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Herpetofauna and bat monitoring at three Fiji sites in the Pacific-Asia Biodiversity Transect (PABITRA)

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Abstract— Herpetofauna and bats are two important indicator taxa in Fiji's forests. Herpetofauna (especially frogs) are good indicators of riparian forest health and the presence of introduced predator species while bats are excellent indicators of the forest tree diversity and general forest disturbance. Despite these important roles, prior to 2006 the monitoring of these two taxonomic groups had remained largely qualitative in Fiji PABITRA sites. The reasons for this were primarily due to very low abundances, making quantitative surveys largely cost and time-ineffective (reptiles) and the low survey effort (bats), resulting in incomplete baseline information. In total two frog species, eight reptiles and three bats have been found in three Fiji PABITRA sites on Viti Levu (Savura Reserve, Sovi Basin and Wabu Reserve). Sufficient information has now been collected to determine the optimal methods to begin quantitatively monitoring populations of these taxonomic groups in future surveys.

Introduction

The Pacific-Asia Biodiversity Transect (PABITRA) program was developed to set up a network of ocean-to-mountain transects on a number of islands across the Pacific Ocean and test hypotheses about biodiversity, socio-economic changes, sustainable land use and global change (Mueller-Dombois & Daehler 2005). Long-term monitoring of terrestrial taxa on these transects is seen as a key activity to identifying and monitoring long-term changes in biodiversity, ecosystem disturbance and landscape use. In order for the data to be credible and comparable in sites both within and between Pacific countries, appropriate survey protocols for each taxonomic group need to be developed and utilized.

Herpetofauna (especially frogs) are good indicators of riparian forest health and the presence of introduced predator species (e.g. mongoose) while bats are excellent indicators of the forest tree diversity and general forest disturbance (Weygoldt 1989, Donnelly & Geyer 1994, Gillespie 2001, Hodgkison et al. 2004, Mildenstein et al. 2005, Bianconi et al. 2006, Cushman 2006).

The known terrestrial herpetofauna of Fiji consists of 30 species: three frogs, two iguanas, three snakes, 10 geckos and 12 skinks (Morrison 2005). Forty percent (12 out of 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 (Morrison 2003). Roughly 75% are recorded from rainforest habitats

There are six species of bat currently recognized from Fiji including one endemic monotypic genus, *Mirimiri acrodonata* (Fiji fruit bat, Helgen 2005), two species of flying fox (*Pteropus* spp.), two insectivourous bats (*Emballonura semicaudata*, *Chaerephon bregullae*) and a blossom bat (*Notopteris macdonaldii*) (Ryan 2000). With the exception of *M. acrodonta*, these bat species are all native to Fiji and all are recorded from rainforest habitats.

Due to the globally diverse ecological nature of species in both groups, a wide variety of standard techniques has been developed to quantitatively survey or monitor populations of herpetofauna and bats (Thomas & West 1989, Heyer et al. 1994, Rodda et al. 2001, Flacquer et al. 2007), with the techniques used being dependent on the species and the habitat being studied. Although herpetofauna and bats are known to be important indicators of forest health (Weygoldt 1989, Donnelly & Geyer 1994, Hodgkison et al. 2004, Mildenstein et al. 2005, Cushman 2006), little quantitative work has been conducted on population sizes and temporal fluctuations in abundance for either group in Fiji.

The primary aim of this work was to conduct baseline surveys of herpetofauna and bats in three Fiji PABITRA rainforest sites with a view to developing long-term monitoring protocols for the two groups. More specifically, we wanted to (i) produce a checklist of the herpetofauna and bats species in the PABITRA sites, and (ii) determine the best survey methods for quantitatively monitoring populations over time, allowing abundance data to be compared to other sites both within Fiji and throughout the Pacific.

Materials and Methods

SITES SAMPLING

Surveys for herpetofauna and bats were carried out in three rainforest PABITRA sites – Savura Forest Reserve, Sovi Basin and Wabu Forest Reserve (Fig. 1). The Savura Forest Reserve is a small, lowland rainforest reserve (396 ha, 250-800 m.a.s.l) in the southwest of Viti Levu approximately 10 km from Suva. The Sovi Basin is a 19,600 ha reserve area (250-1200 m.a.s.l) in the south central region of Viti Levu. The primary vegetation type in the Sovi Basin is lowland rainforest along with ridgetop vegetation (>600 m). The Wabu Forest Reserve (500-1300 m.a.s.l) is a 1102 ha forest reserve in the north central region of Viti Levu. The vegetation in the Wabu Reserve is mainly upland rainforest and cloud forest.

Savura Forest Reserve was surveyed in February 2003 and on a monthly basis throughout 2005, the Sovi Basin was surveyed in May 2003 (2 weeks), October 2004 (10 days) and March 2006 (2 weeks). The Wabu Forest Reserve was surveyed in November 2003 (8 days) and January 2006 (2 weeks).

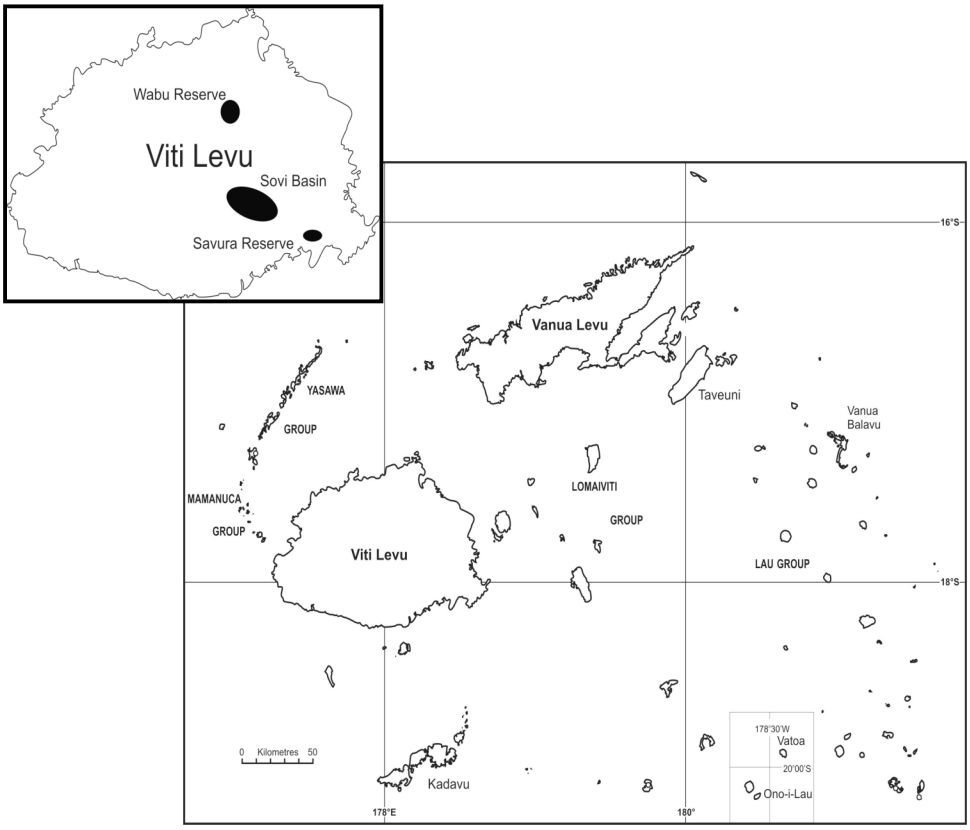

Figure 1. Location of Savura Forest Reserve, Sovi Basin and Wabu Forest Reserve on Viti Levu, Fiji.

SURVEY METHODS

Frogs

Standard nocturnal visual encounter surveys (VES, Heyer et al. 1994) using head torches were usually conducted between 2000-2200 hrs each survey night. Visual searching (in and on plants, between rocks along the stream, on the forest floor) and acoustic surveys were conducted either (i) along a 500 m section of stream with a 5 m buffer on either side or (ii) over a fixed period of time (2 hours) in terrestrial sites away from waterways. We also actively searched for geckos during this time.

Reptiles

Diurnal VES were usually carried out between 0900-1200 hrs on sunny days (skinks are active during this time). This primarily involved active searches conducted in forested habitats for lizards and/or reptile eggs in exposed sunny

areas, in tree hollows, under bark and in rotten wood, on the forest floor, and on trees and shrubs.

Bats

Bats were surveyed using a combination of timed dusk and dawn counts from lookout points, counts at tree roost sites and mist-netting (Savura Reserve and Wabu Reserve only). These surveys were primarily qualitative and used mainly to identify the different bat species at each site. We also searched for caves, as these are often roost sites for Fiji's insectivorous bats (Ryan 2000).

Results

Ten species of herpetofauna were found in the three PABITRA sites including; five species of skinks, two geckos, one snake and two frogs (Table 1). Three of these species are endemic to Fiji, one (the cane toad, *Chaunus marinus* [formerly *Bufo marinus*]), is introduced, and the rest are native. With the exception of the Fiji Tree Frog (*Platymantis vitiensis*), herpetofauna species were found in low abundances in all three sites (Table 1).

Table 1. Checklist of herpetofauna found in three Fiji PABITRA sites.

Species Name	Common Name	Status[1]	Savura[2]	Sovi[2]	Wabu[2]
Platymantis vitiensis	Fiji Tree Frog	E	+++	+++	++
Emoia concolor	Fiji Green Tree Skink	E	+	+	+
E. parkeri	Fiji Copper-headed Skink	E	0	+	0
E. cyanura	Brown-tailed Skink	N	+	+	0
E. impar	Blue-tailed Skink	N	0	0	+
E. trossula	Barred Tree Skink	N	0	0	+
Gehyra oceanica	Oceanic Gecko	N	++	+	0
Lepidodactylus lugubris	Mourning Gecko	N	+	0	0
Nactus pelagicus	Skink-toed Gecko	N	+	+	+
Candoia bibroni	Pacific Boa	N	+	+	0
Chaunus marinus	Cane Toad	I	++	++	+

[1]E = Endemic, N = Native, I = Introduced.
[2]0 = no individuals found, + < 10 individuals/site, ++ 10-30 individuals/site, +++ > 30 individuals/site.

Three species of bat were found in the three PABITRA sites (Table 2). All are native to Fiji. The two fruit bats (*Pteropus* spp.) were common in all three sites while the Fiji Blossom bat was relatively rare in the Savura Reserve and Wabu Reserve and not recorded from the Sovi Basin.

Table 2. Bat species found in three Fiji PABITRA sites.

Species Name	Common Name	Status[1]	Savura[2]	Sovi[2]	Wabu[2]
Notopteris macdonaldii	Fiji Blossom Bat	N	++	0	+
Pteropus samoensis	Samoan Fruit Bat	N	+++	+++	+++
P. tonganus	Pacific Fruit Bat	N	+++	+++	+++

[1]N = Native.
[2]0 = no individuals found, + < 10 individuals/site, ++ 10-30 individuals/site, +++ > 30 individuals/site.

Discussion

Problems with Herpetofauna Surveys in PABITRA Sites

The general low abundance of herpetofauna species (particularly terrestrial species) in these three PABITRA sites makes the use of most standard herpetofauna survey techniques inefficient. Pitfall trapping is a commonly used technique for terrestrial herpetofauna species but is a time-consuming and labor-intensive activity (Doan 2003, Garden et al. 2007). The low terrestrial species abundance makes pitfall trapping an impractical technique for surveys in PABITRA sites, particularly in the Sovi Basin and Wabu Reserve where sites are several hours walk into the forest. The low abundance of species also makes active VES of diurnal lizard species largely ineffective for quantitative studies.

Methods to be used for Future PABITRA Herpetofauna Surveys

Tree frogs were generally the most abundant herpetofauna species found during surveys and were more common along stream transects than in terrestrial plots. Consequently, we recommend that frogs be surveyed using nocturnal VES and auditory surveys along 3-5 permanent 500 m transects in each site, with the frequency of surveys over time depending on frequency of the other PABITRA surveys.

As pitfall traps are generally inefficient for terrestrial reptiles in the PABITRA sites, we recommend the combination of timed active searches in fixed area plots (50 x 50 m) and sticky board traps (10 traps per 50 x 50 m plot) to monitor the abundance of reptile populations. Sticky board traps can also be used to monitor nocturnal geckos. We will not be able to quantitatively monitor snake populations (*Candoia bibroni*) in the plots due to their very low abundance.

Problems with PABITRA Bat Surveys

Pteropus samoensis bats roost in pairs or singly in trees in the forest. As they do not tend to feed in large groups, flyover counts from a fixed lookout and diurnal colony roost counts are not feasible survey methods. The most practical method for this species is to conduct dawn roost counts in conjunction with bird counts. PABITRA bird surveys usually involve timed point counts from 20-30

random points at each site. We will census all *P. samoensis* found roosting within the range of the random points and compare the abundance of the bats between sites and survey times. Survey effort will be standardized between sites and times.

Pteropus tonganus are much more gregarious than *P. samoensis* and roost together in communal tree roosts. As such, the best methods for surveying *P. tonganus* are counts of individuals at roost sites during the day and dusk and dawn flight counts from fixed lookouts. By visiting the same roost sites and fixed lookouts during each survey, we are able to monitor changes in population sizes over time.

Notopteris macdonaldii are unusual fruit bats in that they roost in colonies in caves (Ryan 2000). To date, most of the work on *N. macdonaldii* has focused on finding cave roost sites. Caves have been found in the Savura and Wabu Reserves allowing us to monitor populations by harp trapping or mist-netting individuals as they leave cave roosts.

Implications of Results for Future PABITRA Long-Term Monitoring

Using the survey protocols presented here for herpetofauna and bat monitoring, we will be able to collect quantitative and credible data that can be used to monitor changes in populations of these groups. By using a standard protocol in all of the sites, we will be able to compare population trends in different sites and in different Pacific countries. These data, in conjunction with data from other terrestrial taxa, will provide a reliable indication of the effects of global environmental and socio-economic change on biodiversity, ecosystem health and landscape use in the Pacific.

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