

Specialist Consultancy

**LONG-TERM MONITORING OF HUMID
FORESTS ON THE GORO NICKEL LEASE
IN PRONY**

Cygnat Surveys & Consultancy

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Prepared by: Cygnet Surveys & Consultancy
2 Acron Street
St Ives 2075 NSW
AUSTRALIA
Email: gerryswan@bigpond.com

For: Goro Nickel

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SUMMARY

- Humid forests in the region of Baie de Prony have a rich and diverse lizard fauna (17 sp.) including a number of species endemic to the south of Grande Terre and a number of high conservation significance.
- As part of a strategy to detect for potential impacts on the lizard fauna of the humid forests in the region from activities associated with development of the GNI mining lease a monitoring programme was trialled in November 2007 in the forests of the Special Reserves Foret Nord, Pic du Grand Kaori and Pic du Pin.
- The trial monitoring programme was aimed at assessing whether a suite of target lizard species representing different 'guilds' within the forest were sufficiently abundant to monitor population trends and *vis a vis* reflect trends in the 'health' of the forest.
- Three approaches to the monitoring programme were trialled: timed day searches aimed primarily at recording day active ground dwelling skinks; timed night searches aimed primarily at recording night active arboreal geckos; and pitfall traps aimed at recording both crepuscular day active ground dwelling skinks.
- Weather conditions encountered during the trial monitoring programme were not optimal, but sufficient to indicate the following species as suitable candidates for future monitoring studies:
 - the diurnal skink *Caledoniscincus atropunctatus* for monitoring at a regional scale across all three forest Reserves.

- the nocturnal gecko *Bavayia sauvagii* for monitoring at a local scale at Foret Nord.
 - the nocturnal gecko *Rhacodactylus sarasinorum* for monitoring at a local scale at Col d'Antenne on Foret Nord.
 - and potentially the small semi-fossorial skink *Sigaloseps deplanchei* at a local scale at Foret Nord if capture rates could be improved with modifications to pitfall trap design.
- It is recommended that regional monitoring of lizard community diversity also be undertaken as part of the overall monitoring programme with the aim of tracking population trends in non-target species that may not necessarily be reflected in the target species identified above.

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1. BACKGROUND

Project Goro Nickel involves extensive development of the Goro Plateau and adjacent areas in the region of Baie de Prony in the far south of the Grande Sud. The major features of this project involve:

- development in much of the drainage of the Kue River that includes the mine area and associated infrastructure (Kwe east) and stocktake area for residue (Kwe west).
- an extensive base camp, administrative centre, processing plant and power generation plant between the Kwa Ni range and Baie de Prony
- a system of access roads that link the mine and the processing plant that traverse the Kwe drainage and cross the range at 'Col de l'Antenne'.
- a port facility in the Baie de Prony.

Two Special Reserves, Foret Nord and Pic du Grand Kaori, are located within the immediate or near vicinity of the project and both lie on the Kwe Range. Foret Nord is bounded on its northern margin by the development in Kwe East and the crossing of the range at 'Col de l'Antenne', and along its western margin by the access road to the facilities associated with the base camp, administration centre, processing plant and power generation plant. Pic du Grand Kaori is located on the Kwe Range approximately 5km north of Foret Nord, the main sealed road from Noumea and la Capture runs parallel to the base of the range. These reserves contain large areas of humid forest and have been identified in baseline fauna studies as areas of high conservation value for lizards in the region (Sadlier and Shea 2004 & 2006; Sadlier 2006).

Preservation of the humid forest and its fauna and flora is now recognized as one of the major conservation issues in New Caledonia nationally (CI, 1998) and internationally (Mittermeier et al., 1999). For lizards the forests in the region of the Grande Sud are considered to be of particular conservation significance (Sadlier, 2006) for the following reasons:

- humid forest is the richest habitat in terms of number of species and abundance of individuals, and contains the greatest number of species of conservation significance.
- they have not been affected by the invasive Little Fire Ant (*Wasmannia auropunctata*) which has invaded many coastal forests and low to mid elevation moist forest sites elsewhere in the Grande Sud where they are believed to have adversely affected lizard species diversity and abundance.
- genetic studies show that in some cases lizard populations in the region are different from those further north on the chaine centrale, in some instances representing different species.

Given the regional importance of the humid forests on (or adjacent to) the GNI lease a management strategy that incorporates long-term monitoring of various components of the fauna and flora has been identified as necessary to detect potential changes associated with development in the region.

Table 1. Distribution and conservation status of endemic lizard species recorded from humid forests in the Grand Sud.

	Foret Nord	Pic du Grand Kaori	Pic du Pin	Regional Records	Southern Endemic	Cons. Status
<i>Caledoniscincus atropunctatus</i>	*	*	*			LR-LC
<i>Caledoniscincus austrocaledonicus</i>	*	*	*			LR-LC
<i>Caledoniscincus festivus</i>	*		*			LR-LC
<i>Graciliscincus shonae</i>	*	*			*	V
<i>Lioscincus greeri?</i>				*		V
<i>Lioscincus nigrofasciolatum</i>	*	*	*			LR-LC
<i>Marmorosphax tricolor</i>	*	*	*			LR-LC
<i>Nannoscincus mariei</i>	*				*	V
<i>Phoboscincus garnieri</i>				*		LR-LC
<i>Sigaloseps deplanchei</i>	*	*	*		*	LR-NT
<i>Simiscincus aurantiacus</i>	*		*		*	E
<i>Tropidoscincus variabilis</i>	*	*	*		*	LR-LC
<i>Bavayia geitaina</i>	*				*	LR-NT
<i>Bavayia robusta</i>	*				*	DD
<i>Bavayia cf. sauvageii</i>	*				*	DD
<i>Bavayia septuiclavis</i>	*	*	*		*	LR-NT
<i>Eurydactylodes symmetricus</i>				*	*	V
<i>Eurydactylodes vieillardii</i>				*		LR-LC
<i>Rhacodactylus auriculatus</i>	*	*	*			LR-LC
<i>Rhacodactylus ciliatus</i>				*	*	V
<i>Rhacodactylus leachianus</i>	*					V
<i>Rhacodactylus sarasinorum</i>	*	*	*		*	V
<i>Rhacodactylus trachyrhynchus</i>				*		V
TOTAL: 23	17	10	11		12	

Conservation Status: **DD** Data Deficient; **LR-LC** Lower Risk – Least Concern; **LR-NT** Lower Risk – Near Threatened; **V** Vulnerable; **E** Endangered. From Sadler and Bauer 2004.

2. STUDY DETAILS AND METHODS

Cygnnet Surveys & Consultancy was requested by the Société Minière Goro-Nickel to develop and trial a program of long-term monitoring of representative species to assist in detecting potential changes in the lizard fauna associated with development in the region.

2.1. Potential Impacts.

The potential impacts and their consequences that could arise as part of the development activities in the region identified here and in previous reports are:

- emissions from the power generation plant.
 - changes to invertebrate community structure and abundance.
 - changes to water quality on leaves for geckos.
 - reduction of foliage in the forest canopy affecting humidity levels in the forest.
- increased light levels.
 - reduced availability of foraging sites for geckos in the canopy or at the forest edge.
- dust.
 - loss of arboreal sheltering and foraging sites.
 - changes to water quality on leaves for geckos.
- invasive species.
 - changes to food availability and sheltering and foraging sites.
 - loss of recruitment to population by direct predation upon eggs and juvenile cohort.
 - displacement of native species by competition for resources.

There is little documentation of cause and affect for the scenarios of emissions, light levels and dust outlined above, however, from what is known of the species biology it is reasonable to assume that the potential for these activities to impact on the native lizard populations exists. To detect the introduction of invasive species or an increase in numbers of introduced species and to identify the extent of impact on the lizard fauna a concordant program of surveillance monitoring for the invasive species (Little Red Fire-ant, rats and cats) and abundance of particular lizard species is required.

2.2. Target Species for Long-term Monitoring.

The humid forests of the region have a diverse lizard fauna of 10-17 (potentially 23) species (depending on forest size and type), including a number of conservation significance (Table 1). They occupy a range of strata within the forest from at and below the forest floor to the upper parts of the canopy - most species are highly dependant on this habitat type.

Targeted species monitoring was aimed at detecting changes in abundance for a group of species each representing a particular lizard 'guild' within humid forest (see also Sadlier & Shea, 2006) - one or more of the following criteria were used to select species for the trial monitoring programme:

- the species is sufficiently abundant to allow quantitative analysis of population trends.
- the species has particular habits that might be affected by impacts that could arise as part of the development activities.
- the species is of high conservation significance.

Based on information from previous studies the following species were considered possible candidates for trialling to monitor changes in abundance that

might reflect changes in the 'health' of the forests (the consequences of potential impacts from proposed developments are listed in Table 2):

- *Sigaloseps deplanchei* - small semi-fossorial skink.
- *Caledoniscincus atropunctatus* - small, day active, surface dwelling skink.
- *Bavayia septuiclavis* - small arboreal gecko, lower stratum of the forest.
- *Rhacodactylus sarasinorum* - a large arboreal gecko, lower and upper stratum of the forest, and endemic to the region.

2.3. Monitoring Sites.

As part of its overall environmental management strategy GNi is undertaking inventory and long-term monitoring of both fauna and flora on the lease area and adjacent habitats of conservation significance. In collaboration with IRD invertebrate monitoring sites in humid forests have been established at:

- Special Reserve Foret Nord.
 - site at base of the west face of the range.
- Special Reserve Pic du grand Kaori
 - near control site at the base of the west face of the range.
- Special Reserve Pic du Pin
 - distant control site for the Foret Nord and Pic du grand Kaori.

At each of the invertebrate monitoring sites three transect lines were established, each approximately 200 metres long and separated by a gap of 30 metres. At each site one transect was placed on flat ground at the base of the ridge, one where the ridge starts to rise, and one on the slope of the ridge. The area covered by the transects at these sites represents approximately ??? % of the average area covered by forest at each location.

The same area occupied by the invertebrate monitoring sites was used for trialling monitoring protocols for forest dependant lizard species.

In addition a forest site on Route de l'Antenne was selected to trial for targeted monitoring of giant geckos (*Rhacodactylus* species). This particular site was chosen for several reasons:

- it has a known history having had opportunistic collections and observations made since 1995.
- it is located close to the air quality and vegetation monitoring sites on the ridge.
- aspects of the biology of these species makes them suitable candidates for monitoring the potential impact of emissions.
- it is a significant site for *Rhacodactylus sarasinorum*, a regional endemic.

2.4. Monitoring Protocol.

The aim of the monitoring is to record sufficient individuals of the target species during a monitoring period that can be used to track trends in population abundance. Three approaches were trialled were:

- Pitfall traps
- Timed transect day searches.
- Timed transect night searches.

The protocol for each technique was aimed at giving maximum objectivity in recording. At Foret Nord and Pic du Grand Kaori, the lizard monitoring transects were placed either side of invertebrate transect II (middle transect line) approximately midway between transect II and each adjacent invertebrate transect, and at Pic du Pin either side of invertebrate transect I (base of ridge transect line) due to steepness of the lower slope at transects II and III at this site.

Sightings of all other lizard species were recorded to provide a profile of community level diversity and abundance and to track population trends of non-

target species as these may not necessarily reflect population trends of the target species.

2.4.1. Pitfall Traps.

Aims: pitfall traps were established primarily to obtain records of two target species for monitoring, the small semi-fossorial skink *Sigaloseps deplanchei* and the small, day active, surface dwelling skink *Caledoniscincus atropunctatus*, and also to provide records of other fossorial and day active skink species for tracking changes in community level diversity.

Advantages

- provides an objective estimate of abundance free of observer bias.
- operates at all times when the lizards are active.

Disadvantages

- a passive technique and requires an opportunistic encounter with the target species requiring it to be operational over a long enough period of time to record sufficient encounters.
- traps must be checked on a regular basis to retrieve, mark and release captures.
- occasional loss of captures through predation.

Methodology Trialled: Along each transect a line of pitfall traps each consisting of ten 2 litre buckets each 20 metres apart were placed. Buckets were not necessarily located directly on the transect line but rather in the most appropriate location at the 20 metre interval where the bucket could be placed correctly. Buckets were placed with the lip just below ground level and as upright as possible. Leaves were placed in the bucket to provide shelter from predators and prevent dehydration. Each bucket was provided with drainage holes which in turn



Figure 2a.
Marmorosphax
tricolor
in pitfall bucket.

Figure 2c. GNI biology
staff marking lizard
with colored paints.

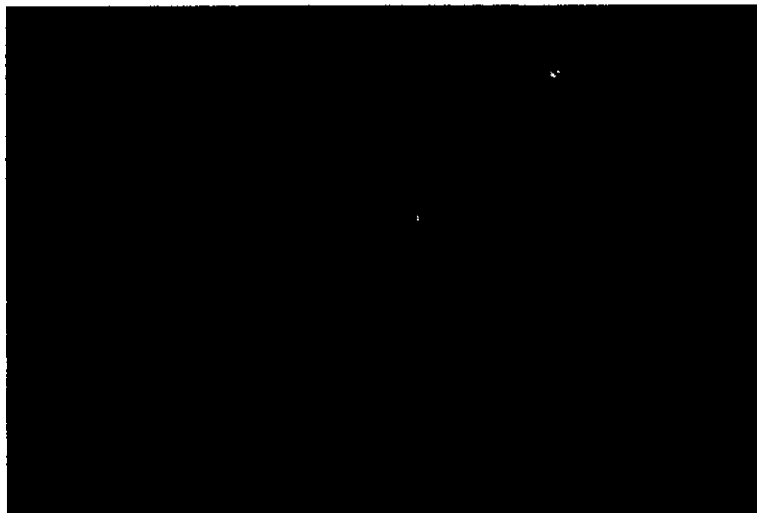
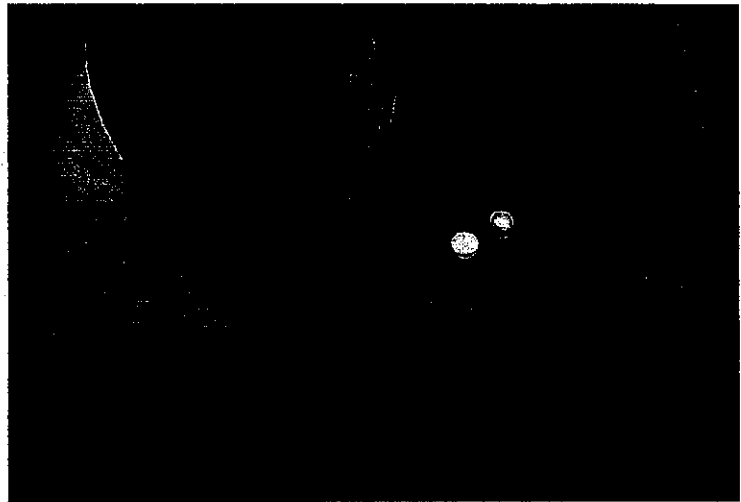
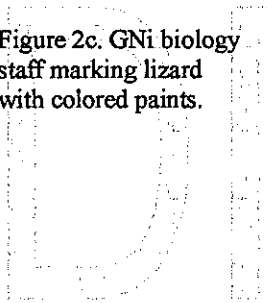


Figure 2c.
Marmorosphax
tricolor with
identification mark
on shoulder.

were covered with porous fabric to prevent escape of small lizards.

Pitfall traps were checked daily, generally between mid-morning and mid-afternoon. The transect location of captured lizards was noted, the lizards identified, sexed where possible, marked and released at an appropriate shelter site not less than 1 metre distant from the pitfall bucket. Marking involved placing a small spot of fast drying water-based paint on a position on the body that denoted the day on which the transect was checked – different coloured paint was used for each of the transect lines to provide a check for movement between the transect lines and for overall population estimates.

To assess the effectiveness of the pitfall traps in terms of both assessing abundance of target species and the overall species diversity of the forests the trapping session at each site ran for 5 days and nights during the trial monitoring project.

At the conclusion of a trapping session lids were placed on the buckets and then covered with leaves – the location of each bucket was marked with a metal peg with flagging tape.

2.4.2. Day Searches

Aims: day searches were conducted with the aim of obtaining records of the target species *Caledoniscincus atropunctatus*, a day active, surface dwelling skink, and also to provide records of other day active skink species useful for tracking changes in community level diversity.

Advantages

- large numbers of individuals can be observed under optimal conditions.

Disadvantages

- results are highly dependent on weather conditions during the survey period.
- requires a level of competency in observation in identification.

Methodology Trialled: Each 200 metre transect line was marked at 10 metre intervals and was walked by two persons, one either side of the transect, and covering an area approximately five metres from the transect line – both observers therefore record lizards over an area 10 metres wide by 200 metres long in the forest.

Timed day transects were generally undertaken in the late morning (1030-1200 hrs.) or early afternoon (1200–1400 hrs) when the strength of the sun and level of sunlight reaching the forest floor was conducive to lizard activity, transects run at earlier times yielded poor results. Prior to each transect readings for humidity, temperature, average wind, percentage cloud cover and time of commencement were noted, changes in weather conditions during the transect were noted at the end of the search period. Each lizard observed was identified to species when possible, the sex noted when possible, and its position between the 10 metre markers noted.

2.4.3. Night Searches

Aims: night searches were conducted to primarily obtain records of two nocturnal geckos, *Bavayia septuiclavis* for long-term monitoring of population abundance, and to track the long-term persistence of the giant gecko *Rhacodactylus sarasinorum* in the region.

Advantages

- fewer environmental variables to account for than day active skinks i.e. not dependant on levels of sunlight

Disadvantages

- results are highly dependent on weather conditions during the survey period, rain before or during the search period affects detection of smaller geckos.
- requires a level of competency in observation in identification.

Methodology Trialled: Along each transect line a 100 metre sector located between the 50 and 150 metre markers was walked at night by two persons. The primary spotter and scanned vegetation to a distance of up to 25 metres with a light mounted on binoculars to detect reflective eye-shine from geckos. Tree trunks and vegetation were scanned concentrating on the lower stratum (0-10 metres) and the search range was extended to the mid to upper strata where possible to search for giant geckos. The second person was the auxiliary spotter, scanning low vegetation with a high powered hand-torch. When a gecko was detected by binoculars the auxiliary spotter was directed towards the gecko to assist with its identification.

Timed night transects were undertaken early in the evening when temperatures are mild. Prior to each transect readings for humidity, temperature, average wind, percentage cloud cover and time of commencement were noted.

Lizards were identified to species when possible, and their position between the 10 metre markers noted. Information on its position (height above ground) and characteristics of its perching site (sapling vs small tree vs large tree) were noted.

3. REVIEW OF RESULTS

Trialling of the monitoring protocols was undertaken in the period between 22nd October and 1st November 2007. Despite this being the period generally identified

as dry and warm sub-optimal conditions in the form of extensive cloud cover and intermittent rain were experienced for considerable periods during the trial monitoring period. Cloud cover and rain affect the level of activity for small, day active, surface dwelling skinks, and rain prior to or during night surveys for geckos reduces the ability to detect reflective eyeshine of smaller species.

3.1. Pitfall Traps Overview

The overall number of lizards recorded by pitfall trapping was low, and the number of individuals of each target taxa recorded varied considerably between sites, as did the range of species detected between sites:

- for a total of 100 trap days per site trap success was below 10% (Foret Nord 9%; Pic du Grand Kaori 8%; Pic du Pin 7%)
- the target species *Sigaloseps deplanchei* represented 8 of the 11 lizards recorded from Foret Nord but only 2 of 6 from Pic du Grand Kaori and 5 of 9 from Pic du Pin.
- the target species *Caledoniscincus atropunctatus* was not captured in pitfall traps.
- pitfall trapping did record additional species to the target taxa including the burrowing species *Simiscincus aurantiacus* and *Graciliscincus shonae* which are difficult to detect by standard day search methods.

The number of individuals of target species recorded using the trap configuration trialled was insufficient to permit analysis of population trends, either within or between sites.

To improve capture rate on the existing trap configuration it is proposed to provide barriers to intercept lizards to increase the chance of moving them toward and into the buckets. The barriers will consist of pieces of corrugated plastic 90cm in length and 20cm in height placed either side of the bucket and buried 2cm into

the ground, the flexibility of the plastic allowing placement of barriers with minimum disturbance to the forest floor and minimal risk to researchers.

3.2. Day Searches Overview

The main target species *Caledoniscincus atropunctatus* was recorded at all sites and under optimal conditions the numbers of individuals recorded by day searches was good - several additional lizard species were also recorded:

- 11-18 *Caledoniscincus atropunctatus* were recorded for ~2 person hours per site at each site at Pic du Grand Kaori and Pic du Pin under optimal conditions, however Foret Nord was problematic in that markedly fewer individuals of this species were recorded for the same length of time albeit not under optimal conditions.
- *Marmorosphax tricolor* and *Sigaloseps deplanchei* were recorded at all three sites but the number of individuals varied considerably between sites and was insufficient to permit analysis of population trends.
- *Tropidoscincus variabilis* was only recorded on a few occasions at Pic du Grand Kaori and Pic du Pin, whereas previous studies in the region recorded it present at all sites and to be reasonably abundant.

The single most important variable for day searches is weather condition, in particular the ratio of cloud cover to sunshine. Searches conducted with 50% or less cloud cover were regarded as optimal, 50-75% cover sub-optimal and greater than 75% cover in effect yielded negligible results, despite there being only a slight difference of several degrees in the ambient shade temperature within the forest across the full range of cloud conditions.

*Flexibility in the timing of searches is required for future monitoring projects such that they are conducted under optimal conditions.

The other variable that should be taken into account is the degree of ease with which transects can be traversed and searched. Thick understory vegetation will limit the amount of near and distant ground litter that can be scanned for lizards and will affect the ability of the observer to record lizards. Similarly steep areas such as the sides of natural gullies found at Pic du Pin and Pic du Grand Kaori limit the rate at which the observer can move through the transect and the effectiveness with which lizards are seen.

3.3. Night Searches Overview

The species composition and number of individuals of *Bavayia* recorded at Foret Nord and Pic du Pin varied considerably, giant geckos (*Rhacodactylus* species) were only seen on a few occasions in the forest transects but were seen in good numbers on a survey of the sentier de la antenne:

- *Bavayia sauvagii* was most abundant at Foret Nord with 6-16 individuals observed over two ~2 person hour per sessions, whereas the target species *Bavayia septuiclavis* was not recorded at this site .
- *Bavayia septuiclavis* was the only *Bavayia* species recorded from Pic du Pin and was uncommon with only 3 individuals recorded over one ~1.5 person hour session.
- the giant gecko *Rhacodactylus sarasinorum* was seen on seven occasions at Foret Nord and once at Pic du Pin.
- a search of 200 metres of trackside forest on the sentier de la antenne recorded a diversity of giant geckos, including one *Rhacodactylus lechianus*, 3 *Rhacodactylus auriculatus*, and 7 *Rhacodactylus sarasinorum*.

Night searches of Pic du Grand Kaori were not undertaken during the time available due to the lack of suitable conditions (rain and/or wind).

Bavayia septuiclavis is widespread in the region whereas *Bavayia sauvagii* is more scattered distribution, the difference in distribution and abundance of *Bavayia* species observed at Foret Nord and Pic du Pin is consistent with that seen in previous studies of these sites.

The variable presence and relatively low abundance of *Bavayia septuiclavis* across the study sites indicate it is not a suitable subject to monitor for changes in population abundance between sites.

The relatively abundance of *Bavayia sauvagii* at Foret Nord indicate this species would be a suitable subject to monitor for changes in population abundance of that species at a local level at this site.

The relatively low abundance of *Rhacodactylus sarasinorum* across the study area indicates it is not a suitable subject to monitor for changes in population abundance between sites.

The relative abundance of *Rhacodactylus sarasinorum* along the sentier de l'antenne at Foret Nord indicate this species could be a suitable candidate to monitor for changes in population abundance at that site.

4. DISCUSSION

4.1. Targeted Species Monitoring

Targeted species monitoring was proposed to detect changes in abundance of species representing particular lizard 'guilds' within humid forest that might in turn reflect changes in the 'health' of the forests.

4.1.1. Regional Monitoring of Targeted Species

Targeted monitoring of particular species at a regional level was proposed to assess trends in population abundance at a local site in close proximity to mining related activities (Foret Nord), in a regional context via a near control site (Pic du Grand Kaori), and at a distant control site (Pic du Pin).

The results of the trial monitoring indicate that only a single species, the small, day active, surface dwelling skink *Caledoniscincus atropunctatus* (Figure 3a), occurs in sufficient numbers across all sites could be considered as a potential candidate to monitor for changes in population abundance between sites. However, several limitations exist to making this species an ideal candidate for this type of study:

- successful monitoring of this species is highly weather dependent.
- it represents only a single lizard guild and the stability, or changes, detected in abundance might not be widely applicable to the lizard community in general, reflecting mainly the impact of threats operating at only one stratum of the forest, with only a limited response to impacts at other strata in the forest.
- the number of observations made at Foret Nord were consistently lower than those made at Pic du Grand Kaori and Pic du Pin, calling into question the comparability of this site to the near and distant control sites.
- positive identification between *Caledoniscincus atropunctatus* and *Caledoniscincus austrocaledonicus* can be difficult at times, and will rely on the experience of the observer – during each survey a number of individuals could not confidently assigned to one species or the other .

Table 2: Potential threats that could arise as part of development activities in the region and their impact on the lizards of the humid forests.

Potential Impact	Consequences	Target Species Affected			
		<i>Sigaloseps deplanchei</i>	<i>Cal. atropunctatus</i>	<i>Bavayia septuiclavis</i>	<i>Rhac. sarasinorum</i>
emissions from power generation plant	• changes to invertebrate community structure and abundance	Y	Y	Y	Y
	• changes to water quality	?	?	Y	Y
	• loss of foliage in the forest canopy leading to lowered humidity levels	Y	Y	Y	Y
increased light levels at night	• reduced availability of foraging sites for geckos in the canopy or at the forest edge.			Y	Y
dust	• loss of arboreal sheltering and foraging sites			Y	Y
	• changes to water quality			Y	Y
invasive species	• changes to invertebrate community structure and abundance (invasive ants)	Y	Y	Y	Y
	• lowered recruitment to population through predation (rats) on eggs and juvenile cohort			Y	Y
	• displacement of native species by competition for resources			Y	?

Caledoniscincus atropunctatus and *Caledoniscincus austrocaledonicus* are both found broadly across the region, generally *austrocaledonicus* inhabits more open areas and the forest edge whereas *atropunctatus* is found mainly within the more mesic forest interior. Along transects at Foret Nord *austrocaledonicus* was also recorded at large sunlit patches of the forest floor where there was a break in the forest canopy, but was only infrequently seen along the transects through Pic du Grand Kaori and Pic du Pin – these results are consistent with previous studies (Sadler and Shea 2004 & 2006). It is unclear whether the difference in distribution of *Caledoniscincus austrocaledonicus* reflects a difference in forest structure between Foret Nord and the other two sites but again raises the issue of comparability between sites and the effectiveness of Pic du Grand Kaori and Pic du Pin as control sites.

Studies by (Jourdan et al., 2000, 2001, work in progress) on the interaction between lizards and the invasive Little Fire Ant (*Wasmannia auropunctata*) indicate the species of *Caledoniscincus* show a significant decrease in abundance in areas impacted by ants. Detection protocols for the Little Fire Ant have been established at each site. Monitoring of populations of *C. atropunctatus* would complement the ant detection program as the skink could provide an indicator of success of eradication methods should an invasion of the ant occur.

The studies undertaken by Jourdan et al. indicate that changes in abundance of *Caledoniscincus* species with invasion by the Little Fire Ant are most likely related to changes in food availability in the form of shifts in the structure and abundance of the small invertebrate community. As such *C. atropunctatus* may prove to be a useful indicator of changes in the structure and abundance of the small invertebrate community brought about by other causes (see Table 2).



Figure 3a.
Caledoniscincus
atropunctatus -
closed forest at Foret
Nord.

Candidate species
for monitoring at a
regional level.

Figure 3b.
Bavayia cf.
sauvagei - closed
forest at Foret
Nord.

Candidate species
for monitoring at a
local level.



4.1.2. Local Monitoring of Targeted Species

Three lizard species were recorded in numbers suitable for monitoring for changes in population abundance at a local level at Foret Nord.

In the initial monitoring proposal the small arboreal gecko *Bavayia sauvagii* (Figure 3b) was not proposed for targeted monitoring at a regional level given it has a scattered distribution in the region and was not recorded in previous studies from Pic du Grand Kaori and Foret Nord. It was relatively abundant during

nocturnal searches along transects through Forêt Nord, making it a suitable subject for monitoring changes in population abundance at that site.

Bavayia sauvagii is active at night in the lower to mid strata of the forest, shelters by day under logs and rocks on the forest floor, preys on small invertebrates and takes water by licking moisture from leaves. These aspects of its biology indicate it is likely to be affected by a wide range of impacts associated with development adjacent to the forest (Table 2), most significant of which would be those associated with emissions from the power generation plant and excessive dust levels close to roads directly affecting the quality of moisture on leaves. It is also likely to be affected by invasive species either directly through displacement (introduced gecko species or loss of sheltering and foraging sites by invasive ants) or indirectly through changes in availability of food (invasive ants).

Trial monitoring at a local level target species was proposed for giant geckos at Forêt Nord along trackside forest on the sentier de l'antenne. The results of the survey work undertaken confirmed that *Rhacodactylus sarasinorum* (Figure 4a) were present in numbers suitable for monitoring for changes in population abundance at this site – several *Rhacodactylus auriculatus* (Figure 4b) and single juvenile *Rhacodactylus lechianus* (Figure 4c) were also recorded. The number of *R. sarasinorum* recorded during the trial monitoring was similar to that of 10 years before when the area was undeveloped, indicating the population is relatively stable and not undergone any discernable decline in the past decade.

The giant gecko *Rhacodactylus sarasinorum* is active at night in the mid to upper strata of the forest, is known to shelter by day in tree hollows in the lower strata of the forest and presumably also in the forest canopy, it preys on small and large invertebrates and takes water by licking moisture from leaves. As such it is likely to be affected by a range of threats similar but subtly different to those identified for the small arboreal gecko *Bavayia sauvagii*, most notably the potential impacts

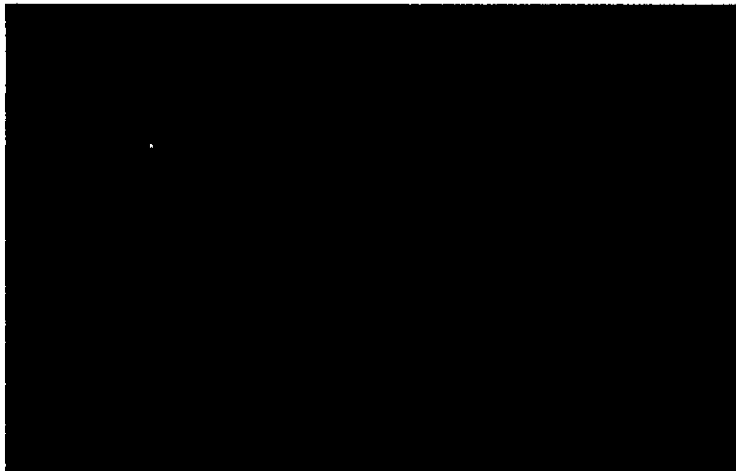


Figure 4a.
Rhacodactylus
sarasinorum - closed
forest on Col de
l'Antenne.

Figure 4b.
Rhacodactylus
auriculatus - closed
forest on Col de
l'Antenne.



Figure 4c.
Rhacodactylus
leachianus -
closed forest on
Col de
l'Antenne.

of emissions from the power generation plant, increased light levels at night on nocturnal activities, and excessive dust levels at all levels within the forest affecting foraging and sheltering sites, food availability, and leaf moisture quality.

The small semi-fossorial skink *Sigaloseps deplanchei* was initially intended for targeted monitoring at a regional scale but was not recorded consistently across the study sites, and is therefore not suitable for assessing trends in population abundance in a regional context. It was most abundant at Foret Nord and would be a suitable subject for monitoring changes in population abundance at that site if proposed modifications to the pitfall trap configuration improve catch rate.

Sigaloseps deplanchei is active by day and night on the forest floor, shelters under logs and rocks on the forest floor, and preys on small invertebrates. Its biology indicates it is likely to be affected mainly by threats that could change moisture levels and food availability at the forest floor level.

Monitoring at a local level of *Rhacodactylus sarasinorum*, *Sigaloseps deplanchei* and *Bavayia sauvagii* at Foret Nord in combination with region wide monitoring of *Caledoniscincus atropunctatus* gives representation across all four major lizard guilds within the forest at that site.

4.3. Regional Monitoring of Community Diversity

Humid forests in the Grande Sud have a diverse lizard fauna, 23 of the 27 species found in the region have been recorded from these forests, and half of these are highly reliant on this habitat type, have a highly specialised biology, and *vis a vis* are often uncommonly encountered.

From the trial monitoring in November 2007 the suite of potential target species representing major lizard guilds within the forests was identified (above) for monitoring at a regional and local level for changes in abundance that might

reflect changes in the ‘health’ of the forests, that is to function as bio-indicators. While monitoring of population trends of select target lizard species might reflect and alert to environmental changes, it is uncertain as to whether these trends could be extrapolated across a range of lizard species in any one guild. In particular lizard species with a highly specialised biology are likely to show greater degrees of sensitivity to a range of environmental variables, and while each species may not be effectively monitored on an individual basis their combined presence and persistence in the lizard community are a long-term measure of its health and in turn a reflection of the health of the environment.

For this reason it is desirable to record the presence of all other lizard species to provide a profile of community diversity at the regional and local level, and in the case of more abundant species to track population trends in non-target species which may not necessarily reflect those of the target species.

5. RECOMMENDATIONS

The following recommendations are aimed at providing a multi tiered approach to monitoring of the lizard fauna as potential bio-indicators of the ‘health’ of the regions forests:

- proceed with regional targeted monitoring of the skink *Caledoniscincus atropunctatus* at the reserves Forêt Nord, Pic du Grand Kaori and Pic du Pin for a period of at least three years to assess whether sufficient data can be reliably and consistently recorded with respect to population trends in this species.

- initiate local targeted monitoring of the skink *Sigaloseps deplanchei* and the gecko *Bavayia sauvagii* at Foret Nord to track long-term trends population abundance of these species at this site.
- initiate local targeted monitoring of the giant gecko *Rhacodactylus sarasinorum* at the sentier de la antenne at Foret Nord to track long-term trends in population abundance of this species at this site.
- proceed with regional pitfall trap surveys of lizards at the reserves Foret Nord, Pic du Grand Kaori and Pic du Pin to track long-term trends in lizard community structure at these sites.
- undertake complementary base line studies on the biology of key target species identified for regional and local monitoring, and a range of non-target species, to determine aspects of ecology (diet; reproductive cycles; age structure etc.) that are likely to be important in assessing any changes in population abundance detected in the monitoring studies.

The recommendations above are aimed to provide as broad a range of options as is practical to the task of detecting potential impacts on the regions lizard fauna from development associated with the GNi project.

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7. APPENDICES

Note: FN – Foret Nord; PK – Pic du Grand Kaori; PP – Pic du Pin.

Appendix 1a: Weather conditions during timed day forest transects - October 2007.

Date	Location	Time	Temp. (C)	Humidity (%)	Cloud	Comments
26 October	PP-transect 2	10.30-11.00	?	?	?	
27 October	PK-transect 1	10.40-11.15	25.3	75	10%	
27 October	PK-transect 2	11.20-12.00	23.0	75	40%	
27 October	FN-transect 1	14.20-14.50	24	66	10%	
27 October	FN-transect 2	14.55-15.16	21	78	10%	
28 October	FN-transect 1	10.30-10.55				Overcast, 10 min. sunlight
28 October	FN-transect 2		22.3	78	60+%	Overcast, 5 min. sunlight
28 October	FN-transect 1	11.15-11.40				Overcast, 5 min. sunlight
28 October	FN-transect 2	11.11-11.47				Overcast, 5-10 min. sunlight
28 October	PP-transect 1	13.35-14.05	24.0	64	7%	
28 October	PP-transect 2					
29 October	PP-transect 1	10.35-11.00	22	81	70-75%	10 minutes of rain midway
29 October	PP-transect 2	10.35-10.45				Overcast
30 October	FN-transect 1	10.40-11.00	23.9	78	100%	
30 October	FN-transect 2					
30 October	PK-transect 1		24.0	80	100%	
30 October	PK-transect 2					
31 October	PK-transect 1	10.35-11.05	21.5	100	100%	Overcast, rain intermittent
31 October	PK-transect 2					
31 October	PP-transect 1		Completely overcast, rain intermittent - transect abandoned			
31 October	PP-transect 2					

Appendix 1b: Weather conditions during night searches of forest transects - October 2007.

Date	Location	Time	Temp. (C)	Humidity (%)	Cloud	Moon
26 October	FN-transect 1	19.50	22.0	87		0
27 October	FN-transect 1	18.30-19.20	20.5	80.4	10-20%	
27 October	PP-transect 1		21	80.0		
27 October	PP-transect 2		23.4	72		
29 October	FN- col	19.30-21.15	23.5	75	80%	

Appendix 2a: Results of trial monitoring undertaken in October 2007 - timed day searches.

Date	Site	<i>C. austrocaledonicus</i>	<i>C. atropunctatus</i>	<i>C. festivus</i>	<i>G. shonae</i>	<i>L. greeri?</i>	<i>L. nigrofasciolatum</i>	<i>M. tricolor</i>	<i>N. mariei</i>	<i>P. garnieri</i>	<i>S. deplanchei</i>	<i>S. aurantiacus</i>	<i>T. variabilis</i>	<i>B. geitaina</i>	<i>B. robusta</i>	<i>B. cf. sauvagei</i>	<i>B. sephiclavus</i>	<i>E. symmetricus</i>	<i>E. viellardi</i>	<i>R. auriculatus</i>	<i>R. ciliatus</i>	<i>R. leachianus</i>	<i>R. sarasinorum</i>	<i>R. trachyrhynchus</i>
26 October	PP-transect ? - DS																							
27 October	PK-transect 1	.	6	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
27 October	PK-transect 2	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
27 October	FN-transect 1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
27 October	FN-transect 2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
28 October	FN-transect 1 no.1	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
28 October	FN-transect 2 no.1	4	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
28 October	FN-transect 1 no.2	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.
28 October	FN-transect 2 no.2	9	3	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
28 October	PP-transect 1	2	13	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
28 October	PP-transect 2	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
29 October	PP-transect 1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
29 October	PP-transect 2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Appendix 2a (continued): Results of trial monitoring undertaken in October 2007 - timed day searches.

Date	Site	<i>C. austrocaledonicus</i>	<i>C. atropunctatus</i>	<i>C. festivus</i>	<i>G. shonae</i>	<i>L. greeri?</i>	<i>L. nigrofasciolatum</i>	<i>M. tricolor</i>	<i>N. mariei</i>	<i>P. garnieri</i>	<i>S. deplanchei</i>	<i>S. aurantiacus</i>	<i>T. variabilis</i>	<i>B. geitaina</i>	<i>B. robusta</i>	<i>B. cf. sauvagei</i>	<i>B. septuiclavus</i>	<i>E. symmetricus</i>	<i>E. vieillardii</i>	<i>R. auriculatus</i>	<i>R. ciliatus</i>	<i>R. leachianus</i>	<i>R. sarasinorum</i>	<i>R. trachyrhynchus</i>
30 October	FN-transect 1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
30 October	FN-transect 2	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
30 October	PK-transect 1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
30 October	PK-transect 2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
31 October	PK-transect 1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
31 October	PK-transect 2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
31 October	PP-transect 1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
31 October	PP-transect 2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Transects abandoned midway due to rain –
nil results

Appendix 2b: Results of trial monitoring undertaken in October 2007 - timed night searches.

Date	Site	Time	Temp. (C)	Humidity	Comments	<i>B. geitaina</i>	<i>B. robusta</i>	<i>B. cf. sauaegeii</i>	<i>B. septuiclavus</i>	<i>E. symmetricus</i>	<i>E. vieillardii</i>	<i>R. auriculatus</i>	<i>R. ciliatus</i>	<i>R. leachianus</i>	<i>R. sarasinorum</i>	<i>R. trachyrhynchus</i>	Unknown
26 October	FN-transect 1	19.50-??.??	22.0	87	No moon	.	.	16	.	.	.	.	.	.	.	.	8
27 October	FN-transect 1	18.30-19.20	20.5	80.4	Cloud 10-20%	.	.	6	.	.	.	.	.	.	.	.	4
28 October	PP-transect 1		21.4-23.4	80.0-72.0		.	.	.	.	.	.	.	.	.	.	.	3
28 October	PP-transect 2					.	.	.	3	.	.	1	.	.	1	.	?
29 October	FN-antennae transect	19.30-21.15	23.5	75.0	overcast but light	3	.	.	3	.	.	3		1	7	.	.

Appendix 2c: Results of trial monitoring undertaken in October 2007 – pitfall traps.

Date	Site	<i>C. austrocaledonicus</i>	<i>C. atropunctatus</i>	<i>C. festivus</i>	<i>G. shonae</i>	<i>L. greeni?</i>	<i>L. nigrofasciolatum</i>	<i>M. tricolor</i>	<i>N. mariei</i>	<i>P. garnieri</i>	<i>S. deplanchei</i>	<i>S. aurantiacus</i>	<i>T. variabilis</i>	<i>B. geitaina</i>	<i>B. robusta</i>	<i>B. cf. sauvagei</i>	<i>B. septuiclavus</i>	<i>E. symmetricus</i>	<i>E. vieillardi</i>	<i>R. auriculatus</i>	<i>R. ciliatus</i>	<i>R. leachianus</i>	<i>R. sarasinorum</i>	<i>R. trachyrhynchus</i>
26 October	FN-transect 1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
26 October	FN-transect 2	1	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.
26 October	PK-transect 1	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
26 October	PK-transect 2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
26 October	PP-transect 1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
26 October	PP-transect 2	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
27 October	FN-transect 1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
27 October	FN-transect 2	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
27 October	PK-transect 1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
27 October	PK-transect 2	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
27 October	PP-transect 1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
27 October	PP-transect 2	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
28 October	FN-transect 1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
28 October	FN-transect 2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Appendix 2c (continued): Results of trial monitoring undertaken in October 2007 – pitfall traps.

Date	Site	<i>C. austrocaledonicus</i>	<i>C. atropunctatus</i>	<i>C. festivus</i>	<i>G. shonae</i>	<i>L. greeri?</i>	<i>L. nigrofasciolatum</i>	<i>M. tricolor</i>	<i>N. mariei</i>	<i>P. garnieri</i>	<i>S. deplanchei</i>	<i>S. aurantiacus</i>	<i>T. variabilis</i>	<i>B. geitaina</i>	<i>B. robusta</i>	<i>B. cf. sauvageii</i>	<i>B. septuiclavus</i>	<i>E. symmetricus</i>	<i>E. vieillardi</i>	<i>R. auriculatus</i>	<i>R. ciliatus</i>	<i>R. leachianus</i>	<i>R. sarasinorum</i>	<i>R. trachyrhynchus</i>
28 October	PK-transect 1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
28 October	PK-transect 2	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
28 October	PP-transect 1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
28 October	PP-transect 2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
29 October	FN-transect 1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
29 October	FN-transect 2	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
29 October	PK-transect 1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
29 October	PK-transect 2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
29 October	PP-transect 1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
29 October	PP-transect 2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
30 October	FN-transect 1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
30 October	FN-transect 2	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
30 October	PK-transect 1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Appendix 2c (continued): Results of trial monitoring undertaken in October 2007 – pitfall traps.

Date	Site	<i>C. austrocaledonicus</i>	<i>C. atropunctatus</i>	<i>C. festivus</i>	<i>G. shonae</i>	<i>L. greeni?</i>	<i>L. nigrofasciolatum</i>	<i>M. tricolor</i>	<i>N. mariei</i>	<i>P. garnieri</i>	<i>S. deplanchei</i>	<i>S. aurantiacus</i>	<i>T. variabilis</i>	<i>B. geitaina</i>	<i>B. robusta</i>	<i>B. cf. sauvagei</i>	<i>B. septuiclavus</i>	<i>E. symmetricus</i>	<i>E. vieillardii</i>	<i>R. auriculatus</i>	<i>R. ciliatus</i>	<i>R. leachianus</i>	<i>R. sarasinorum</i>	<i>R. trachyrhynchus</i>
30 October	PK-transect 2	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
30 October	PP-transect 1	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.
30 October	PP-transect 2	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
31 October	FN-transect 1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
31 October	FN-transect 2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
31 October	PK-transect 1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
31 October	PK-transect 2	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
31 October	PP-transect 1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
31 October	PP-transect 2	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
1 November	FN-transect 1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
1 November	FN-transect 2	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
1 November	PK-transect 1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
1 November	PK-transect 2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.