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Forest Conservation in Fiji: Herpetological Provinces for Assessing Representation in Fiji's Forest Reserve Network.

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Summary

1. There are currently 24 confirmed species of native or endemic herpetofauna in Fiji. There are a further 6 species that are human-mediated colonizers.
2. With the exception of the iguanas (restricted to dry forest habitats), the frogs and one of the skink species, *Emoia campbelli*, (restricted to wet forest habitats), the herpetofauna of Fiji is widespread in terms of both geography and habitat type.
3. There are 2 locally endemic species – *Leiolopisma alazon* (Ono-i-Lau in the southern Lau group) and *Lepidodactylus gardineri* (Rotuma). *Ogmodon vitianus* also has a limited distribution being restricted to Viti Levu.
4. Due to small number of species and fairly ubiquitous nature of most of the species, there are no real distinct species assemblages or communities in Fiji.
5. Highest current species richness based on data available to date occurs in Taveuni, Ovalau, Gau, Kadavu, and Yadua Taba.
6. Important to note that the areas with the highest species richness and abundance are those without mongoose.
7. In order to conserve highest herpetofauna species diversity would need to establish or maintain reserves on Yadua Taba, Taveuni (particularly the northern and eastern sides of the island), Ono-i-Lau, Ovalau, Gau, Rotuma, and the Monasavu area of Viti Levu.
8. Important to note that there are gaps in the geographic distributions of the species resulting from incomplete surveys of several areas of the country. Further targeted surveys are needed.
9. Need to resurvey the Lau Group with particular emphasis on *L. alazon* (determine whether endemic to Ono-i-Lau).

Introduction

The known terrestrial herpetofauna of Fiji consists of 30 species: 3 frogs, 2 iguanas, 3 snakes, 10 geckos and 12 skinks. Forty percent (12/30) of these species are endemic to Fiji while a further 40% are considered native species. The remaining six species (20%) are human-mediated colonizers.

To date, work on the distribution and abundance of Fiji's herpetofauna has been fairly limited in scope. The work done by George Zug, Dick Watling, Paddy Ryan, Stanley Gorham and a few other researchers, has provided some valuable information on the species however, there remain many large gaps in both our knowledge and areas of the country that remain to be surveyed. Consequently, it is important to note that while the recommendations made in this study are based on previous studies and additional field surveys, there remain areas in the country that still need to be surveyed which were beyond the scope of this project.

Brief methodology

Data for this project was collected in three ways: (1) from an analysis of published and unpulished literature, (2) consultations with other researchers familiar with the field, and (3) from targeted field surveys. The literature surveyed has been included in the Appendices.

Results

Geographic gaps in knowledge

There are many areas within Fiji that have not been adequately surveyed for reptiles and amphibians (Map 1). On Viti Levu, the most obvious of these areas are: Nakauvadra, Nakorotubu, Wainibuka, Serua, Malomalo and the Koronayitu Range. The largest unsurveyed areas of Vanua Levu are Dreketi, Udu Point, Natewa Peninsula, Waisali, Seatura Range, Saqani and Vaturora. Surveys of most of these areas are unlikely to produce many species as they have been heavily disturbed through forest clearing. Areas worth surveying in the future are Natewa Peninsula, Waisali and Seatura Range on Vanua Levu and Koronayitu Range, Nakorotubu and Wainibuka areas on Viti Levu. Whilst many of the islands in the Lau Group have been surveyed, these previous surveys have not been thorough or systematic in many cases.

Geographic distribution and habitat type for known terrestrial fauna

Most of the species have broad geographic distributions and are found on several islands throughout Fiji (Table 1). There are however, several exceptions including two species that have a very restricted distribution and are considered local endemics (*L. gardineri* and *L. alazon* – discussed in more detail later). Six other species also have a fairly restricted recorded distribution: *Ogmodon vitianus* is only found in the interior of Viti Levu, *E. caeruleocauda* has only been recorded from two sites on Viti Levu and one on Taveuni, *E. mokosariniveikau* has only been confirmed from one location on Vanua Levu (possible recent sightings on Viti Levu are discussed later), whilst *E. nigra* and *P. vitianus* have been extirpated from much of their original range essentially limiting them to mongoose-free islands.

Many of the herpetofauna species are also found in more than one major habitat type (Table 1). The most common are *G. oceanica* (6 habitats), *E. concolor* (5) and *N. pelagicus*, *E. cyanura*, *E. impar* and *E. trossula* (4 each). Five species are restricted to a particular habitat: *E. mokosariniveikau* and *G. vorax* in lowland rainforest, *B. vitiensis* in dry forest and *L. alazon* in small island vegetation. The rest of the species occur in 2-3 different habitats throughout the country.

Species within each major habitat type

Lowland rainforest, dry forest and highland rainforest are the three most important habitat types in terms of herpetofauna species richness and endemicity (Table 2). Lowland rainforest supports 18 species, three of which are endemic to the habitat including one local endemic species (*L. gardineri*) in Rotuma. Dry forest supports nine species, including one endemic (the endangered *B. vitiensis*), which can almost be referred to as a local endemic (Yadua Taba is the stronghold). Highland rainforest supports five species, one of which is endemic to the habitat, *E. campbelli*. Coastal stand vegetation, agricultural areas and small island vegetation each support 10 species but there are no species endemic to these habitats and all species found in these areas are also common in other habitats. The majority of the species occurring in the urban areas are human-mediated colonizers rarely found in other habitats.

As dry forest is the most endangered vegetation habitat type in Fiji, its role in supporting reptile species becomes more important and/or crucial. The dry forest on Yadua Taba not only supports the largest population of Fijian Crested Iguanas but is also an important habitat for *E. trossula* and other species occurring in dry forest that are severely affected by mongoose predation.

Species assemblages

As previously mentioned, there are very few species restricted to a single habitat type or single location (see Table 3 for summary). Consequently, there are no clearly defined species assemblages for the different habitat types.

The only split in habitat type that can be loosely made using reptile and amphibian species in Fiji is that between wet and dry forests. Both general habitat types have a number of species (9 in total) in common however, the two iguana species are restricted to dry forest whilst the two frog species and *Emoia campbelli* are restricted to wet forest habitats. It is important to note however, that these are not always reliable indicators as not all dry forests have iguanas and not all wet forests have frogs and/or *E. campbelli*.

Local endemics

There are two locally endemic reptile species in Fiji. They are the Rotuman gecko (*Lepidodactylus gardineri*, Map 2) and the Lauan skink (*Leiolopisma alazon*, Map 3) restricted to Rotuma and Ono-i-Lau in the southern Lau group respectively. The relatively isolated location of Rotuma would suggest that *L. gardineri* is unlikely to be found elsewhere and is almost definitely a true local endemic. There have been very few surveys in the Lau Group for herpetofauna and those that have been conducted are far from systematic or thorough. As there are several islands in relatively close proximity to Ono-i-Lau we cannot rule out the possibility that *L. alazon* occurs on other islands in the region. Consequently, a thorough survey of the Lau Group (especially the southern islands in the group) should be conducted to confirm the distribution of this species (and others) in the region.

Ogmodon vitianus is the only member of the endemic Ogmodon genus. It is closely related to the Vermicella group (group restricted to 2 endemic genera in the Solomons, one in Fiji and one in Australia) and is considered a primitive elapid. Due to its fossorial nature records of its distribution are few. To date it is considered restricted to the Navua and Rewa watersheds of southeast Viti Levu (Map 4). It appears to be a montane valley species that prefers moist deep soil of forests or recently forested areas.

There are skink specimens from two areas (Namosi on Viti Levu and Dogotuki on Vanua Levu) whose identities are yet to be confirmed. It is thought that the Namosi specimens are geographic variants of *E. mokosariniveikau*. The Dogotuki lizards may be representatives of *Emoia samoensis*. Until these identifications are completed, I will not discuss these specimens further.

Discussion

Geographic gaps in knowledge

There are several areas in the country that remain to be surveyed (or thoroughly surveyed) for herpetofauna. Although there are several large geographical gaps in knowledge, most of these areas are unlikely to produce many species due to their heavily disturbed nature. Areas worth surveying in the future are Natewa Peninsula, Waisali and Seatura Range on Vanua Levu and Koronayitu Range, Nakorotubu and Wainibuka areas on Viti Levu. Most of the Lau Group should also be resurveyed.

Areas with highest species richness and/or diversity

The forest types that support the highest herpetofauna species richness and diversity are lowland rainforest, highland rainforest and dry forest. Consequently, these habitats are the most important to the preservation of herpetofauna in Fiji. Lowland rainforest is found throughout the Fiji islands however, the lowland rainforest areas with the greatest herpetofauna species richness and diversity are found mainly in Taveuni, Gau, Ovalau and the southeastern corner of Viti Levu. The highland rainforest has a more restricted distribution than lowland rainforest with the best sites for herpetofauna conservation being Monasavu, Taveuni and Gau. Dry forest is by far the most restricted of the three important habitats and as such, all dry forest areas should be conserved including those on Yadua Taba, Vatia Peninsula (Viti Levu) and Waitabu (Vanua Levu).

Role of mongoose

Many of the species of reptiles and amphibians in Fiji are now missing from much of their original ranges. These local extinctions have been attributed to several factors including habitat destruction, modification and pollution and the introduction of predators. Habitat destruction aside, predation by mongoose is the most devastating factor affecting species abundance and distribution. Mongoose are believed responsible for the exirpation of many of the terrestrial herpetofauna species on the mainland islands of Viti Levu and Vanua Levu. This is particularly apparent in the case of the Ground frog (*Platymantis vitianus*) and several of the larger skink species e.g. *Emoia nigra* and *E. trossula*. The arboreal and semi-arboreal species appear less affected but have still demonstrated severe declines in abundance and have become locally extinct in some areas of Viti Levu/Vanua Levu. The removal of mongoose from areas of the mainland is not technically feasible highlighting the importance of the "mongoose-free islands" as reserves for amphibian and reptile species (e.g. Taveuni, Gau, Viwa, Yadua Taba etc.). Every effort should also be made to prevent the introduction of mongoose to these islands.

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Paddy Ryan – Pacific Island Books, New Zealand

George Zug – Smithsonian Institute, Washington

Alifereti Naikatini – South Pacific Regional Herbarium, USP, Fiji

Targeted Field Surveys from March-September 2003

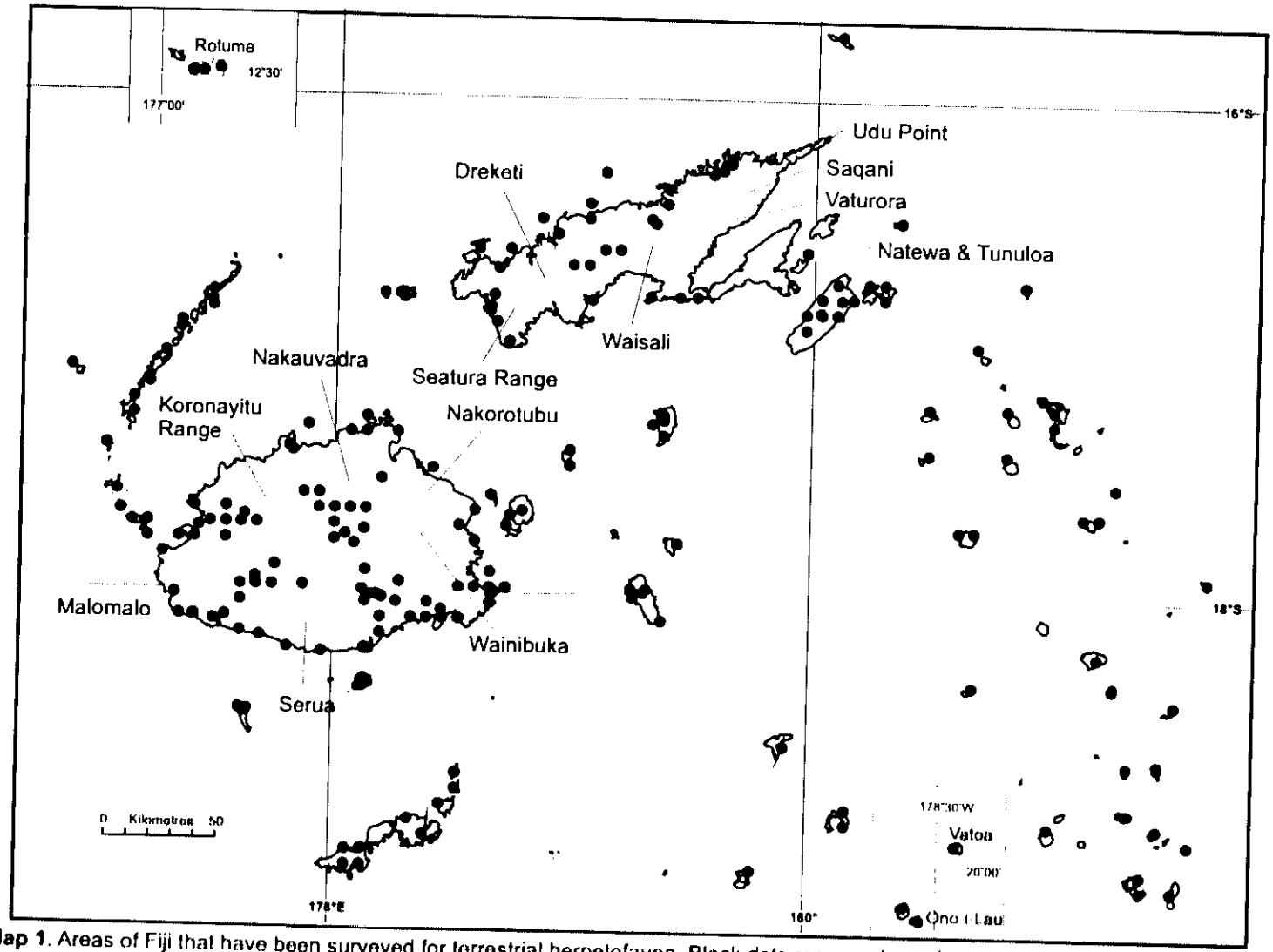
Taveuni - Bouma, Lavena, Waitavala

Vanua Levu – Dogotuki, Mali Island, Nabouwalu, Waitabu, Macuata

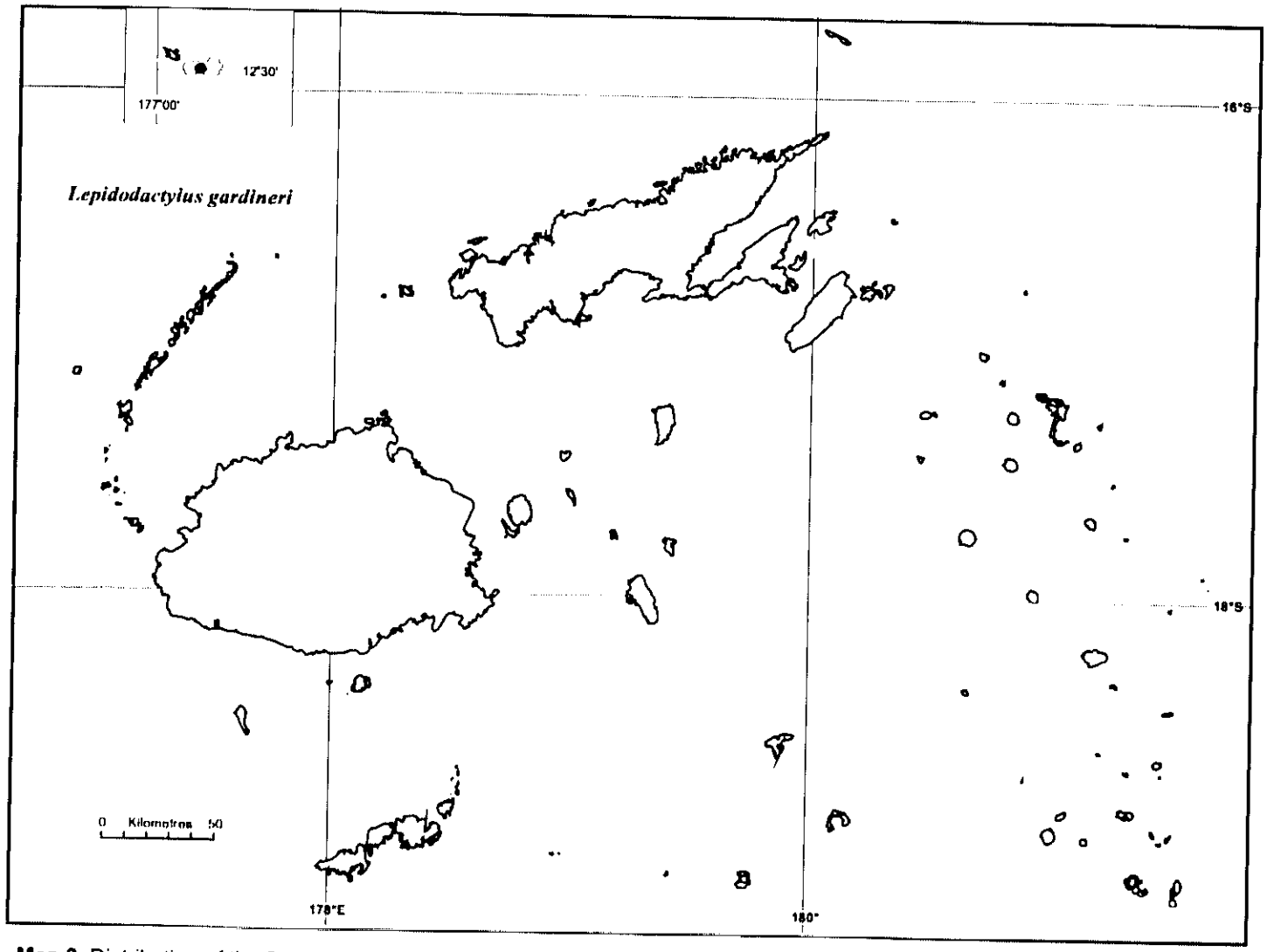
Viti Levu - Vatia Peninsula, Sovi Basin, Sigatoka River, Abaca, Savura, Colo-i-Suva, Deuba, Sovi Basin, Tavua, Navai, Mt Korobaba

Viwa Island

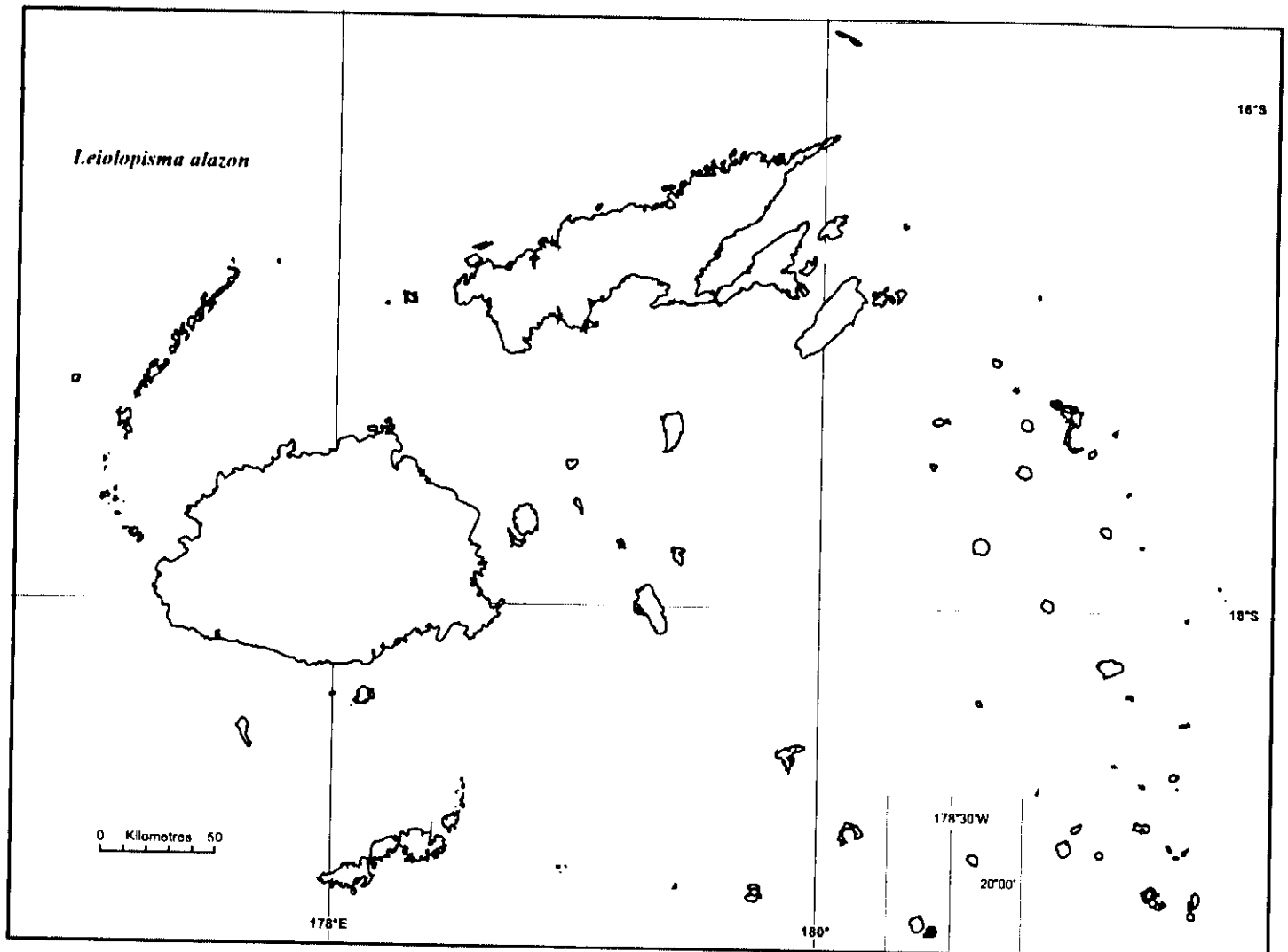
Several other opportunistic surveys on Viti Levu and Vanua Levu



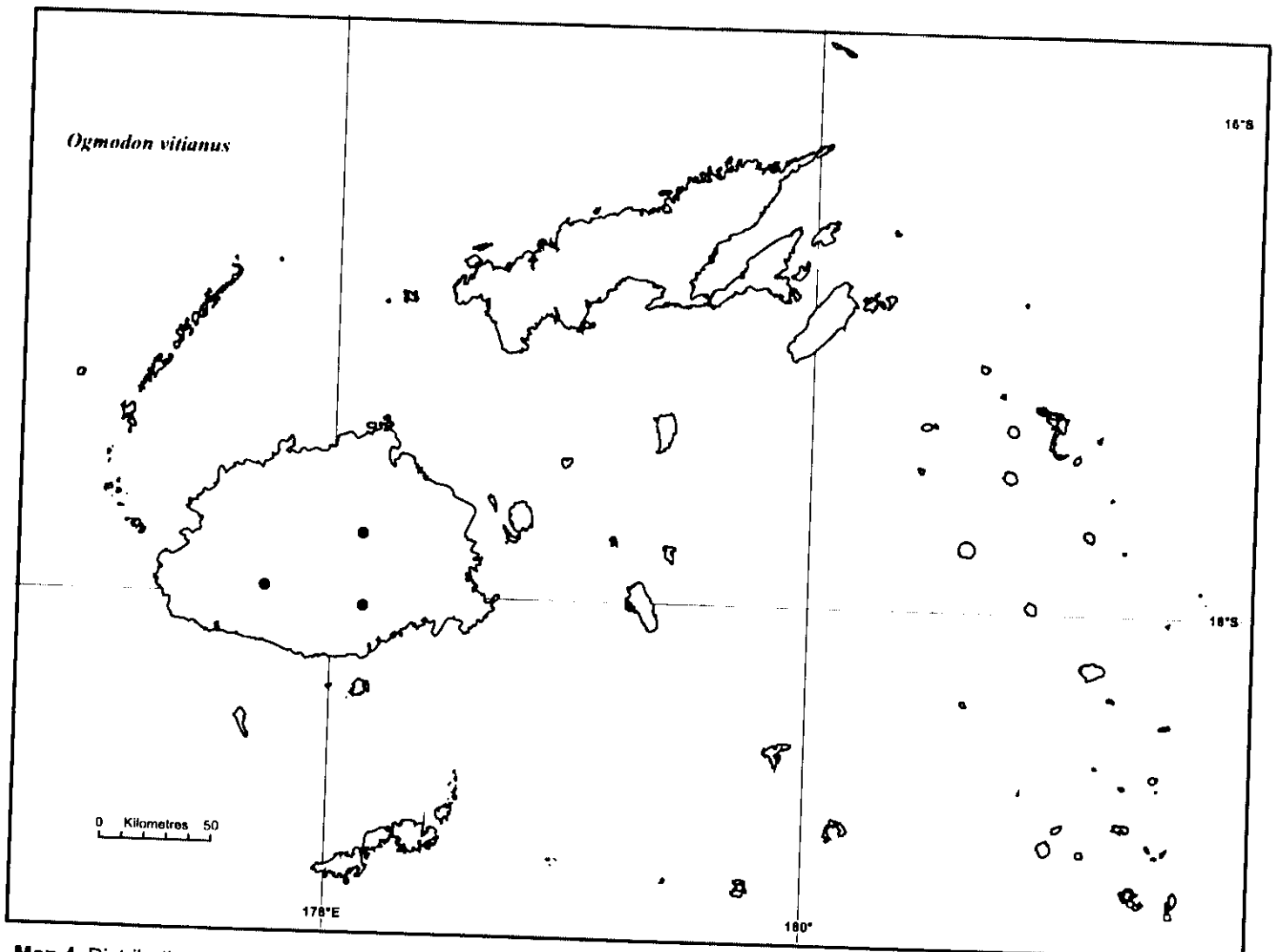
Map 1. Areas of Fiji that have been surveyed for terrestrial herpetofauna. Black dots represent species records. Multiple dots in one area represent different species.



Map 2. Distribution of the Rotuman Forest Gecko, *Lepidodactylus gardineri*, in Fiji



Map 3 Distribution of the Lauan Ground Skink, *Leiolopisma alazon*, in Fiji



Map 4. Distribution of the Fiji Burrowing Snake, *Ogmodon vitianus*, in Fiji.

Table 1 Detailed geographic distribution and habitat type for known herpetofauna in Fiji. Species marked with an asterix (*) are endemic to Fiji.

Species	Geographic Dist.[1]	Habitat Type[2]	Distribution[3]
*Platymantis vitianus**	VL[a], VAL[a], TA, OV, KO, GA, KA, VI	LRF, CSV, AGR	WIDE
*P. vitiensis**	VL, VAL, TA, OV	LRF, HRF, AGR	WIDE
Candoia bibroni	VL, TA, OV, KA, VI	DF, LRF, CSV	WIDE
*Ogmodon vitianus**	VL	LRF, AGR	REST. (Geog.)
Brachylophus fasciatus	VL, VAL, OV, KO, MM, NLA, SLA	CSV, DF, SIV	WIDE
*B. vitiensis**	YAT, YAS	DF	REST (Geog.)
Gehyra mutilata	VL, OV, ROT	URB, AGR	WIDE
G. oceanica	Found throughout	CSV, MAN, LRF, DF, SIV, URB	WIDE
G. vorax	VL, VAL, TA, OV, GA, KO	LRF	WIDE
Hemidactylus frenatus	VL, VAL, OV, MM	URB	WIDE
H. garnotti	VL, TA	URB, AGR	WIDE
Hemiphyllodactylus typus	VL, VAL	URB, AGR, LRF	WIDE
Lepidodactylus manni *	VL, OVA, KA	LRF, HRF, DF	WIDE
L. lugubris	Found throughout	URB, AGR, CSV, SIV, LRF	WIDE
*L gardineri**	ROT	LRF, CSV	WIDE
Nactus pelagicus	VL, VAL, KA, TA, OV, KO, MO, NLA, SLA	CSV, AGR, SIV, LRF	WIDE
*Cryptoblepharus eximius**	VL, VAL, KO, OV, YAT, TA, MO, KA, NLA, SLA	CSV, SIV	WIDE
*Leiolopisma alazon**	Ono I Lau	SIV	END
Lipinia noctua	Found throughout	CSV, LRF, SIV	WIDE
Emoia cyanura	Found throughout	LRF, CSV, AGR, SIV	WIDE
E. impar	Found throughout	LRF, CSV, AGR, SIV	WIDE
E. caeruleocauda	VL, TA	AGR, DF, LRF	WIDE
*E. campbelli**	VL	HRF	END? (Monasavu)
*E. concolor**	VL, VAL, YAS, NLA, SLA, MO, OV, KO, KA, GA, YAT, ROT	LRF, HRF, AGR, SIV, DF	WIDE
*E. parkeri**	VL, OV, KA, TA	LRF, DF	WIDE
E. nigra	VL[a], VAL[a], TA, OV, KO, ROT	AGR, LRF, SIV	WIDE[b]
E. trossula	VL, VAL, KA, YAT, TA, OV, GA, MO, YAS, NLA, SLA	AGR, LRF, SIV, DF	WIDE
*E. mokosarineveikau**	VAL, VL[c]	LRF	REST (Geog.)

[1] VL Viti Levu, VAL Vanua Levu, TA Taveuni, KA Kadavu, OV Ovalau, KO Koro, GA Gau, YAS Yasawas, YAT Yadua Taba, MO Moala Group, MM Mamanuca Group, NLA Northern Lau Group, SLA Southern Lau Group, VI Viwa, ROT Rotuma.

[2] LRF Lowland Rainforest, HRF Highland Rainforest, CF Cloud Forest, DF Dry Forest, MAN Mangrove, CSV Coastal Stand Vegetation, SIV Small Island Vegetation, URB Urban (buildings, man-made structures), AGR Agriculture including gardens.

[3] WIDE Wide distribution based on geography and habitat type, REST Restricted to particular habitat type OR geographic location, END Endemic to a particular habitat type AND geographic location

[a] Now believed to be extinct on these islands

[b] May soon be restricted due to heavy predation pressure

[c] Recent discovery awaiting confirmation of identity

Table 2 Species within each major habitat type. Endemic species are those that are restricted to a particular habitat type whilst regional endemics are restricted to a particular habitat in a specific geographic location.

Habitat type	Species present	Endemic species	Regional endemics[1]
Lowland rainforest	*P. vitianus, P. vitiensis, C. bibroni, O. vitianus, G. oceanica, G. vorax, L. gardineri, L. lugubris, L. manni, E.concolor, Hemi. typus, E. nigra, E. trossula, E. cyanura, E. impar, E. parkeri, E. mokosarineveikau, N. pelagicus*	*L. gardineri* *E. mokosarineveikau* *G. vorax*	*L. gardineri (ROT)*
Highland rainforest	*P. vitianus, P. vitiensis, L. manni, E. concolor, E. campbelli*	*E. campbelli*	*E. campbelli (MON) – Joske's?*
Cloud forest	*P. vitiensis*		
Dry forest	*B. fasciatus, B. vitiensis, C. bibroni, G. oceanica, E. parkeri, E. caeruleocauda, E. concolor, E. cyanura, E. trossula, L. manni, Hemiphyllodactylus typus*	*B. vitiensis*	*B. vitiensis (YAT, YAS)*
Mangroves	*G. oceanica*		
Coastal Stand	*P. vitianus, B. fasciatus, C. bibroni, G. oceanica, L. gardineri, L. lugubris, C. eximius, E. cyanura, E. impar, Lipinia noctua*		
Urban	*G. mutilata, G. oceanica, L. lugubris, H. frenatus, H. garnotti, Hemi. typus*	*H. frenatus*	
Agricultural	*G. oceanica, L. lugubris, H. garnotti, E. concolor, Hemi. typus, E. caeruleocauda, E. impar, E. cyanura, E. trossula, E. nigra*		
Small island vegetation	*B. fasciatus, G. oceanica, L. lugubris, N. pelagicus, Leiolopisma alazon, Lipinia noctua, E. eximius, E. concolor, E. cyanura, E. impar*		

[1] ROT Rotuma, MON Monasavu (Central Viti Levu), YAT Yadua Taba, YAS Yasawas

Table 3 Summary of species habitat and geographic distribution

Species	Habitat Type	Wet/dry/both	High/low/both	Inland/coastal/ both
*Platymantis vitianus**	LRF, CSV, AGR	W	B	B
*P. vitiensis**	LRF, HRF, AGR	W	B	I
Candoia bibroni	DF, LRF, CSV	B	B	B
*Ogmodon vitianus**	LRF, AGR	B	L	I
Brachylophus fasciatus	CSV, DF, SIV	D	B	B
*B. vitiensis**	CSV, DF	D	L	C
Gehyra mutilata	URB, AGR	B	L	C
G. oceanica	CSV, MAN, LRF, DF, SIV, URB	B	B	B
G. vorax	LRF	B	L	B
Hemiphyllodactylus typus	URB, AGR, LRF	B	L	B
Lepidodactylus manni *	LRF, HRF, DF	B	B	I
*L gardineri**	LRF, CSV	B?	L	C
Nactus pelagicus	CSV, AGR, SIV, LRF	B	B	B
*Cryptoblepharus eximius**	CSV, SIV	B	L	B
*Leiolopisma alazon**	SIV	B	L	C
Lipinia noctua	CSV, LRF, SIV	B	B	B
Emoia cyanura	LRF, CSV, AGR, SIV	B	L	B
E. impar	LRF, CSV, AGR, SIV	B	L	B
E. caeruleocauda	AGR, DF, LRF	B	B	I
*E. campbelli**	HRF	W	H	I
*E. concolor**	DF, LRF, HRF, AGR, SIV	B	L	B
*E. parkeri**	LRF, DF	B	B	I
E. nigra	AGR, LRF, SIV	B	B	B
E. trossula	DF, AGR, LRF, SIV	B	L	B
*E. mokosarineveikau**	LRF	B	L	I
Totals		**3W/2D/20B**	**11L/1H/13B**	**7I/4C/14B**

LRF Lowland Rainforest, HRF Highland Rainforest, CF Cloud Forest, DF Dry Forest, MAN Mangrove, CSV Coastal Stand Vegetation, SIV Small Island Vegetation, URB Urban (buildings, man-made structures), AGR Agriculture including gardens

All B's = 7
2 B's = 10
1 B = 5
No B's = 2 – *B. vitiensis* D, L, C + *E. campbelli* W, H, I