Monitoring the reproductive success of endangered Fijian ground frog on Viwa, Fiji Islands

Final report for one year research and monitoring completed on Viwa Island, June 2007.

Submitted by Edward Narayan (BSc, MSc upgraded, PhD completing)

PO Box 1806
Nausori,
Fiji Islands
Email: edwardnnryn@yahoo.com
Date: 08 June 2009

MONITORING THE REPRODUCTIVE SUCCESS OF ENDANGERED FIJIAN GROUND FROG ON VIWA, FIJI ISLANDS

The Fijian ground frog (*Platymantis vitianus*) is an iconic and endemic amphibian species of the Fiji Islands with important eco-tourism and biodiversity values. It is listed as endangered under the current World Conservation Union (IUCN) **Red List Category B1ab (v)** because of its severely fragmented distribution and declining *in-situ* population. The distribution of *P. vitiana* throughout Fiji remains inadequately known, although Watson (1960) and Ryan (1984) suspected that it was once found on Viti Levu, Kadavu, Beqa and Moturiki. Confirmed populations are noted from Waisali Forest Reserve (Vanua Levu), Nakauvadra, Viti Levu (Tuiwawa pers. comm.), and four other mongoose free islands in the mid-eastern parts of Fiji Islands including, Viwa Island in Tailevu; Ovalau and Gau in the Lomaiviti group; and Taveuni (Thomas, 2007).

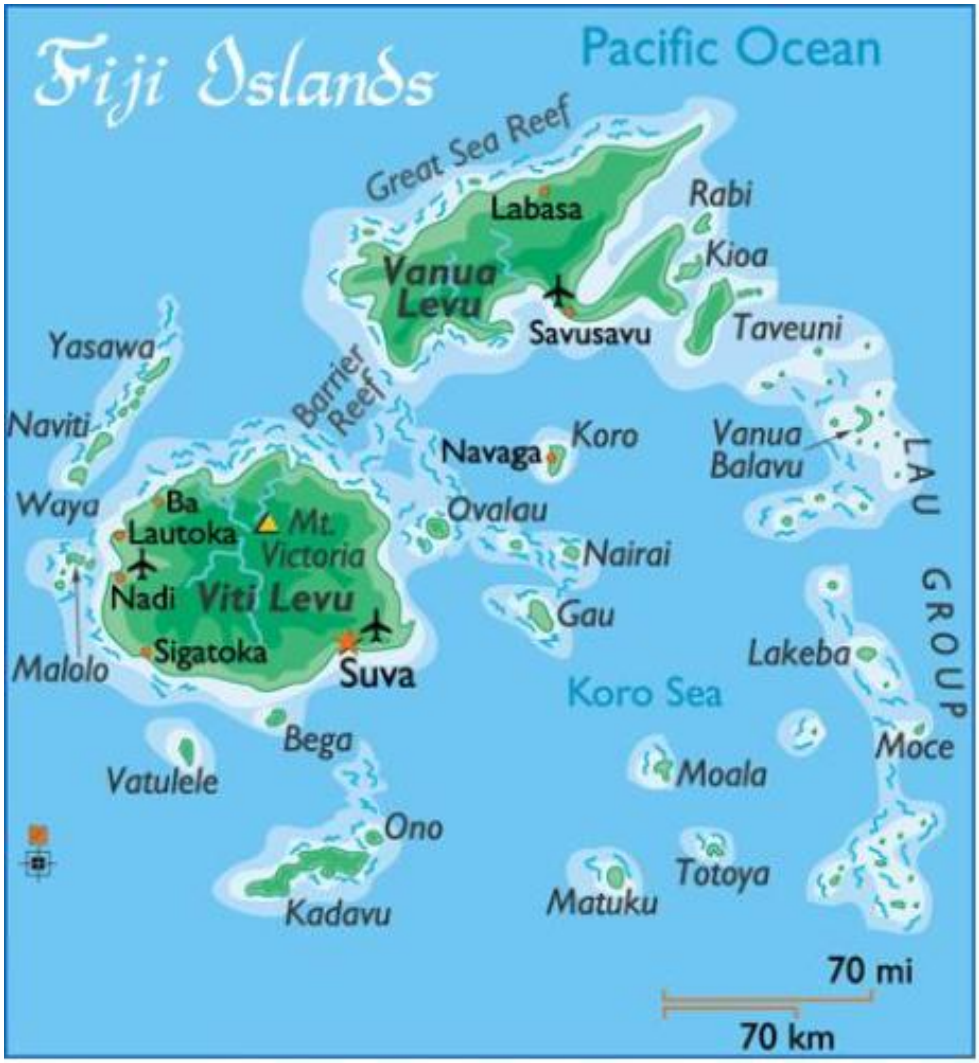


Figure 1.0 map of Fiji Islands showing the two mainlands, Vitilevu and Vanua Levu. Viwa Island is shown marked by a red arrow. (Map by fijiislandvacationmap.com)

The decline in populations is thought to be caused by introduced mammalian predators (especially mongooses, rats and cats) and habitat modification, although only limited studies have been carried out to assess their status. However, one of the serious biological threats to

P. vitianus population are cane toads (*Chaunus bufo marinus*), possibly predating on the frogs or out competing them for habitat space and food. On Viwa Island, the higher population of invasive cane toad outnumbers *P. vitianus* by a factor of 4 to 1 (est. 20,000 cane toads to 5,000 frogs) [Thomas, 2007]. The potential for *P. vitianus* becoming extirpated from Viwa Island and other parts of Fiji remains high since threats such as *C. marinus* populations are not controlled. It is likely that in the presence of *C. marinus*, the reproductive success of *P. vitianus* is halted. **Therefore, through this project we carried out an annual assessment of the variation(s) of reproductive status of *P. vitianus* on Viwa Island within cane toad accessible and inaccessible sites.**

Figure 2.0 invasive cane toads (left) and endangered Fijian ground frog (right). [Photo by Craig Morley]

SPECIFIC OBJECTIVES

This project aimed to study the variations in reproduction i.e. comparison of the total numbers of gravid females, metamorphs, nesting areas between cane toad accessible and inaccessible habitat sites.

The types of potential nesting sites of *P. vitianus*, morphometrics of egg clutches (number of eggs and arrangement), egg morphology and morphometrics of *P. vitianus* froglets found within the natural habitats were also studied.

Furthermore, this study aims to show that *P. vitianus* can survive and its reproductive capacity increases within cane toad inaccessible sites on Viwa Island and the impacts of cane toads on *P. vitianus*.

METHODS

Initiation of project and village team

It is critical to get approval from the traditional Fijian land owners before conducting any sort of studies within indigenous owned land. A traditional Fijian ceremony "sevusevu" was presented to the chief "Ratu" of the island on the 20th of April, 2008. The presentation included a large bundle of Kava (traditional Fijian drink) root. This ceremony was witnessed by research scientists from the University of the South Pacific (USP). The kava was presented to the "Ratu" on our behalf by the "Turaga-ni-Koro" - village spokesman. The village spokesman basically discussed our project idea with the chief. Once the chief was satisfied with the project goals and its benefits to the local people and conservation of *P. vitianus*, then at the end of the ceremony, the chief of the village accepted the Kava root. This indicated that the people of Viwa Island granted permission for the project to be conducted on Viwa Island and indicating full support of the community.

Field Sites

Viwa is a 60 ha island – 30 km northeast of Suva and 0.95 kms from Viti Levu. It has a dense and open forest with mangroves, ponds and small agricultural plots. The mean rainfall on Viwa Island is 1300 mm per year with two seasons, wet (Nov-Apr) and dry (May-Oct). The island is easily traversed with many permanent tracks developed and maintained by the local residents. Viwa has one main settlement with 25 houses – 120 people live on the island. The island has two main landing points. There is a main pond (approx. 20m diameter) and 6 man-made ponds used for bathing and washing clothes but are only utilized as a last resort. To date, cats, dogs and rats have already been eradicated from the island.

Two natural habitat locations (Site A and Site B) of *P. vitianus* were selected on Viwa Island based on species distribution data provided by Thomas (2007). Field site A was totally fenced in 100m x 100m of area and 50cm height. Fencing was done using a fine mesh netting (2mm x 2mm gaping which prevented anything in through apart from air circulation). All cane toads were manually removed from this site during 10 days and nights of continuous surveys. The second field site was left open and accessible to both *C. marinus* and *P. vitianus*. A visual encounter survey [VES] for one night after the removal of *C. marinus* from the first site found 10 adult male and 10 adult female *P. vitianus* inside site one while site two had 10 adult male and 10 adult female *P. vitianus*. The total cane toad count was 10 adult male and 10 adult female present inside site two. Two field assistants were assigned to carry out the surveys.

Figure 3.0 Viwa Island during low tide (top photo) and aerial view of Viwa Island (bottom photo). [Top photo by Edward Narayan and bottom photo by Craig Morley]

Adult and froglet counts

For both of the selected natural habitat locations, fortnightly field surveys were conducted to carryout morphometric measurements of *P. vitianus* including snout-vent length and body-weight measurements. The numbers of frogs caught were recorded and were scanned to note the pit tag and each individual was assigned into the following categories (gravid and non-gravid females; adult males; juveniles and metamorphs and froglets).

Egg mass counts and hatching success

Throughout the year, the two experimental sites were systematically searched 2 times per week (depending on rainfall and frog activity) for newly deposited egg masses. The eggs of *P. vitianus* could be distinguished from those of snails and other micro-invertebrates by the large size of the marble shaped ova, which is creamy and transparent with a thick outer jelly like cuticle. Given the small size of the two field sites and the distinctive nature of *P. vitianus* egg masses, we believe we found all egg masses deposited. Clutch size was estimated using a water displacement technique similar to Davis and Folkerts (1986). A sub-sample of eggs was used to determine how many eggs were required to displace 1 ml of water in a graduated cylinder, and by extrapolation, the number of eggs in each mass was calculated. Throughout the breeding season, egg masses were checked several times per week (sometimes daily) to determine hatching date and to measure hatching success. After

hatching and when froglets were completely of the egg mass, the number of undeveloped eggs was counted for each mass. We compared embryo mortality for each nest by using the average number of undeveloped eggs per mass.

Reproductive Characteristics

The potential nesting areas of *P. vitianus* within both of the selected field sites were recorded for the following;

- Total number of nests
- Nest location
- Egg clutch size
- Egg morphometrics
- Froglet morphology
- Froglet movement and micro-habitat preferences

Data Analysis

After completion of the twelve months of field surveys on Viwa Island, the raw data were used for making the following comparisons;

(a) Variations in reproduction i.e. comparison of the mean number of gravid females, metamorphs and nesting areas between the two habitat locations.

(b) The average monthly growth rate(s) of as many froglets found in any of two habitat locations.

(c) A detailed account of the total number of potential nesting sites, egg clutches, number of eggs per clutch, froglet biometrics of *P. vitianus* were noted.

Conservation Imperative

This project is recognised highly amongst conservation scientists, managers and interested individuals because it deals with the protection and management of an endangered amphibian species in Fiji Islands. The safeguarding of native fauna is critical towards the future of this country, which is a recognised biodiversity "hot spot" due to its high rates of native species and endemism.

Furthermore, this project is a first one to explore the reproductive variability of a native frog species as a result of direct competition with the invasive cane toad. Since cane toads are a major biological threat to native species survival worldwide thus it is very important to understand its effects upon the native Fijian frogs. This project could be replicated by neighbouring pacific island countries such as New Caledonia where the cane toads have become a major problem.

Conservation Outcome

We have published a scientific article from this research work. The publication was entitled "Reproduction and Ecology of the endangered Fijian ground frog (*Platymantis vitiana*)" published in the peer reviewed journal- South Pacific Journal of Natural Sciences (SPJNS).

Visit the following URL: http://www.publish.csiro.au/?act=view_file&file_id=SP08004.pdf

The next important step is to prepare a **Management Action Plan for Recovery of the Endangered Fijian Ground Frog,** which will be a very important reference document for conservation scientists and the people of Fiji and the global community to be aware of the immediate and long term actions that are required for the recovery of this iconic frog species. Together with educational programmes on Viwa Island and schools from around Fiji Islands to inform and educate the children and people of Fiji Islands about Fijian ground frogs and the importance of its conservation. We will be applying for the RGS second grant for support.

RESULTS

Key Findings and Highlights

1. Habitat and retreat sites

By day most *P. vitianus* were found under piles of coconut husks, under rotting logs and other ground debris underneath the cool shaded forest canopy. It was difficult to search for many frogs during the daytime searches since they were inactive and remained hidden under wet or moist retreat sites.

A frog was usually observed in a water conserving posture such as pressed flat on the ground or underneath rotting logs. Froglets of *P. vitiana* were most frequently found underneath or inside crevices within rotting logs. This observation indicated that rotting logs are a major retreat site for the froglets. Adult male frogs were 40.4-59.7 mm in SVL and adult female frogs were 60.3-110 mm in SVL. Adult cane toads (both males and females) were found in the open during the day-time and most often near the barks of tree trunks.

2. Variations in reproductive status between sites A and B

The total counts of gravid females (those carrying eggs) varied between the two field sites (site A and site B). More gravid female *P. vitianus* were observed at site A (cane toad inaccessible site) while site B had low numbers of gravid females recorded [Fig 4].

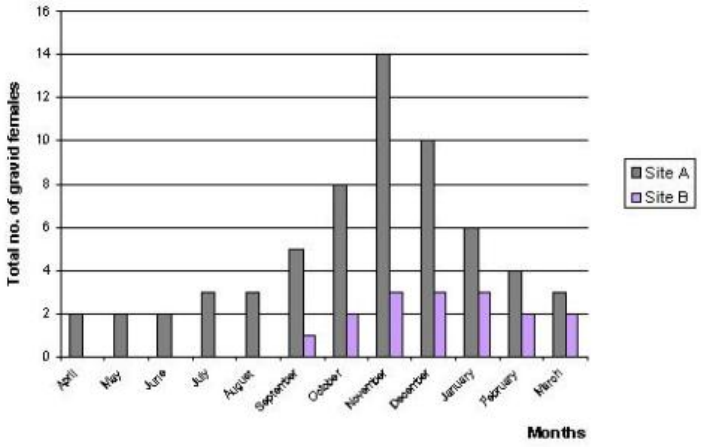


Figure 4.0 The total number of gravid female *P. vitianus* observed at site A and site B throughout the year.

The above graph clearly shows that higher number of reproductively active (gravid females) were found at the site A, which was inaccessible to cane toads. In fact, a total of 15 gravid females were found in site A while site B, which was accessible to cane toads, had only 3 gravid females. Therefore the percentage reproductive status difference between the two sites was at 80 %.

3. Egg mass counts

Egg masses were deposited as later in the year in December, January, February and March.

Month	Site A Number of egg nests discovered	Site B Number of egg nests discovered
December	4	0
January	4	0
February	2	1
March	1	0
Total	11	1

Table 1.0 shows the total number of eggs discovered at sites A and B on Viwa Island.

Egg mortality was relatively low at field site A. On average a total of 80% of the eggs from each nest (n= 11) hatched into froglets. The mortality rate of the single egg mass discovered at field site B was also low and 75% of the eggs hatched into froglets. Cane toads generally did not prey upon eggs since the eggs were protected within the covered nests.

	Site A			
Types of egg nest discovered	**Nest 1**	**Nest 2**	**Nest 3**	**Nest 4**
Location	Bamboo	Rotting log	Coconut husk	Rotting log
Substrate type	All nests were covered with decaying leaf litter and nests were created using moist soil on the ground			
Nesting area	Each egg nest was roughly organised, circular with shallow depression (av. length 9cm; depth 2cm; nest circumference of 30cm)			
	Nest 1	**Nest 2**	**Nest 3**	**Nest 4**
Fecundity and Egg arrangement	40 eggs; eggs were arranged close to each other; 3 unfertile eggs present near the outer boundary of the nest)	54 eggs; egg were arranged close to each other; 12 unfertile eggs (10 present 1cm deep within the soil, 2 unfertile eggs present near the outer boundary of the nest)	48 eggs; egg were arranged close to each other; 10 unfertile eggs (8 present 1cm deep within the soil, 2 unfertile eggs present near the outer boundary of the nest)	45 eggs; egg were arranged close to each other; 5 unfertile eggs (6 present 1cm deep within the soil, 3 unfertile eggs present near the outer boundary of the nest)
	Nest 1	**Nest 2**	**Nest 3**	**Nest 4**
Fertility of eggs (%)	93	78	79	89
Nesting area temperature (°C)	26-27	27-28	27-28	26-27
Humidity (%)	98	96	96	97

Table 2.0 shows the morphometrics of *P. vitianus* egg nests on Viwa Island.

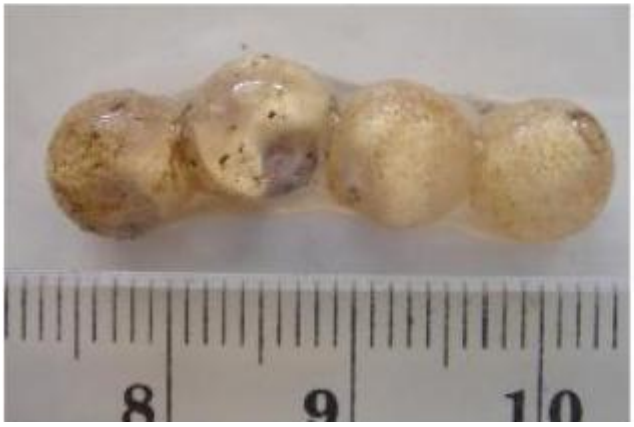
4. Developmental period and froglet morphology

The metamorphosis of *P. vitianus* eggs on average took 29-31 days from egg incubation to hatching of froglets. Newly hatched froglet on average measured 8.0mm in snout-vent length. The froglets upon hatching remained within the broken egg jelly case and slowly moved inside crevices within the substrates such as rotting logs. The froglets had remains of egg yolk underneath their belly which is used as food source until the froglet is strong enough to forage.

Illustration of nesting sites and eggs:

a. Bamboo nesting site

b. Rotting log nesting site

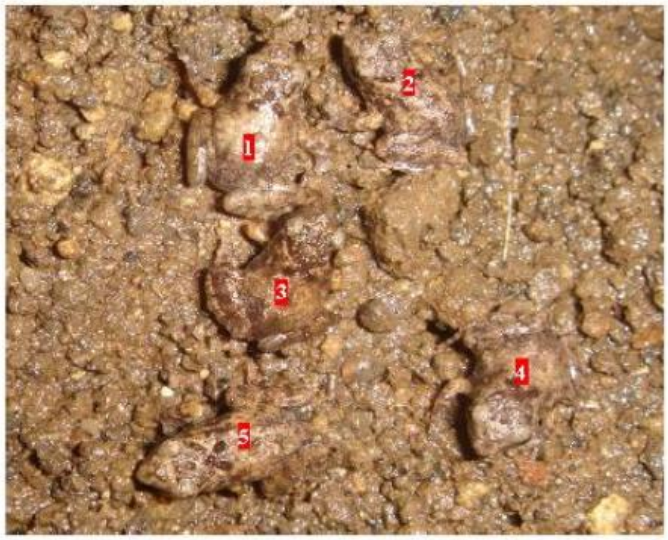


c. Fijian ground frog eggs (n=4) placed on a sterile piece of moist cotton wool for measurement using mm rule.

Each froglet was morphologically similar to the adult frogs and they retained the characteristic blackish brown stripped patterns on the dorsal surface of both anterior and posterior limbs.

d. Fijian ground frog froglets resting on rotting logs.

e. Newly hatched Fijian ground frog froglet (8.0mm SVL) placed on Fijian 10 cents coin.



f. Newly hatched froglets of Fijian ground frog [n=5] grouped on soil substrate. Numbers 1-5 have been used to depict the froglets in this photo.

Froglets of Fijian ground frogs were generally found within natural substrates such as rotten logs, coconut husks and leaf litter. It was easier to locate the metamorphs and juveniles underneath rotting logs and sometimes the froglets were found in crevices within the logs.

From a few nesting site, froglets (n =60) were carefully collected by hand and transported back to the USP laboratory where the froglets were maintained into a glass aquarium. Froglets were kept in the laboratory and growth and health was monitored on a regular basis. After one month of monitoring these froglets were released back into the natural habitat on Viwa Island.

5. Laboratory glass aquarium

The dimensions of the laboratory glass aquarium design were 46 x 32 cm square and 41cm in height. The top cover of the glass aquarium was a wooden lid designed with a removable mesh (10mm fine gauge) top. The floor of the glass aquarium was covered with 5cm height moist sterile soil substrate and a pot plant *(Palaquium hornei, Heterospathe phillipsii)* was placed within it. The sterile soil layer was covered with small pieces of sterile rotting logs, sterile decaying leaf litter. All of the substrate items mentioned above were previously sterilized in an autoclave set at temperature of 100oC for 15 minutes. Distilled water was sprinkled into the glass aquarium at three times daily (0800 dawn, 1200 noon and 0800 dusk). The supplementary food composed of ripe banana, pawpaw and pineapple that attracted insects, mainly Pacific fruit fly (*B. xanthodes*) and *B. distincta*. These were added into the glass aquarium *ad-lib*.

6. Froglet biometry records

The body-weight (gm) and snout-vent-length (mm) records of the froglets were taken through-out the study in order to monitor the froglet growth and development.

Table 3.0 shows biometry records of P. vitianus froglets taken during laboratory management

Date n=60 froglet	**Average Bodyweight (gm)**	**Average snout vent-length (mm)**
29/12/07 (at hatching)	0.098	8.0
03/01/07	0.106	8.0
08/01/07	0.109	8.0
13/01/07	0.113	9.0
18/01/07	0.117	9.0
23/01/07	0.119	10.0
03/02/07	0.121	10.0

7. *P. vitianus* froglet behaviour

All of the five *P. vitianus* froglets were nocturnal (active at night time) and were capable of climbing surface of the glass aquarium. The froglets occasionally rubbed their anterior digits over their head and eyes causing their eye lids to shut. Normal urination behaviour of the froglets was observed. The froglets were frequently observed grouping under the rotting log, on soil substrate in the glass aquaria.

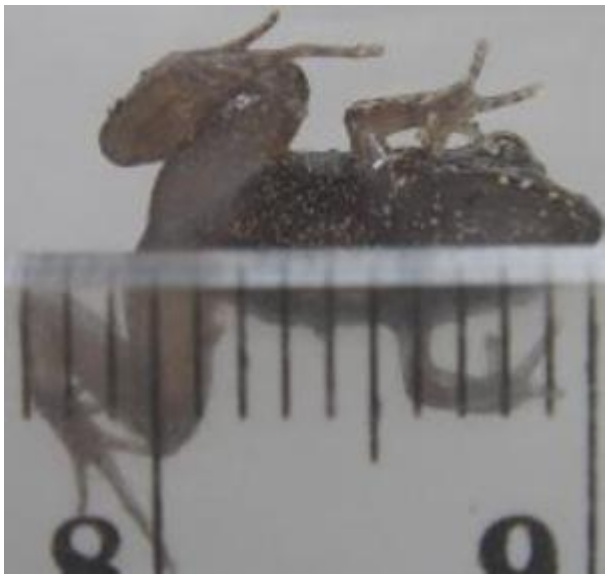


Figure 5.0 Snout vent length of P. vitianus froglet taken using mm rule

8. Cane toad movement and behaviour

Adult cane toads were easily able to move in and out of field site B while no cane toads were found within field site A throughout the study. Toads were found inside crevices within trunks of Tahitian chestnut (*Inocarpus fagifer*) trees, rocks and open-ground cover. At night-time the toads foraged in majority of these areas for insect preys. The *I. fagifer* trees also have plenty mosquitoes which were providing good sources of food for the toads.

Figure 6.0 cane toads found within I. fagifer tree trunks.

A highly concerning observation was that adult cane toads were found foraging within the habitats of *P. vitianus* froglets. Therefore, it is highly likely that the cane toads prey upon the froglets.

Figure 7.0 shows cane toads within rotting logs which are the most favourable retreat site for P. vitianus froglets.

Furthermore, the cane toads were also found within the same habitat sites as *P. vitiana* and in most cases the cane toads were out numbering the frogs.

Figure 8.0 (top figure) shows a cane toad and P. vitianus encounter during foraging at night time, and (bottom figure) shows a P. vitiana female surrounded by several cane toads.

DISCUSSION

This is the first study to document the impacts of cane toads upon the reproductive success of Fijian ground frogs on Viwa Island. Results showed that cane toads definitely affect the reproductive success of the endangered Fijian ground frogs on Viwa Island. The direct effects are in terms of competition for insect prey sources, habitat space and the most serious impact is in terms of predation upon hatched froglets and possibly upon juveniles. The access of cane toads to field site B resulted in lower numbers of gravid female frog encounted in this site during the breeding season. However, site A recorded the highest numbers of gravid females as this site had no cane toad access. The froglets of the Fijian ground frogs were generally found within dense micro-habitats such as rotting logs and hence it is important to allow the froglets to easily access these sites. However, the recent high level of agricultural activities on Viwa Island is causing the forest to deteriorate and soon it will be unfavourable for survival of Fijian ground frogs.

The use of exclosures can provide excellent breeding grounds for Fijian ground frogs within their natural habitats. Advantages of using such system are many and include such as:

- fast behavioural adaptation of the frogs,
- no unnecessary translocations off the island,
- reproductive status can be easily monitored with assistance from villagers,
- recovery of the frog population can be very easy with no risk of diseases (through reintroductions)
  and,
- fast learning capacity of newly hatched froglets.

Apart from cane toads, the Fijian ground frog population on Viwa Island faces two primary threats: (1) destruction of habitats and microhabitats especially frog breeding habitats or areas adjacent to the habitat; and (2) reinvasion of the island by predators such as mammals.

This project has provided substantial new baseline scientific data on reproductive status of *P. vitianus* on Viwa Island. The main benefit of knowing more about the reproductive biology of *P. vitianus* is critical towards its overall conservation and safeguarding this frog species from extinction. The complete eradication of cane toads on Viwa Island is possible with the help of additional funding support. Additionally, a key benefit to the local people of Viwa Island is thorough knowledge empowerment and engagement in protecting *P. vitianus*. Village youths were paid for assistance in field surveys.

RECOMMENDATIONS

Recovery of the Fijian ground frog

The recovery of Fijian ground frogs will be much faster if we are aware of the biological and physical threats that they face and the actions that are being taken to study this species. Therefore, a more coordinated approach is very important for fast recovery of the Fijian ground frogs. We need to develop a management action plan for the Fijian ground frog urgently since this document is lacking. This document will contain the life-history characteristics, threats, and important conservation measures for this frog species. It can be a five year management action plan which is developed through discussions and workshops with scientists and the people of Viwa Island.

Community Awareness

Even though the people of Viwa Island had lived closely with the Fijian ground frogs, they were not aware of how unique the species was and how vulnerable it was to habitat destruction. Any conservation effort on Viwa Island will have to consider the system of land ownership on the island. In any Fijian community, the landowning unit (**mataqali**) decides on any development on their land. Viwa Island has six **mataqalis** each of which own parts of the island, and whom will need to be approached for any conservation work on the whole island. It is critical that the head of every **mataqali** is present when seeking permission to work on their land, as this is the protocol that is practiced on Viwa Island. Landownership conflicts (which are common in Fiji), can delay conservation programmes or even halt them if not addressed during the initial phase of any
conservation efforts.

Biosecurity

As previously mentioned, a mammal eradication program was recently conducted on Viwa Island with the removal of cats, dogs and rats from the island using a combination of poison baits and traps. Care must be taken to ensure that these potential predators are not accidentally (or deliberately) reintroduced to the island.

CONCLUSION

The endangered Fijian ground frog (*Platymantis vitianus*) is under high risk of extirpation unless we act swiftly towards its recovery. From this study we have found out that cane toads affect the reproductive success of *P. vitianus* by acting as a competitor for natural habitat space, food and preying upon froglets and juveniles. Therefore, the removal of cane toads from Viwa Island is highly recommended. Furthermore, exclosures can be used to provide a suitable breeding ground for *P. vitianus*. The immediate step is to develop a management

action plan for *P. vitianus* which can be used as a guideline for undertaking scientific and conservation measures for the rapid recovery of *P. vitianus* populations.

ACKNOWLEDGEMENT

I sincerely thank RSG for supporting this study to make known the impacts of cane toads upon endangered Fijian ground frogs in Fiji Islands.

APPENDIX

Underbelly eggs of a gravid female Fijian ground frog

Fijian ground frog sitting on tree trunk

Fijian ground frog foraging at night

Fijian ground frog resting on coconut

Close-up of Fijian ground frog eye

Day old Fijian ground frog froglet placed on Fijian 5 cent coin (10 mm)

Edward (light green shirt) sharing Kava with friendly Viwa villager (red shirt)

Agricultural activities (burning forest) leading to destruction of Fijian ground frog habitat