aspleniaceae	*Asplenium laserpitiifolium*		E	Ind		MT
Athyriaceae	*Diplazium harpeodes*		H	Ind	GK	MT
Athyriaceae	*Diplazium proliferum*	ota	H	Ind		MT
Blechnaceae	*Blechnum milnei*		H	Ind		MT
Blechnaceae	*Blechnum orientale*		H	End	Gk	MT
Cyatheaceae	*Calochlaena straminea*		H	Ind		MT
Cyatheaceae	*Cyathea affinis*	balabala	T	Ind		MT
Cyatheaceae	*Cyathea hornei*	balabala	T	Ind	GK	MT
Cyatheaceae	*Cyathea lunulata*	balabala	T	Ind	GK	MT
Cyatheaceae	*Cyathea microlepidota*	balabala	T	End.		MT
Cyatheaceae	*Cyathea propinqua*	balabala	T	End		MT
Cyatheaceae	*Dicksonia brackenridgei*	balabala	T	Ind		MT
Davalliaceae	*Davallia solida*		V	Ind.	GK	MT
Davalliaceae	*Humata botrychioides*		V	End		MT
Davalliaceae	*Nephrolepis biserrata*		H	Ind	GK	MT
Davalliaceae	*Nephrolepis hirsutula*		H	Ind	GK	MT
Davalliaceae	*Nephrolepis tuberosa*		E	Ind	GK	MT
Davalliaceae	*Oleandra neriiformis*	Sova ni gata	E	Ind	GK	MT
Dennstadtiaceae	*Dennstaedtia spp.*		H	Ntv		MT
Gleicheniaceae	*Dicranopteris spp*	qato	H/V	Ntv	GK	MT
Hymenophyllaceae	*Hymenophyllum spp.*	Filmy ferm	H/V	Ntv		MT
Lomariopsidaceae	*Lomagramma cordipinna*		V	Ind.		MT
Lomariopsidaceae	*Lomagramma polyphylla*		V	Ind.	GK	MT
Lycopodiaceae	*Huperzia cf. serratum*		E	Ind		MT
Lycopodiaceae	*Huperzia magnificum*		E	End		MT
Lycopodiaceae	*Lycopodiella cernua*		E	ind	GK	MT
Marattiaceae	*Angiopteris evecta*	basovi	H	Ind		MT
Marratiaceae	*Marratia smithii*		T	Ind		MT
Osmundaceae	*Leptopteris wilkesiana*		H	Ind		MT
Polypodiaceae	*Belvisia mucronata*		E	ind		MT
Polypodiaceae	*Drynaria rigidula*		E	Ind.	GK	MT

Polypodiaceae	*Phymatosorus grossus*	vativati	V	Ind		MT
Psilotaceae	*Psilotum complanatum*		E	Ind		MT
Psilotaceae	*Psilotum nudum*		E	Ind	GK	MT
Schizaeaceae	*Lygodium reticulatum*		V	Ind		MT
Selaginellaceae	*Selaginella viridangula*		H	End		MT
Thelypteridaceae	*Christella harveyi*		H	Ind		MT
Vittariaceae	*Antrophyum alatum*		E	Ind		MT

Appendix 2. Summary of vegetation community structure assessment plots for KFCA

Key: T1P1 = refers to the plot number (Plot #) Transect 1 plot 1; # Ind. = number of individuals; spp. = refers to more than one species; Av. dbh = Average diameter of a tree trunk at breast height (1.2m from the ground); B. Area – Basal area of a tree trunk; Dom. Sp. = dominant species in term of biomass; Rel. Dom. = relative dominance. For the species names used in the table it refers to the first three letters of the genus followed by the first three letters of the species i.e. Mac_mem = Macaranga membranacea etc.

Lowland Vegetation Type – Lowland flat forest type											
Plot #	**Longitude; Latitude**	**# Ind. ≥ 5 cm**	**# Tree spp.**	**Most com. spp.**	**Largest trees**	**# Ind. ≥ 10 cm**	**Av. dbh (cm)**	**Range (cm)**	**B. area (stems ≥ 10cm dbh)**	**Dom. sp.**	**Rel. Dom. (%)**
T1P1	-16.80393°S	12	7	Mac_mem	Par_ins	7	15.07	6 to 59	3758.1	Par_ins	3.7
	178.96675°E	9	6	Tri_ric	Her_orn	6	18.4	6 to 52.1	3675.7	Her_orn	na
		17	9	End_mac	Mas_rob	7	14.7	5-51.8	4608.7	Mas_rob	na
		18	12	none	End_mac	9	14.1	5 to 31.1	4467.7	Par_ins	4.5
		19	11	Crp_spp.	Cry_spp	7	20.1	5.5-68	13061	Crp_spp.	13.2
		18	11	Myr_cas	Par_ins	11	17.1	5 to 42	62478	Par_ins	63
		17	10	Myr_gil	Par_ins	9	13.6	6 - 32.6	3108.3	Par_ins	3.1
		17	10	Gir_cel	Par_ins	13	15.1	5.5- 32.5	3743.2	Par_ins	3.7
Total		**15.9**	**9.5**			**8.6**	**16; 24.6**		**98900.7**		
Lowland Vegetation Type – Lowland slope forest type											
T2P1	-16.80358°S	15	11	Gir_cel	*Cyn_ins*	10	20.2	6 to 80	8357	Cyn_ins	9.7
	178.97374°E	15	11	Syz_spp	Syz_spp	9	14.6	6 to 31	3268	Syzy_spp	33.8
		13	10	Myr_cas	*Xyl_pac*	9	17	7 to 36	3687	Myr-cas	4.2
		9	7	Cya_mic	*Pre_pro*	4	8.9	5 to 12	2692	Cya_aff	na
		11	8	Ana_lut	*End_spp*	10	26.7	5-85.5	9873	End_spp	11
		14	9	Syz_spp	Syz_spp.	7	19	5.5-51	8232	Syz_spp	9.5
		17	13	none	*Corikula*	11	18.8	5 to 41	6693	Myr_cas	7.7
		12	9	Gir_cel	Myr_cas	3	11.6	5 to 44	312.4	Myr_cas	na
T3P1	-16.80531°S	16	12	Psy_spp	Ret_vit	5	15.1	5-64.6	6941.5	Ret_vit	8
	178.97798°E	16	10	Hap_flo	*Hap_flo*	10	15.3	5.3-49.5	4302	Hap-flo	5
		17	13	Hap_flo	*Hap_flo*	10	17.9	5.6-43	6162.7	Hap_flo	7
		24	18	Ret_vit;	*Ret_vit*	16	15.8	6-49.5	6595.9	Ret_vit	7.6

		16	8	Dol_lat	*Cal_neo*	10	13.3	5.2-45	3586.7	Cal_neo	4.2
		30	12	Myr_gil; Vei_fil; Bar_sea	*Cal-neo*	17	12.8	5-44.5	5371.5	Cal_neo	6.2
		16	15	Neu_cor	Can_har	7	15.9	5.2-60	5359.1	Can_har	6
		26	19	Syz_spp	Hap_flo	12	13.7	5.3-32.5	4409.7	Hap_flo, Xyl-pac	na
Total		**16.7**	**11.6**			**9.4**	**15.3; 23**		**85843.5**		

Appendix 3. Location of point count stations

Transect	Point code	Latitude	Longitude
Road	KLK01-01	-16.8037	178.9767
Road	KLK01-02	-16.803	178.975
Road	KLK01-03	-16.8012	178.9733
Road	KLK01-04	-16.7998	178.97
Road	KLK01-05	-16.8013	178.97
Road	KLK01-06	-16.8027	178.97
Road	KLK01-07	-16.8017	178.9667
Road	KLK01-08	-16.7998	178.965
Road	KLK01-09	-16.7976	178.9631
Road	KLK01-10	-16.7953	178.96
Road	KLK01-11	-16.7928	178.96
Road	KLK01-12	-16.789	178.96
1	KLK02-13	-16.8008	178.9667
1	KLK02-14	-16.802	178.965
1	KLK02-15	-16.8032	178.965
1	KLK02-16	-16.8045	178.965
1	KLK02-17	-16.8057	178.9633
1	KLK02-18	-16.8068	178.9633
1	KLK02-19	-16.8082	178.9617
2	KLK03-20	-16.8033	178.97
2	KLK03-21	-16.8035	178.97
2	KLK03-22	-16.805	178.97
2	KLK03-23	-16.8065	178.9683
2	KLK03-24	-16.8082	178.9667
2	KLK03-25	-16.8105	178.9667
Road 2	KLK04-26	-16.8048	178.9783
Road 2	KLK04-27	-16.8053	178.98
Road 2	KLK04-28	-16.8052	178.983
Road 2	KLK04-29	-16.8054	178.9851
Road 2	KLK04-30	-16.8059	178.9879
Road 2	KLK4-31	-16.806	178.9901
Road 2	KLK04-32	-16.8062	178.9929
4	KLK05-33	-16.8061	178.9795
4	KLK05-34	-16.807	178.9782
4	KLK05-35	-16.8086	178.9782
4	KLK05-36	-16.8105	178.9767
3	KLK06-37	-16.8045	178.6422
3	KLK06-38	-16.8056	178.9747
3	KLK06-39	-16.8072	178.9738

Appendix 4. List of bat species recorded at KFCA in February 2018 and May 2016

Common name	Local Name	Scientific name	Conservation Status & IUCN RedList 2017	Threat	KFCA February 2018	Kilaka May 2016
Cave Dwelling Fauna (Habitat type – Cave ins and domes or on overhangs)						
Pacific sheath tail bat	Bekabeka	*Emballonura semicaudata*	Native to the Pacific, Endangered	Extirpated from Viti Levu. Threatened by predators, pesticide use and disturbance of roosts.		Cave found by hunter, confirmed by Bat Conservation International and BLI to be an overhang – collapsed after cyclone Winston
Fijian free-tailed bat	Kalakalavo	*Chaerephon bregullae*	Native, Endangered	Very vulnerable because there is only one globally known roost for this species. Biggest threat is roost disturbance and harvest.		Cave confirmed and preliminary analysis of acoustic detector confirmed species
Fiji blossom bat	Manumanu vakabuina	*Notopteris macdolandi i*	Native, Vulnerable	Only 5 known colonies remaining, threatened by roost disturbance and deforestation.	Two sighting	
Tree dwelling - Roosts in Trees						
Pacific Flying fox	Beka Dina	*Pteropus tonganus*	Native to the Pacific, Least Concern	Loss of native forests, tropical storms and harvesting.		Observed in Kilaka Village
Samoan Flying fox	Beka lulu	*Pteropus samoensis*	Native to the Pacific, Near threatened	Loss of habitat and harvesting. Much greater threat of harvesting in Samoa, not so much in Fiji.	Observed on numerous occasions across several transects	

Appendix 5. List of herpetofauna species found in KFCA other species previously recorded from Vanua Levu

Genus	Species	Previously documented from Vanua Levu	Fiji endemic	Vanua Levu endemic	Introduced	Kilaka survey Feb 2018	Common name	Local name
Anura								
Rhinella	*marinus*	1			1	1		
Cornufer	*vitianus*	1	1			1	Fiji tree frog	Ula, Dreli
Cornufer	*vitiensis*	1	1			1	Fiji ground frog	Ula, Boto ni Viti
Gekkonidae								
Gehyra	*mutilata*	0						
Gehyra	*oceanica*	1				1	Oceanic gecko	Moko kabi
Gehyra	*vorax*	1				1	Giant forest gecko	Moko kabi
Hemidactylus	*frenatus*	1			1			
Hemidactylus	*garnotti*	0						
Hemidactylus	*typus*	1						
Lepidodactylus	*gardineri*	0					Rotuman forest gecko	
Lepidodactylus	*lugubris*	1			1			
Lepidodactylus	*manni*	1	1				Mann's forest gecko	Moko kabi
Nactus	*pelagicus*	1				1	Skink-toed gecko	
Skincidae								
Cryptoblepharus	*eximius*	1	1				Pygmy snake-eyed skink	
Emoia	*caeruleocauda*	0					Pacific blue tailed skink	
Emoia	*campbelli*	0					Montane tree skink	
Emoia	*concolor*	1	1				Fijian green tree skink	Boliti
Emoia	*cyanura*	1				1	Brown-tailed copper-striped skink	
Emoia	*impar*	1					Blue-tailed copper-striped skink	
Emoia	*mokosarini veikau*	1	1	1		1	Fiji forest skink	
Emoia	*nigra*	1					Pacific black skink	Moko loa
Emoia	*parkeri*	0	1			1	Fijian copper-headed skink	
Emoia	sp. aff. *parkeri*	1	1	1		1	Vanua Levu copper-headed skink	
Emoia	*trossula*	1				1	Barred tree skink/ Dandy skink	
Lipinia	*noctua*	1				1	Moth skink	

Iguanidae								
Brachylophus	*fasciatus*						Fiji banded iguana	Vokai, Saumure
Brachylophus	*bulabula*	1	1				Viti banded iguana	Vokai, Saumure
Iguana	*iguana*	1			1		Green iguana (Giant Invasive Iguana/ American Iguana)	
Candoia	*bibroni*	1					Pacific boa	Gata, balei
Ramphotyphlops	sp.	0					Taveuni blind snake	
Ramphotyphlops	*braminus*	0						

Appendix 6. Checklist and abundance of moths collected from KFCA in February 2018

**** Endemic species, **Endemic and only found in Vanua Levu, ***Endemic and new record for Vanua Levu*.**

Species name	Family	Transect 1 (flat)	Transect 1 (slope/strem)	Transect 2	Transect 4	Remarks
*Adetoneura lentiginosa***	EREBIDAE		1			Rare species restricted to primary forest, only recorded from Namosi and Mt. Korobaba
Bocana manifestalis	EREBIDAE	1	1	1	2	Uncommon species, apparently restricted to well established secondary vegetation in the wet zone of the largest islands
*Calliteara fidjiensis**	EREBIDAE	1	1	1	3	Endemic species but widespread, apparently restricted to the largest islands of the Fiji group Synonym: *Dasychira fidjiensis* Hübner (1806)
Mocis sp.	EREBIDAE					Common and widespread species
Hydrillodes surata	EREBIDAE		1		1	Common and widespread species
Comostola pyrrhogona	GEOMETRIDAE		1		1	Moderately common species of primary and secondary forest areas
*Cleora sp.**	GEOMETRIDAE	1	4	1		
Episteira nigrilinearia enochra	GEOMETRIDAE	1		1	3	Uncommon species but widespread in forested areas
*Horisme chlorodesma**	GEOMETRIDAE	1	1	1	1	Common species in primary and secondary wet zone vegetation, especially around fringes
Scotocyma miscix	GEOMETRIDAE				1	Restricted to good forest
*Thalassodes fiona****	GEOMETRIDAE		1			Endemic species and has never been recorded in Vanua Levu (new record)

*Thalassodes figurata**	GEOMETRIDAE	1		1		Endemic, uncommon species found in good forests
Petelia aesyla	GEOMETRIDAE				1	Common species in forest areas
Perixera sp.	GEOMETRIDAE				1	Moderately common forest species
Geometrid sp.	GEOMETRIDAE				1	
Geometrid sp.	GEOMETRIDAE		1		1	
*Beggina sp.**	LIMACODIDAE				2	All species within this genus are endemic (center of radiation - Fiji)
*Beggina minima***	LIMACODIDAE		5			All species within this genus are endemic (center of radiation - Fiji), only found in Vanua Levu
*Beggina zena**	LIMACODIDAE				1	All species within this genus are endemic (center of radiation - Fiji)
Maceda mansueta	NOLIDAE		1			Uncommon species found in primary and secondary forest
*Locastra ardua****	PYRALIDAE		2		1	Endemic, not previously recorded from Vanua Levu
*Vitessa vitialis**	PYRALIDAE		1			Endemic species
*Urapteroides anerces**	URANIIDAE	2		2		Endemic, common species in secondary and primary forest
*Aeolopetra palaeanthes****	CRAMBIDAE		3		5	Endemic and new record for Vanua Levu
Palpita sp.	CRAMBIDAE		1			
Meroctena staintoni i	CRAMBIDAE		5		6	Common and widespread species
Parotis sp.	CRAMBIDAE		1		1	Widespread
Microlepidoptera	CRAMBIDAE	25	16	20	16	Smaller micro-moths that could not be identified in time-frame
Unidentified		9	3	9		Damaged specimens
Total per transect		**42**	**50**	**37**	**48**	