Survey of Endemic, Native, and Invasive Vertebrates in the Sovi Basin, Fiji, 2003–2015¹

*Alivereti Naikatini,^{2,8} Nunia Thomas,³ David Boseto,⁴ Lekima Copeland,² Isaac Rounds,⁵
Sarab Pene,² Marika Tuiwawa,² Clare Morrison,⁶ and Linton Winder⁷*

Abstract: The Sovi Basin is a site within the Pacific-Asia Biodiversity Transect (PABITRA) network. It is located in Naitasiri Province, Viti Levu, and represents the largest area of undisturbed lowland forest within the Fiji Islands. It is considered to be one of the most biologically diverse areas within the Polynesia-Micronesia biodiversity hot spot. Four intensive surveys conducted between 2003 and 2015 assessed vertebrate fauna within the Sovi Basin. The study confirmed the biological importance of the site when compared with other locations within Fiji: 85%, 50%, 39%, and 38% of the Viti Levu fauna of birds, mammals, herpetofauna, and ichthyofauna were recorded during the surveys, respectively. In addition to the rich native and endemic fauna, invasive species were recorded (mongoose, feral pigs, black rats, red-vented bulbuls, tilapia, and cane toads), the impact of which is completely unknown. Further monitoring and possible management of these invasive species is needed to ensure that the Sovi Basin is appropriately managed for nature conservation. In addition, emerging threats such as a proposed mining scheme and agricultural activities are discussed in relation to the ecological integrity of the site for conservation purposes.

THE SOVI BASIN, located in Naitasiri Province, Viti Levu, represents the largest area of undisturbed lowland forest (ca. 100–600 m altitude) within the Fiji Islands (Keppel et al. 2011, Keppel et al. 2012). Covering about 19,600 ha, it is considered to be one of the most biologically diverse areas within the Polynesia-Micronesia biodiversity hot spot (IUCN 2013). About 50% of the total native

flora has been recorded within the basin (Keppel et al. 2011, Tuiwawa 1999), and it is also recognized for its importance as a site for both vertebrates and invertebrates. Although it is only about 35 km from the capital, Suva, it is physically isolated, being ringed by steep volcanic peaks, and therefore hard to access. Due to its isolation and its high biodiversity, the Sovi Basin is considered to be an area of substantial conservation value and is important as a refuge for native plant and animal communities that have been compromised by invasive species and human activities elsewhere (Keppel et al. 2012).

In recognition of the regional and national importance of the Sovi Basin, conservation efforts resulted in protection of the site. Organizations including the Fiji Government, NZ Aid, McArthur Foundation, Darwin Initiative, Wildlife Conservation Society, Pacific Biological Foundation, Australian Government, Food and Agriculture Organization, Conservation International, Fiji Water, University of the South Pacific, and National Trust of Fiji have all contributed to support this action. In 2012, the Sovi Basin Protected

¹ Manuscript accepted 23 December 2016.

² Institute of Applied Science, University of the South Pacific, Suva, Fiji.

³ NatureFiji-MareqetiViti, Suva, Fiji.

⁴ Ecological Solutions, Gizo, Solomon Islands.

⁵ Conservation International, Suva, Fiji.

⁶ School of Environment, Griffith University, Australia.

⁷ Department of Forestry and Resource Management, Toi Ohomai Institute of Technology, Rotorua, New Zealand.

⁸ Corresponding author (e-mail: naikatini_a@usp.ac.fj).

Area became legally protected when it was formally leased by the National Trust of Fiji from the landowning communities (represented by the iTaukei Land Trust Board). Reports, including the influential Fiji Biodiversity Strategy and Action Plan (Government of Fiji 2007), have been strong drivers for such conservation action to be taken. The lease is long term (99 yr) and for conservation purposes (National Trust of Fiji 2014). This arrangement was facilitated by partnerships with Conservation International and the Fiji Water Foundation. To ensure that the goal of long-term conservation can be met, Conservation International has also established the Sovi Basin Trust Fund. This fund is intended to finance conservation action beyond the 99-yr lease. The fund is designed to meet commitments regarding compensation for lost timber revenues, land rents, and development of alternative economic opportunities that support both the local community and conservation efforts (Conservation International 2016).

The basin is currently uninhabited, although the area was previously inhabited but was abandoned due to poor soils and access difficulties (IUCN 2013). Under the management plan, landowners may use the protected area for traditional harvesting and fishing purposes and will be directly involved with the implementation of the management plan at all levels. Subsistence hunting of feral pigs and some harvesting of prawns, eels, and freshwater fish is conducted by the landowners. However, although the land area itself is now strongly protected and managed, this conservation action does not eliminate threats to the biota of the area. In particular, invasive species do not respect conservation area boundaries and pose a substantial threat to ongoing conservation efforts. For example, incursions of the African tulip tree (*Spathodea campanulata*) are known to threaten the site.

The Sovi Basin is included within the Pacific-Asia Biodiversity Transect (PABITRA) network of survey sites (Keppel 2005, Mueller-Dombois and Daehler 2005). The PABITRA project focuses on biodiversity assessments across the Pacific-Asia region, with strong involvement from locally based sci-

tific communities (Mueller-Dombois 2008). Within this project, four key data types are included for collection (species inventory, community description, ecological data, and long-term monitoring). This study addresses the first of these priorities. Following the site's inclusion in the PABITRA network, knowledge regarding species within the Sovi Basin has been strengthened through a series of intensive biodiversity assessments. Carried out over 12 yr, these assessments comprised four major biodiversity surveys that brought together a range of partners and provide an important record of Fijian ecology.

Comparison of results from similar assessments conducted at other locations within Fiji could provide valuable information regarding both species representation and their biological importance. However, such comparisons are difficult because there are relatively few published studies that attempt to systematically describe vertebrate species composition. However, some studies have been completed (Table 1) and provide vital baseline information to evaluate the comparative importance of specific sites for conservation purposes.

We provide a synthesis of surveys of endemic, native, and introduced vertebrates (birds, mammals, herpetofauna, and ichthyofauna) conducted in the Sovi Basin over 12 yr and compare these results with Viti Levu checklists. We characterize species assemblages of endemic and native species and evaluate the threat posed by invasive species to the integrity of the reserve. We hypothesized that given the isolation of the area, invasive species incursions might be limited and new invasion occurrences infrequent. Management options are considered in relation to our findings and recommendations made.

MATERIALS AND METHODS

Surveying: General Methods

Four intensive surveys were conducted within the Sovi Basin between 2003 and 2015 supported by multiple organizations (Table 2). Base camps were established (Figure 1), and Wainavalau (−17.90546°, 178.2223°) and

TABLE 1
Comparative Surveys of Vertebrate Species from Other Sites on Fiji’s Main Islands Viti Levu and Vanua Levu

<i>Site:</i>	Nakauvadra Range, Ra Province	Nakorotubu Range, Ra-Tailevu Province	Delaikoro Range, Macuata- Cakaudrove Province
<i>Location:</i>	Viti Levu, Fiji	Viti Levu, Fiji	Vanua Levu, Fiji
<i>Habitat:</i>	Fragmented Lowland/ Upland Rain Forest	Fragmented Lowland/ Upland Rain Forest	Fragmented Lowland/ Cloud Rain Forest
<i>Conservation Status:</i>	No Protection	No Protection	No Protection
Birds			
Native species	30	34	27
Total species	34	38	27
% Viti Levu native species	75	85	—
Mammals			
Native species	3	3	3
Total species	9	—	—
% Viti Levu native species	75	75	—
Hepetofauna			
Native species	9	9	7
Total species	11	10	8
% Viti Levu native species	50	50	39
Ichthyofauna			
Native species	6	13	16
Total species	8	15	18
% Viti Levu native species	15	33	40

Note: Data from Naikatini (2009), Forestry and Protected Area Management (2014), Morrison and Nawadra (2009), Morrison et al. (2010).

Wainavobo (−17.92079°, 178.24729°) were utilized more than once. For this synthesis, data were collated from unpublished reports, technical reports, and other sources including Morrison (2003*b*, 2006), Morrison and Naikatini (2008), Morrison and Nawadra (2009), Morrison et al. (2010), and Pene and Tuiwawa (2016).

Sampling for each vertebrate group (birds, mammals, herpetofauna, and fish) was done using appropriate observational methods (described further later in the article). All surveys were conducted by highly experienced surveyors. The four surveys were conducted over similar durations and focused on extending sampling coverage by surveying a new geographical area on each occasion. Due to this, and the observational approach adopted, data were summarized on a presence basis. In addition, these data were consolidated to create a single record of observation with an additional frequency measure that simply represented the number of survey occasions on which each species was observed (1–4). These

records were compared with checklists for Viti Levu as a whole. It was assumed that, given the intensive nature of the surveys, the sampling effort on each survey occasion was sufficient to achieve a reliable picture of species extant within the surveyed areas.

We compared the sightings of any invasive species against the ISSG Global Invasive Species Database and identified species recognized as the “100 worst” as a measure of threat (ISSG 2015). We also compared endemic and native species against the IUCN’s Red List categorization (CR, Critically Endangered; EN, Endangered; VU, Vulnerable; NT, Near Threatened) excluding LC (Least Concern) to identify threatened species found within the Sovi Basin (IUCN 2015). The bird species were also assessed according to the Fiji Threat Status (Watling 2013), which includes three key categories for species: AR (At Risk), CC (Conservation Concern), and DD (Data Deficient), with the lists of threatened species usually derived directly from the IUCN Red List.

TABLE 2
Summary of Surveys Conducted during the Study

Survey	2003	2004	2006	2015
Base camps	–17.90546°, 178.2223° 17.92079°, 178.24729°	–17.89380°, 178.11752° 17.87979°, 178.14473° 17.92797°, 178.15338° 17.94195°, 178.16337° 17.94435°, 178.18770°	–17.90546°, 178.2223° 17.92079°, 178.24729°	–17.90546°, 178.2223°
Date	5–17 May	13–20 October	20–31 March	25 June–2 July
Days in field	13	8	12	10
Season	Dry-cool	Wet-warm	Wet-warm	Dry-cool
Team size	24	24	28	36
Participating organizations	Landowners University of the South Pacific Department of Forestry Wildlife Conservation Society Birdlife International	Landowners University of the South Pacific Department of Forestry Wildlife Conservation Society Birdlife International	Landowners University of the South Pacific Department of Forestry Wetlands International National Trust of Fiji Fiji Museum	Landowners University of the South Pacific Department of Forestry Conservation International National Trust of Fiji Fiji Museum Nature Fiji-Mareqeti Viti

Surveying: Birds

Birds were surveyed on most days from first light (ca. 0600 hours) until about 1000 hours and in the afternoon from 1500 hours to 1700 hours (peak detectability periods) in all years. In 2003 and 2004, most of this time was spent in the forest quietly walking and stopping regularly for periods of several minutes to listen and watch, while recording all observed species. From 2006 onward a point count method was adopted following the method of Bibby et al. (2000), utilizing an observer and recorder to conduct the surveys. Stations were placed at least 200 m apart to minimize the likelihood of double counting. In 2006, 10 stations were surveyed using an 8 min count period, recording all birds detected within a 50 m radius of the point station. Point counts were done at locations adjoining the camp areas that were established along the route of travel. In 2015, a 5 min count period was used with 90 stations surveyed following the method above. The 5 min count was adopted to allow additional locations to be assessed. In addition to the point surveys, opportunistic recordings were made when previously undetected species were observed.

The checklist of Viti Levu birds was compiled based primarily on Watling (2001), Masibalavu and Dutson (2006), and Watling (2013), which summarized the distribution of Fiji’s 68 species of breeding land birds. In addition, further data were integrated into the checklist from surveys conducted by the Institute of Applied Science, Birdlife International, Environmental Consultants Fiji, and the National Trust of Fiji collected over the last 20 yr.

Surveying: Mammals

Unlike the bird survey, the mammal survey was conducted opportunistically. While carrying out bird counts we also recorded *Pteropus* spp. (fruit bats) if observed. Because the bird counts were conducted during the day, this method was more focused towards recording *P. samoensis*, which is considered a more diurnal species than *P. tonganus*. If a bat roost was observed, a GPS location was recorded, species identified, and population estimated by direct count. Occasionally, if there was a good opening on a ridge that was accessible, mist nets were set up, which were opened and monitored throughout the night.

FIGURE 1. Map of the Sovi Basin on Viti Levu, Fiji. The different patterned areas represent survey sites from different years.

In addition, if a bat detector was available, then it was operated around the camp to detect microspecies.

Rat trapping was mainly done around the camp or along trails using domestic rat traps. Trapping was carried out over 2 to 3 nights, and the number of traps ranged between 10 and 20. All the rats caught were identified, and other mammal species such as mongoose and wild pigs were recorded anecdotally following observation. The Viti Levu checklist was sourced from Pernetta and Watling (1978) and Atkinson and Atkinson (2000).

Surveying: Herpetofauna

Herpetofauna were sampled by intensive visual surveys. Frogs were surveyed primarily using standard nocturnal visual surveys using head torches between 2000 hours and 2200 hours each night, along streamside transects or in terrestrial sites away from water. Diurnal active visual surveys of 2 to 4 hr duration

were also conducted along stream edges (for frogs) and in other forest habitats (for lizards or snakes) by a minimum of three observers.

The Viti Levu checklist was sourced from the comprehensive field guide published by Morrison (2003a), which was the first compilation of all data on Fiji's herpetofauna; the 1991 monograph on the lizards of Fiji (Zug 1991); and additional personal field observations by Clare Morrison, Nunia Thomas, Rob Fisher, and Dick Watling conducted during surveys by the South Pacific Regional Herbarium (Institute of Applied Sciences) and Nature Fiji-Mareketi Viti recorded between 2003 and 2015.

Surveying: Ichthyofauna

A combination of sampling techniques was used to survey the ichthyofauna within the Sovi Basin, namely: (1) observation with mask and snorkel; (2) the use of a spear to catch large mobile species such as flagtails (*Kublia*

spp.) and eels (*Anguilla* spp.); (3) beach seine nets (0.4 cm² mesh); (4) hand nets (1 cm² mesh) used to collect bottom-dwelling species. Seine netting was conducted by two people holding the net approximately 2–3 m downstream from a third person who carefully dislodged small pebbles and gravel to corral the fish into the net. Sampling was conducted once a day in different river or creek sections for approximately 4 hr.

The ichthyofauna checklist for Viti Levu was compiled from the inventories by Boseto (2006), Jenkins et al. (2010), and Copeland et al. (2016). Since early 2000, the Institute of Applied Sciences based at the University of the South Pacific, Fiji, and Wetlands International have conducted extensive surveys to characterize the ichthyofauna across the Fiji archipelago.

RESULTS

In total, 34 native (including endemic) and one invasive bird were observed over the four surveys, representing 85% and 11%, respectively, of species found on Viti Levu (Table 3). Of these species, six have IUCN Red List threatened designations: *Charmosyna amabilis* (CR), *Clytorhynchus nigrogularis* (VU), *Erythrura kleinschmidti* (VU), *Gallicolumba stairi* (VU), *Prosopeia perosnata* (NT), and *Trichocichla rufa* (EN). In addition, two species have Fiji Threat Status designations: *Falco peregrinus* (AR) and *Porzana cinereus* (CC). Species considered to have restricted ranges are the endemics *Accipiter rufitorques*, *Artamus mentalis*, *Cettia ruficapila*, *C. amabilis*, *Chrysoenas luteovirens*, *C. nigrogularis*, *Ducula latrans*, *Erythrura pealii*, *E. kleinschmidti*, *Gymnomyza viridis*, *Phigys solitaries*, *P. perosnata*, *Mayrornis lessona*, *Myzomela jugularis*, *T. rufa*, and *Zosterops explorer* and the natives *Aplonis tabuensis*, *Clytorhynchus vitiensis*, *Foulehaio carunculata*, *Gallicolumba stairi*, *Myiagra vauikoroensis*, *Ptilinopus perousii*, and *Rhipidura spilodera* (Watling 2001, Masibalavu and Dutson 2006). The invasive *Pycnonotus cafer* (red-vented bulbul) was also observed, a species included in ISSG's invasive species database. For the bird species, most were observed on at least three occasions, indicating that the popula-

tions were established rather than ephemeral (Table 3).

The two bat species observed, *P. samoensis* and *P. tonganus*, are both native to Fiji (Palmeirim et al. 2007) and represent 50% of the native or endemic mammals known to be present on Viti Levu. They were observed on all sampling occasions. *Pteropus samoensis* is designated under the IUCN Red List (NT). Three introduced mammals were also observed, which represent 25% of those recorded on Viti Levu (Table 4). The three introduced species (*Sus scrofa vittatus*, *Herpestes* spp., and *Rattus rattus*) are listed within ISSG's "100 worst" invasive species. No microbat species were recorded, including the endangered *Emballonura semicaudata* (Scanlon et al. 2014).

Seven native (including endemic) and one introduced herpetofauna species were observed, which represented 39% and 17%, respectively, of Viti Levu species (Table 5). Of the native or endemic species, four have IUCN Red List threatened designations: *Emoia concolor* (NT), *E. parkeri* (VU), *Lepidodactylus manni* (VU), and *Platymantis vitianus* (EN). Most of the species were observed on at least three occasions (Table 5), although *L. manni* and *Candoia bibroni* were observed only once. The invasive species *Rhinella marina* (cane toad) is included in the world's 100 worst invasive species.

Fifteen native (including endemic) and two introduced ichthyofauna species were observed, which represented 38% and 20% of Viti Levu species, respectively (Table 6). Of the native or endemic species, four have IUCN DD designations (*Anguilla megastoma*, *Belobranchius belobranchius*, *Kuhlia marginata*, and *Stiphodon pelewenis*). The introduced species *Oreochromis niloticus* (Nile tilapia) is listed with the world's 100 worst invasive species. The frequency of observation (Table 6) of fish was more variable than that of the other vertebrate taxa surveyed.

DISCUSSION

This long-term study confirms the importance of the Sovi Basin for conservation purposes within the Fiji Islands (and the

TABLE 3
Endemic, Native, and Introduced Birds Observed during the Four Surveys, 2003–2015

Scientific Name	Common Name	Viti Levu ^a	2003	2004	2006	2015	Frequency ^b
Ardeidae							
<i>Egretta sacra</i>	Pacific reef-egret	N	✓	✓	✓	✓	4
Anseriformes							
<i>Anas supersiliosa</i>	Grey duck	N		✓	✓	✓	3
Phasianidae							
<i>Coturnix ypsilophora</i>	Brown quail	I					—
Falconiformes							
<i>Accipiter rufitorques</i>	Fiji goshawk	E	✓	✓	✓	✓	4
<i>Circus approximans</i>	Pacific harrier	N	✓	✓		✓	3
<i>Falco peregrinus</i>	Peregrine falcon	N					—
Rallidae							
<i>Porzana cinereus</i>	White-browed crake	N					—
<i>Porzana tabuensis</i>	Spotless crake	N					—
Columbidae							
<i>Columba livia</i>	Rock pigeon	I					—
<i>Columba vitiensis</i>	Metallic pigeon	N					—
<i>Streptopelia chinensis</i>	Spotted dove	I					—
<i>Gallinula stairi</i>	Shy ground-dove	N	✓	✓	✓		3
<i>Ducula latrans</i>	Peale's imperial pigeon	E	✓	✓	✓	✓	4
<i>Pratincola perousii</i>	Many-colored fruit-dove	N	✓	✓		✓	3
<i>Chrysocolaptes luteovirens</i>	Golden dove	E	✓	✓	✓	✓	4
Psittacidae							
<i>Phigys solitarius</i>	Collared lory	E	✓	✓	✓	✓	4
<i>Charmosyna amabilis</i>	Red-throated lorikeet	E					
<i>Prosopaea perosnata</i>	Masked shining parrot	E*	✓	✓	✓	✓	4
Cuculidae							
<i>Cacomantis flabelliformis</i>	Fan-tailed cuckoo	N		✓	✓		2
Tytonidae							
<i>Tyto alba</i>	Barn owl	I					—
Apodidae							
<i>Aerodramus spodiopygius</i>	White-rumped swiftlet	N	✓	✓	✓	✓	4
Alcedinidae							
<i>Todirhamphus chloris</i>	Collared kingfisher	N	✓	✓	✓	✓	4
Hirundinidae							
<i>Hirundo tabitica</i>	Pacific swallow	N					—
Artamidae							
<i>Artamus mentalis</i>	Fiji woodswallow	E	✓	✓	✓	✓	4
Sturnidae							
<i>Aplonis tabuensis</i>	Polynesian starling	N	✓	✓	✓	✓	4
<i>Acridotheres tristis</i>	Common myna	I					—
<i>Acridotheres fuscus</i>	Jungle myna	I					—
Pycnonotidae							
<i>Pycnonotus cafer</i>	Red-vented bulbul	I		✓	✓		2
Mursciapidae							
<i>Turdus poliocephalus</i>	Island thrush	N	✓	✓	✓	✓	4
Sylviidae							
<i>Cettia ruficapila</i>	Fiji bush-warbler	E	✓	✓		✓	3
<i>Trichocichla rufa</i>	Long-legged thicketbird	E		✓	✓	✓	3
Eopsaltriidae							
<i>Petroica multicolor</i>	Scarlet robin	N	✓	✓	✓	✓	4
Monarchidae							
<i>Rhipidura spilodera</i>	Streaked fantail	N	✓	✓	✓	✓	4
<i>Mayrornis lessona</i>	Slaty monarch	E	✓	✓	✓	✓	4
<i>Clytorhynchus vitiensis</i>	Fiji shrikebill	N	✓	✓	✓	✓	4
<i>Clytorhynchus nigrogularis</i>	Black-throated shrikebill	E	✓	✓	✓	✓	4

TABLE 3 (continued)

Scientific Name	Common Name	Viti Levu ^a	2003	2004	2006	2015	Frequency ^b
<i>Myiagra vanikoroensis</i>	Vanikoro flycatcher	N	✓	✓	✓	✓	4
<i>Myiagra azureocapilla</i>	Blue-crested flycatcher	N	✓	✓	✓	✓	4
Pachycephalidae							
<i>Pachycephala pectoralis</i>	Golden whistler	N	✓	✓	✓	✓	4
Camopephagidae							
<i>Lalage maculosa</i>	Polynesian triller	N	✓	✓	✓	✓	4
Zosteropidae							
<i>Zosterops explorator</i>	Layard's white-eye	E	✓	✓	✓	✓	4
<i>Zosterops lateralis</i>	Silvereye	N	✓	✓	✓	✓	4
Ploceidae							
<i>Erythrura pealii</i>	Fiji parrotfinch	E	✓	✓	✓	✓	4
<i>Erythrura kleinschmidti</i>	Pink-billed parrotfinch	E*	✓	✓	✓	✓	4
<i>Amandava amandava</i>	Red avadavat	I					—
<i>Padda oryzivora</i>	Java sparrow	I					—
Melaphagidae							
<i>Myzomela jugularis</i>	Orange-breasted myzomela	E	✓	✓	✓	✓	4
<i>Foulebaio carunculata</i>	Wattled honeyeater	N	✓	✓	✓	✓	4
<i>Gymnomyza viridis</i>	Giant forest honeyeater	E	✓	✓	✓	✓	4
Summary							
Number of introduced species recorded		9	0	1	1	0	1
Number of native/endemic species recorded		40	31	32	31	32	34

^a E, Endemic to Fiji; E*, endemic to Viti Levu; N, native to Fiji; I, introduced.
^b Indicates the number of surveys in which a species was observed.

Polynesia-Micronesia hot spot). From the four surveys conducted to date, 85%, 50%, 39%, and 38% of the known Viti Levu fauna for birds, mammals, herpetofauna, and ichthyofauna, respectively, have been recorded in the Sovi Basin. These records are equivalent or generally higher than observations made at other sites in Fiji (Table 1) and highlight the importance of Sovi Basin as a refuge for both Fiji and Viti Levu endemic and native species. Four of the 10 herpetofauna species endemic to Fiji were recorded, as well as one of the three fish species endemic to Fiji. In addition, 13 of the 15 birds endemic to Fiji were observed, and both bird species that are endemic to Viti Levu. As survey coverage increases, the species checklists are likely to grow, further strengthening the perceived biodiversity value of the area. Continued conservation efforts are therefore important to maintain this site of exceptional importance for biodiversity within the Polynesia-Micronesia hotspot. In general, observations of species were repeatedly made between successive sampling occasions, indicating both

that the sampling effort was sufficient and that the populations remained extant within the surveyed areas. Ichthyofauna species appeared to be the most difficult to sample, and it may be necessary to increase sampling effort given that the species may be difficult to observe. Due to the remoteness (rugged terrain) of Sovi Basin, this resulted in the inability to use electrofishing equipment, which would have standardized the method of sampling over the years.

The Sovi Basin appears to have a limited number of invasive species, but the effect of these species within the area is completely unknown. Both terrestrial and freshwater habitats are compromised by the presence of invasive species that are considered to pose a substantial threat to ecosystem integrity. The presence of tilapia in freshwater systems within the Sovi Basin is concerning. *Oreochromis mossambicus* and *O. niloticus* have both been recorded, but it is not known whether they are present due to intentional release or fish farm escape. These species are omnivorous and pose a threat to many native

TABLE 4
Endemic, Native, and Introduced Mammals Observed during the Four Surveys, 2003–2015

Scientific Name	Common Name	Viti Levu ^a	2003	2004	2006	2015	Frequency ^b
Viverridae							
<i>Herpestes</i> spp.	Indian mongoose	I		(✓)	(✓)	✓	3
Felidae							
<i>Felis catus</i>	Cat	I					
Canidae							
<i>Canis familiaris</i>	Dog	I					
Equidae							
<i>Equus caballus</i>	Horse	I					
Suidae							
<i>Sus scrofa vittatus</i>	Pig	I	✓	✓	✓	✓	4
Bovidae							
<i>Bos taurus</i>	Cattle	I					
<i>Capra hircus</i>	Goat	I					
<i>Ovis aries</i>	Sheep	I					
Muridae							
<i>Mus musculus</i>	House mouse	I					
<i>Rattus exulans</i>	Pacific rat	I					
<i>Rattus norvegicus</i>	Norway rat	I					
<i>Rattus rattus</i>	Black rat	I	✓			✓	2
Pteropodidae							
<i>Notopterus macdonaldi</i>	Fijian blossom-bat	N					
<i>Pteropus samoensis</i>	Samoaan flying-fox	N	✓	✓	✓	✓	4
<i>Pteropus tonganus</i>	Pacific flying-fox	N	✓	✓	✓	✓	4
Emballonuridae							
<i>Emballonura semicaudata</i>	Polynesian sheathtail-bat	N					
Summary							
Richness introduced		12	2	2	2	3	3
Richness native/endemic		4	2	2	2	2	2

^a N, Native to Fiji; I, introduced; (✓), unconfirmed observation by local guides.

^b Indicates the number of surveys in which a species was observed.

and endemic species, causing competitive displacement of native species, habitat alteration, and predation (Jenkins et al. 2010, Russell et al. 2012). In addition, the cane toad (*R. marina*) was observed along the riparian edge of river systems. The species was introduced into Fiji as a pest-control agent in sugarcane plantations in the 1930s (Morrison 2003*b*). It is known to compete with native frogs for food and breeding habitats (Morrison et al. 2004, Thomas et al. 2011), and because it is toxic at all life stages, it can pose a threat to native predators such as snakes, birds, and fish. Invasive mammals included the mongoose (*Herpestes* spp.), which has been introduced to many tropical islands in an attempt to control rats and snakes (Veron et al. 2007, Simberloff and Rejmanek 2011). Mongoose are

diurnal and generalist carnivores. Although associated most strongly with human-altered habitats, they can also invade natural ecosystems, with a consequent impact on native species (Gorman 1975, Morley and Winder 2013). Escaped or released pigs (*S. scrofa vittatus*) were also observed during the study. Feral pigs are able to disrupt ecological processes (e.g., succession and species composition) through nest building and soil rooting and are considered to be “ecosystem engineers” (Crooks 2002, ISSG 2015). The continued hunting of pigs by local landowners is probably an important conservation measure to reduce the population of this species. The black rat (*R. rattus*) was also observed and is commonly found in forest habitats. Its broad feeding habits pose a substantial threat to

TABLE 5
Endemic, Native, and Introduced Herpetofauna Observed during the Four Surveys, 2003–2015

Scientific Name	Common Name	Viti Levu ^a	2003	2004	2006	2015	Frequency ^b
Anura							
<i>Rhinella marina</i>	Cane toad	I		✓	✓	✓	3
<i>Platymantis vitianus</i>	Fiji ground frog	E					—
<i>Platymantis vitiensis</i>	Fiji tree frog	E	✓	✓	✓	✓	4
Gekkonidae							
<i>Gehyra mutilata</i>		I					—
<i>Gehyra oceanica</i>	Oceanic gecko	N					—
<i>Gehyra vorax</i>	Giant forest gecko	N					—
<i>Hemidactylus frenatus</i>	House gecko	I					—
<i>Hemidactylus garnottii</i>		I					—
<i>Hemidactylus typus</i>		N					—
<i>Lepidodactylus lugubris</i>		I					—
<i>Lepidodactylus manni</i>	Mann’s forest gecko	E				✓	1
<i>Nactus pelagicus</i>	Skink-toed gecko	N	✓	✓	✓	✓	4
Skincidae							
<i>Cryptoblepharus eximius</i>	Pygmy snake-eyed skink	E					—
<i>Emoia campbelli</i>	Montane tree skink	E*					—
<i>Emoia concolor</i>	Fijian green tree skink	E	✓	✓	✓		3
<i>Emoia cyanura</i>	Brown-tailed copper-striped skink	N	✓		✓	✓	3
<i>Emoia impar</i>	Blue-tailed copper-striped skink	N					—
<i>Emoia parkeri</i>	Fijian copper-headed skink	E		✓	✓		2
<i>Emoia</i> , undescribed species		E					—
<i>Lipinia noctua</i>	Moth skink	N					—
Iguanidae							
<i>Brachylophus bulabula</i>	Viti banded iguana	E					—
Other							
<i>Ogmodon vitianus</i>	Fiji burrowing snake	E*					—
<i>Candoia bibroni</i>	Pacific boa	N			✓		1
<i>Ramphotyphlops braminus</i>	Flowerpot snake	I					—
Summary							
Richness introduced		6	0	1	1	1	1
Richness native/endemic		18	4	4	6	4	7

^a E, Endemic to Fiji; E*, endemic to Viti Levu; N, native to Fiji; I, introduced.
^b Indicates the number of surveys in which a species was observed.

native fauna and flora, and the species has been associated with substantial declines of birds on small islands (Atkinson 1984, Angel and Cooper 2006, Veitch et al. 2011). Although invasive species have a great impact on many of Fiji’s islands, the Sovi Basin has probably escaped the most serious impacts due to its remoteness and isolation. However, given that invasive species that are known to pose a threat are already present within the Sovi Basin, it will take concerted effort to monitor and, if needed, manage these species. Long-term monitoring and management are

vital because development and habitat loss in adjacent areas could still pose a threat to the relative isolation of the protected area and may contribute to changes in the proximity of source populations of invasive species. These changes in habitat quality around the Sovi Basin are recognized as a “pressure indicator” for monitoring and evaluation of the conservation status of the area (National Trust of Fiji 2014). Studies within the Sovi Basin and other remote forested areas in Fiji have shown that rat and mongoose activity was highest to-

TABLE 6

Endemic, Native, and Introduced Ichthyofauna Observed during the Four Surveys, 2003–2015

Scientific Name	Common Name	Viti Levu ^a	2003	2004	2006	2015	Frequency ^b
Carcharchinidae							
<i>Carcharhinus leucas</i>	Bull shark	N					
Anguillidae							
<i>Anguilla obscura</i>	Pacific shortfinned eel	N					
<i>Anguilla marmorata</i>	Marbled eel	N	✓	✓	✓	✓	1
<i>Anguilla megastoma</i>	Polynesian longfinned eel	N	✓				1
Muraenidae							
<i>Gymnotoborax polyuranodon</i>	Freshwater moray	N	✓		✓		2
Ophichthidae							
<i>Lamnostoma kampeni</i>	Freshwater snake eel	N					
<i>Yirkalla gjellerupi</i>	Snake eel	N					
Cyprinidae							
<i>Barbonymus gonionotus</i>	Silver barb	I					
<i>Ctenopharyngodon idella</i>	Grass carp	I					
<i>Rhodeus ocellatus</i>	Rosy bitterling	I					
Poeciliidae							
<i>Gambusia affinis</i>	Mosquito fish	I					
<i>Poecilia mexicana</i>	Shortfin molly	I					
<i>Poecilia reticulata</i>	Guppy	I					
<i>Xiphophorus hellerii</i>	Green sword tail	I					
Syngnathidae							
<i>Microphis argulus</i>	Flat nosed pipefish	N					
<i>Microphis brachyurus</i>	Short tailed pipefish	N					
<i>Microphis brevidorsalis</i>	Stream pipefish	N					
<i>Microphis leiaspis</i>	Barhead pipefish	N					
<i>Microphis retzii</i>	Ragged pipefish	N					
Teraponidae							
<i>Mesopristes kneri</i>	Orange spotted therapon	E					
Kuhliidae							
<i>Kuhlia marginata</i>	Dark-margined flagtail	N	✓	✓	✓	✓	4
<i>Kuhlia rupestris</i>	Jungle perch	N	✓	✓	✓	✓	4
Centrarchidae							
<i>Micropterus salmoides</i>	Largemouth bass	I					
Carangidae							
<i>Caranx papuensis</i>	Brassy trevally	N					
<i>Caranx sexfasciatus</i>	Bigeye trevally	N					
Lutjanidae							
<i>Lutjanus argentimaculatus</i>	Mangrove jack	N					
Mugilidae							
<i>Cestraeus plicatilis</i>	Lobed river mullet	N					
<i>Mugil cephalus</i>	Flat head grey mullet	N					
Cichlidae							
<i>Oreochromis mossambicus</i>	African tilapia	I			✓		1
<i>Oreochromis niloticus</i>	Nile tilapia	I				✓	1
Eleotridae							
<i>Eleotris fusca</i>	Dusky sleeper	N					
<i>Belobranchius belobranchus</i>	Throat spine gudgeon	N	✓		✓		2
<i>Bunaka gyrinoides</i>	Greenback gauvina	N				✓	1
<i>Butis butis</i>	Duckbill sleeper	N					
<i>Eleotris melanosoma</i>	Broadhead sleeper	N					
<i>Giuris margaritacea</i>	Snakehead gudgeon	N			✓		1
<i>Giuris boedti</i>	Gudgeon	N					
<i>Hypseleotris guentheri</i>	Rainbow prigi	N					

TABLE 6 (continued)

Scientific Name	Common Name	Viti Levu ^a	2003	2004	2006	2015	Frequency ^b
Gobiidae							
<i>Awaous guamensis</i>	Goby	N	✓	✓	✓	✓	4
<i>Awaous ocellaris</i>	Goby	N					
<i>Glossogobius illimis</i>	Goby	N			✓		1
<i>Redigobius leveri</i>	Goby	E					
<i>Shismatogobius vitiensis</i>	Goby	E	✓		✓		2
<i>Sicyopterus lagocephalus</i>	Goby	N	✓	✓	✓	✓	4
<i>Sicyopus zosterophorum</i>	Ornate goby	N	✓		✓	✓	3
<i>Stenogobius</i> sp.	Goby	N					
<i>Stiphodon mele</i>	Goby	N					
<i>Stiphodon pelewenis</i>	Goby	N	✓	✓			2
<i>Stiphodon rutilaureus</i>	Goby	N	✓		✓	✓	3
Scatophagidae							
<i>Scatophagus argus</i>	Spotted scat	N					
Summary							
Richness introduced		10	0	0	1	1	2
Richness native/endemic		40	12	6	12	8	15

^a E, Endemic to Fiji; N, native to Fiji; I, introduced.
^b Indicates the number of surveys in which a species was observed.

wards the margins of these forests and highlighted the importance of protecting these critical forest buffers (the outermost 4.5 km of forest) to give better security to the remote core forest areas (Olson et al. 2006). Regular monitoring of the peripheral forests nearest to human settlements outside the Sovi Basin has also been recommended as a location to monitor the encroachment of invasive geckoes and assess their ability to invade native forest (Pene and Tuiwawa 2016).

An adjoining catchment, the Wainavadu Valley (southeast of the Sovi Basin), is currently being assessed as a potential mine waste disposal site for an opencast mine that would be located less than 5 km from the Sovi Basin Protected Area boundary. If mining does go ahead, then substantial development will occur in the adjacent Wainavadu Valley. This may lead not only to fragmentation of the lowland forest system but also to increased risk of incursions of invasive and exotic species (Laurance et al. 2009). The Wainavadu Valley, as well as the high-elevation Korobasabasaga Range behind it, was originally to have been part of the protected area. They were removed from the final lease agree-

ment to allow them to be assessed as part of the mining project, despite them being considered an integral component of the Sovi Basin Protected Area, ecologically and biogeographically. This decision may result in a severed connection between the intact lowland forests of Sovi Basin and the higher-elevation forests of the Korobasabasaga Range, a landscape connectivity that has become increasingly rare and that in itself warrants protection (Olson et al. 2009). In addition, other land use changes including conversion for agricultural purposes may also impact on the integrity of the site. Such development may also increase connectivity between human-impacted land areas, influencing the risk of introduced species incursions or inadvertent release of other species. Tropical forest systems are considered to be particularly sensitive to the impacts of roads and other linear disturbances (Dawson and Weste 1985, Goosem and Marsh 1997, Gascon et al. 1999, Walsh et al. 2004, Brown et al. 2006, Goosem and Turton 2006, Goosem 2008). This study highlights the need for concerted action in areas of such outstanding biological value and provides a baseline against which to measure

changes in the native and introduced vertebrate fauna of the Sovi Basin over time.

ACKNOWLEDGMENTS

We thank the many organizations and individuals who have supported this work, including Fiji Water, The South Pacific Regional Herbarium, Institute of Applied Sciences (University of the South Pacific), Conservation International, Birdlife International, Wildlife Conservation Society, Wetlands International, the National Trust of Fiji, Fiji Department of Forestry, NatureFiji-Mareqeti Viti, and the MacArthur Foundation for funding and/or expert personnel. The Naitasiri and Namosi Provincial councils provided permission for surveys and helped liaise with local landowning communities. The freshwater team also wishes to acknowledge Baravi Thaman and Kinikoto Mailautoka for their work during the fish surveys in 2003, 2004, and 2006. We are very grateful to the local landowning communities from Naivucini, Delailasakau, Nadakuni, Naseuvou, and Nukusere villages for their permission to survey the Sovi Basin, their vital contributions to the fieldwork, and their willingness to share their knowledge of the Sovi Basin and its biodiversity. We also thank two anonymous reviewers who helped us substantially improve this article.

Literature Cited

- Angel, A., and J. Cooper. 2006. A review of the impacts of introduced rodents on the islands of Tristan da Cunha and Gough. RSPB Research Report No. 17. Royal Society for the Protection of Birds, Sandy, United Kingdom.
- Atkinson, I. A. E. 1984. The spread of commensal species of *Rattus* to oceanic islands and their effects on island avifaunas. ICPB Tech. Publ. 3:35–81.
- Atkinson, I. A., and T. J. Atkinson. 2000. Land vertebrates as invasive species on islands served by the South Pacific Regional Environment Programme. Invasive species in the Pacific: A technical review and draft regional strategy. SPREP, Apia, Samoa.
- Bibby, C. J., N. D. Burgess, D. A. Hill, and S. Mustoe. 2000. Bird census techniques. 2nd ed. Elsevier.
- Boseto, D. 2006. Diversity, distribution and abundance of Fijian freshwater fishes. M.Sc. thesis, University of the South Pacific, Suva.
- Brown, G. P., B. L. Phillips, J. K. Webb, and R. Shine. 2006. Toad on the road: Use of roads as dispersal corridors by cane toads (*Bufo marinus*) at an invasion front in tropical Australia. *Biol. Conserv.* 133:88–94.
- Conservation International. 2016. Sustainable development for Fiji's people: Creating a conservation corridor in the Sovi Basin. Accessed 22 December 2016. www.conservation.org/projects/Pages/sustainable-development-for-fiji-people-sovi-basin.
- Copeland, L. K. F., D. T. Boseto, and A. P. Jenkins. 2016. Freshwater ichthyofauna of the Pacific-Asia biodiversity transect (PABITRA) gateway in Viti Levu, Fiji. *Pac. Conserv. Biol.* <http://dx.doi.org/10.1071/PC14928>.
- Crooks, J. A. 2002. Characterizing ecosystem-level consequences of biological invasions: The role of ecosystem engineers. *Oikos* 97:153–166.
- Dawson, P., and G. Weste. 1985. Changes in the distribution of *Phytophthora cinnamoni* in the Brisbane Ranges National Park between 1970 and 1980–81. *Aust. J. Bot.* 33:309–315.
- Forestry and Protected Area Management. 2014. Biological and socio-economical baseline report for the establishment of the Greater Delaikoro Protected Area, Vanua Levu, Fiji Islands. A rapid biodiversity assessment, socioeconomic study and archaeological survey of the Greater Delaikoro Area, June 2014, Suva, Fiji. Accessed 23 December 2016. http://www.fao.org/fileadmin/user_upload/sap/docs/FPAM-Biodiversity%20study%20Fiji.pdf.
- Gascon, C., T. E. Lovejoy, R. O. Bierregaard Jr., J. R. Malcolm, P. C. Stouffer, H. L. Vasconcelos, W. F. Laurance, B. Zim-

- merman, M. Tocher, and S. Borges. 1999. Matrix habitat and species persistence in tropical forest remnants. *Biol. Conserv.* 91:223–229.
- Goosem, M. 2008. Rethinking road ecology. Pages 445–459 in N. Stork and S. Turton, eds. *Living in a dynamic forest landscape*. Blackwell.
- Goosem, M., and H. Marsh. 1997. Fragmentation of a small mammal community by a powerline corridor through tropical rainforest. *Wildl. Res.* 24:613–629.
- Goosem, M., and S. M. Turton. 2006. Weed incursions along roads and powerlines in the Wet Tropics World Heritage Area. Rainforest Cooperative Research Centre. Accessed 22 December 2016. http://rainforest-crc.jcu.edu.au/publications/weed_incursions1.pdf.
- Gorman, M. L. 1975. The diet of feral *Herpestes auropunctatus* (Carnivora: Viverridae) in the Fijian Islands. *J. Zool.* 175:273–278.
- Government of Fiji. 2007. *Fiji Biodiversity Strategy and Action Plan*. Suva.
- ISSG. 2015. Global Invasive Species Database. Accessed December 2015. <http://www.iucngisd.org/gisd/>.
- IUCN. 2013. The terrestrial biodiversity jewel of Polynesia-Micronesia. Factsheet, 21 November. Accessed 28 March 2016. <https://www.iucn.org/content/terrestrial-biodiversity-jewel-polynesia-micronesia>.
- . 2015. The IUCN Red List of threatened species. Accessed December 2015. <http://www.iucngisd.org/gisd/>.
- Jenkins, A. P., S. D. Jupiter, I. Qauqau, and J. Atherton. 2010. The importance of ecosystem based management for conserving aquatic migratory pathways on tropical high islands: A case study from Fiji. *Aquat. Conserv.* 20:224–238.
- Keppel, G. 2005. Botanical studies within the PABITRA wet-zone transect, Viti Levu, Fiji. *Pac. Sci.* 59:165–174.
- Keppel, G., C. Morrison, J. Hardcastle, I. A. Rounds, I. K. Wilmott, F. Hurahura, and P. K. Shed. 2012. Conservation in tropical Pacific island countries: Case studies of successful programmes. *Parks* 18:111–123.
- Keppel, G., M. V. Tuiwawa, A. Naikatini, and I. A. Rounds. 2011. Microhabitat specialization of tropical rain forest canopy trees in the Sovi Basin, Viti Levu, Fiji Islands. *J. Trop. Ecol.* 27:491–501.
- Laurance, W. F., M. Goosem, and S. G. Laurance. 2009. Impacts of roads and linear clearings on tropical forests. *Trends Ecol. Evol.* 24:659–669.
- Masibalavu, V. T., and G. Dutson. 2006. Important bird areas in Fiji: Conserving Fiji's natural heritage. Birdlife International, Suva.
- Morley, C. G., and L. Winder. 2013. The effect of the small Indian mongoose (*Urva auropunctatus*), island quality and habitat on the distribution of native and endemic birds on small islands within Fiji. doi:10.1371/journal.pone.0053842.
- Morrison, C. 2003a. A field guide to the herpetofauna of Fiji. Institute of Applied Sciences, University of the South Pacific, Suva.
- , ed. 2003b. Baseline flora and fauna survey of the Sovi Basin, Naitasiri, Suva. Institute of Applied Science, University of the South Pacific, Suva.
- . 2006. Third baseline flora and fauna survey and establishment of long-term monitoring plots in the Sovi Basin, Naitasiri, 20–31 March 2006. IAS Technical Report, University of the South Pacific, Suva.
- Morrison, C., and A. Naikatini. 2008. Herpetofauna and bat monitoring at three Fiji sites in the Pacific-Asia Biodiversity Transect (PABITRA). *Micronesica* 40:131–137.
- Morrison, C., A. Naikatini, N. Thomas, I. Rounds, B. Thaman, and J. Niukula. 2004. Rediscovery of an endangered frog, *Platymantis vitianus*, on mainland Fiji: Implications for conservation and management. *Pac. Conserv. Biol.* 10:237–240.
- Morrison, C., and S. Nawadra, eds. 2009. A rapid biodiversity assessment of the Nakauvadra highlands, Ra Province, Fiji. Conservation International, Arlington, Virginia.
- Morrison, C., S. Nawadra, and M. V. Tuiwawa, eds. 2010. A rapid biodiversity assessment of the Nakorotubu range, Ra and Tailevu Provinces, Fiji. Conservation International, Arlington, Virginia.

- Mueller-Dombois, D. 2008. The evolution of the Pacific-Asia Biodiversity Transect Network (PABITRA) in the Pacific Science Association. *Micronesica* 40:1–7.
- Mueller-Dombois, D., and C. C. Daehler. 2005. The PABITRA project: Island landscapes under global change. *Pac. Sci.* 59:133–139.
- Naikatini, A. 2009. Monitoring comparative spatial and temporal variation in the land-birds of Vagi-Savura Forest Reserve, a native lowland rainforest in South East Viti Levu, Fiji. M.Sc. thesis, University of the South Pacific, Suva, Fiji.
- National Trust of Fiji. 2014. Sovi Basin Protected Area (SBPA) management plan 2013. Suva, Fiji.
- Olson, D., L. Farley, W. Naisilisili, A. Raikabula, O. M. Prasad, J. Atherton, and C. Morley. 2006. Remote forest refugia for Fijian wildlife. *Conserv. Biol.* 20:568–572.
- Olson, D., L. Farley, A. Patrick, D. Watling, M. Tuiwawa, V. Masibalavu, L. Lenoa, A. Bogiva, I. Qauqau, J. Atherton, A. Caginitoba, M. Tokota'a, S. Prasad, W. Naisilisili, A. Raikabula, K. Mailautoka, C. Morley, and T. Allnutt. 2009. Priority forests for conservation in Fiji: Landscapes, hotspots and ecological processes. *Oryx* 44:57–70.
- Palmeirim, J. M., A. Champion, A. Naikatini, J. Niukula, M. Tuiwawa, M. Fisher, M. Yabaki-Gounder, S. Thorsteinsdottir, S. Qalovaki, and T. Dunn. 2007. Distribution, status and conservation of the bats of the Fiji Islands. *Oryx* 41:509–519.
- Pene, S., and M. Tuiwawa, eds. 2016. 2015 Reassessment of the biodiversity and archaeology of the Sovi Basin Protected Area. IAS Technical Report, University of the South Pacific, Suva, Fiji.
- Pernetta, J. C., and D. Watling. 1978. The introduced and native terrestrial vertebrates of Fiji. *Pac. Sci.* 32:223–244.
- Russell, D. J., P. A. Thuesen, and F. E. Thomson. 2012. A review of the biology, ecology, distribution and control of Mozambique tilapia, *Oreochromis mossambicus* (Peters 1852) (Pisces: Cichlidae), with particular emphasis on invasive Australian populations. *Rev. Fish Biol. Fish.* 22:533–554.
- Scanlon, A., S. Petit, and G. Bottroff. 2014. The conservation status of bats in Fiji. *Oryx* 48:451–459.
- Simberloff, D., and M. Rejmanek. 2011. The encyclopedia of biological invasions. University of California Press.
- Thomas, N., C. Morrison, L. Winder, and C. Morley. 2011. Spatial distributions and habitat preferences of co-occurring vertebrate species: Case study of an endangered frog and an introduced toad in Fiji. *Pac. Conserv. Biol.* 17:68–77.
- Tuiwawa, M. V. 1999. The flora, ecology and conservation of the botanical biodiversity of Waisoi and the southeastern slopes of the Korobasabasaga Range in Namosi Province, Fiji. University of the South Pacific, Suva.
- Veitch, C. R., C. Gaskin, K. Baird, and S. M. H. Ismar. 2011. Changes in bird numbers on Raoul Island, Kermadec Islands, New Zealand, following the eradication of goats, rats and cats. Pages 372–376 in C. R. Veitch, M. N. Clout, and D. R. Towns, eds. *Island invasives: Eradication and management*. Proceedings of the International Conference on Island Invasives, Gland, Switzerland. IUCN, Gland, Switzerland, and The Centre for Biodiversity and Biosecurity (CBB), Auckland, New Zealand.
- Veron, G., M. L. Patou, G. Pothet, D. Simberloff, and A. P. Jennings. 2007. Systematic status and biogeography of the Javan and small Indian mongooses (Herpestidae, Carnivora). *Zool. Scr.* 36:1–10.
- Walsh, P. D., P. Henschel, K. A. Abernethy, C. E. G. Tutin, P. Telfer, and S. A. Lahm. 2004. Logging speeds little red fire ant invasion of Africa. *Biotropica* 36:637–641.
- Watling, D. 2001. A guide to the birds of Fiji and western Polynesia. Environmental Consultants (Fiji) Ltd., Suva.
- . 2013. Fiji: State of birds 2013. NatureFiji-MareqetiViti, Suva.
- Zug, G. 1991. Lizards of Fiji: Natural history and systematics. Bishop Museum Press, Honolulu.