

**A SURVEY OF THE LIZARD FAUNA OF MAQUIS FOREST
HABITAT ON THE VALE INCO MINE SITE
(20 TO 30 YEAR PLAN OF DEVELOPMENT)**



Cygnnet Surveys & Consultancy

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A SURVEY OF THE LIZARD FAUNA OF MAQUIS FOREST HABITAT ON THE VALE NOUVELLE- CALEDONIE MINE SITE (20 TO 30 YEAR PLAN OF DEVELOPMENT)

**Cygnnet Surveys & Consultancy
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Frontcover: *Graciliscincus shonae* – photo Ross A. Sadlier

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1. INTRODUCTION

This report is from the third of studies undertaken to determine the species diversity of lizards in canopied maquis habitats, primarily maquis paraforestier and maquis preforestier, across the area encompassed by the Vale Nouvelle-Calédonie (VNC) mine site on the Goro Plateau. Earlier studies investigated the lizard fauna of canopied maquis in the area of the 5-10 year plan of development (Sadlier and Swan, 2009) and the 10-20 year plan of development (Sadlier and Swan, 2010). The study presented here investigated the lizard fauna of canopied maquis in the area of the 20-30 year plan of development.

The combined results of two previous studies had recorded a moderately rich lizard fauna of 12 species, which included seven skinks (*Caledoniscincus austrocaledonicus*; *Caledoniscincus cf. atropunctatus*; *Lioscincus nigrofasciolatus*; *Marmorosphax tricolor*; *Sigaloseps deplanchei*; *Simiscincus aurantiacus* and *Tropidoscincus variabilis*) and five geckos (*Bavayia goroensis*; *Bavayia cf. sauvagii*; *Bavayia septuiclavis*; *Eurydactylodes symmetricus*; *Rhacodactylus auriculatus*) from canopied maquis habitats on the (VNC) mine site. Earlier studies also (Sadlier and Shea, 2004) identified an additional species of skink (*Nannoscincus mariei*) from canopied maquis habitats in the region. The study presented here recorded an additional two species of skink from canopied maquis in the area of the 20-30 year plan of development. In total 15 species of lizard have now been recorded from this habitat type on the Goro Plateau. This is a level of diversity approaching that recorded for humid forest in New Caledonia, the habitat with the greatest diversity of lizard species (~20 species – Sadlier, 2006), and far greater than maquis shrubland which generally has a relatively low diversity (~5-7 species) and abundance of lizards. A high proportion of the species recorded from canopied maquis habitat (10 of 15) are regional endemics, that is, species restricted to the southern ultramafic ranges. Of these two (*Simiscincus aurantiacus* and *Bavayia goroensis*) are identified as of particular conservation significance under a recent assessment using modified IUCN criteria.

The study presented here on the lizard fauna of the 20-30 year plan of development was undertaken to examine in detail the relationship between the local lizard fauna and canopied maquis habitats and in the area to be impacted by the mine, and complements earlier studies on the 5-10 and 10-20 year plans of development.

2. STUDY SITES AND METHODS

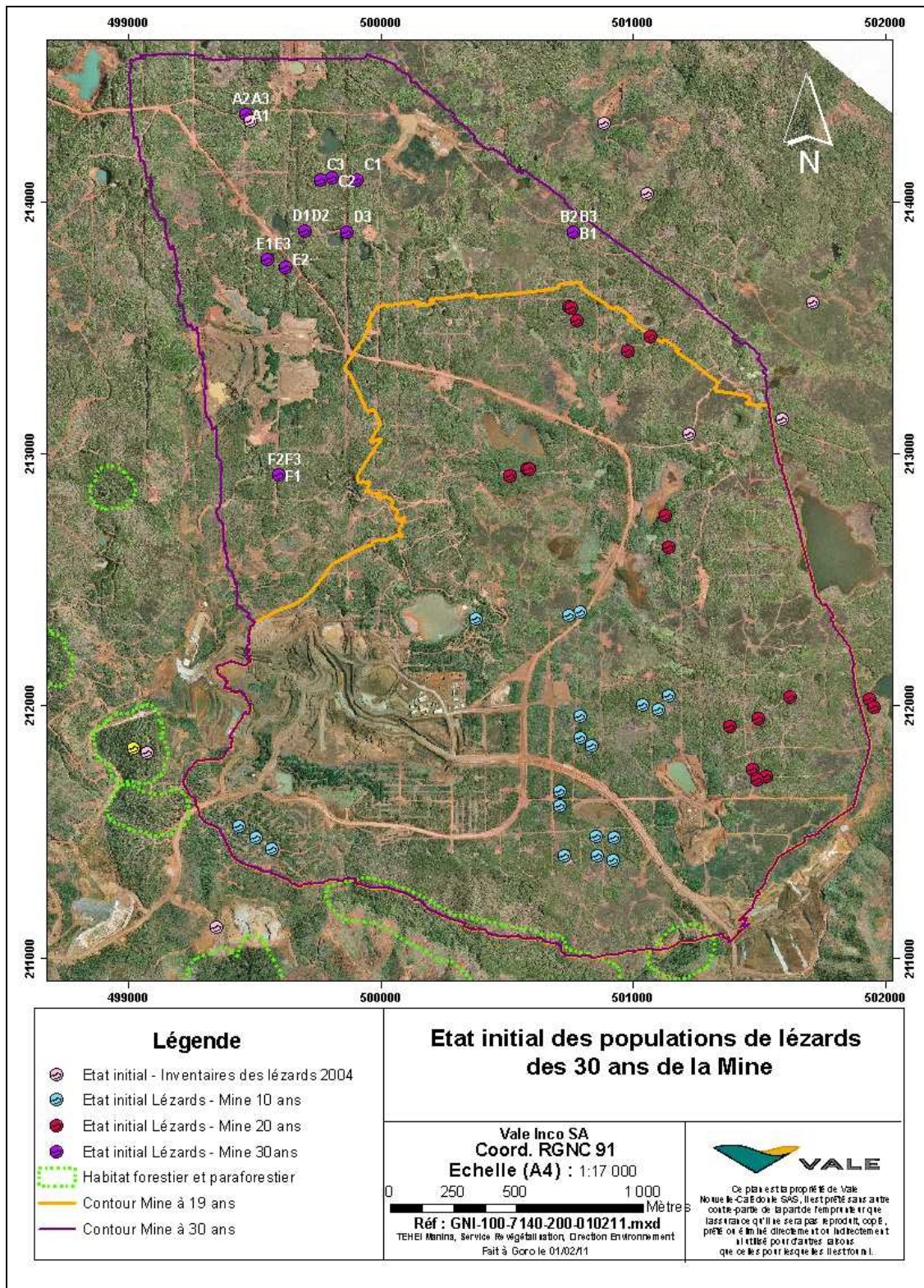
The study was conducted within the projected 20 and 30 year mine boundaries in the dry season of December 2010. Weather conditions during the survey were considered to be average with respect to temperature and below average with respect to clear weather. The sites selected for survey work were areas of canopied maquis. The sites were selected on the basis of size, relative homogeneity of habitat type, and access. In all, six separate sites were investigated, with three replicates at each site.

2.1 Study sites.

The type of canopied maquis habitat varied between sites across the study area, ranging from low canopied maquis arbustif through to relatively tall canopied maquis paraforestier and preforestier, with intermediate stages of development occurring within and between the replicates. Surrounding the patches of canopied maquis are areas of low maquis shrubland of varying density. Sites D-G were located on a plateau with an extensive exposed cuirasse cap, and sites A-C on a low ridge that generally lacked extensive exposed cuirasse rock.

The vegetation of each replicate at each of the major sites was characterized by a visual assessment made at each of 10 transect stations (5-8 metres apart) located along a transect of approximately 50-80 metres in length as follows:

- Maquis arbustif: open to dense with low canopy to 3 metres in height
- Maquis paraforestier: low canopy to 5 metres in height
- Maquis preforestier: canopy height greater than 5 metres



Location of sites examined in December 2010. Orange line is the 20 year mine boundary and purple line the 30 year mine boundary. Survey sites (alphabetic) and replicates (numeral) are in white and approximate location of each replicate is encompassed by the adjacent purple circle.

Site	Co-ordinates UTM	Habitat
A1	702139E 7535538S	paraforestier 100%
A2	As for A1	preforestier 100%
A3	As for A1	preforestier 100%
B1	703436E 7535062S	paraforestier 100%
B2	As for B1	open maquis arbustif 50% ; tall dense maquis arbustif 50%
B3	As for B1	tall dense maquis arbustif 100%
C1	702581E 7535276S	paraforestier 100%
C2	702480E 7535284S	preforestier 100%
C3	702434E 7535275S	preforestier 100%
D1	702373E 7535075S	paraforestier 100%
D2	As for D1	tall dense maquis arbustif 30% ; paraforestier 40%; preforestier 30%
D3	702539E 7535069S	tall dense maquis arbustif 100%
E1	702223E 7534966S	paraforestier 100%
E2	702295E 7534934S	paraforestier 10%; preforestier 90%
E3	As for E1	paraforestier 30%; preforestier 70%
F1	702260E 7534107S	paraforestier 100%
F2	As for F1	tall dense maquis arbustif 20% tall dense maquis arbustif/paraforestier 40% ; paraforestier 40%
F3	As for F1	tall dense maquis arbustif 10% ; paraforestier 20%; preforestier 70%

Table 1: Location of sites and replicates surveyed with total percentage of habitat type for each.

There was a level of homogeneity in habitat within the replicates at most sites:

- Site A replicates A1-A3 were primarily tall maquis paraforestier and maquis preforestier.
- Site B replicates B2 and B3 were primarily tall maquis arbustif with some open maquis arbustif in B2, and replicate B1 a homogenous stand of maquis paraforestier.

- Site C replicates were primarily tall maquis paraforestier and maquis preforestier.
- Site D replicate D1 was primarily tall maquis paraforestier, while D2 was a grade of tall dense maquis arbustif through to maquis paraforestier and maquis preforestier, and D3 a homogenous stand of tall dense maquis arbustif.
- Site E replicate E1 was a stand of tall maquis paraforestier, and replicates E2 and E3 primarily tall maquis preforestier grading to paraforestier.
- Site F replicate F1 was a homogenous stand of tall maquis paraforestier, F2 a grade of tall dense maquis arbustif through to paraforestier, and F3 primarily tall maquis preforestier grading to paraforestier and tall dense maquis arbustif.

Collectively paraforestier and preforestier habitat made up 77.7% of the habitat covered by the transects. Maquis arbustif and transitional stages of this toward a taller (arbustif/paraforestier) canopy comprised 22.3% of habitat.



Site A2 tall canopied maquis preforest typical of the habitat from which the regionally endemic burrowing skink *Graciliscincus shonae* was recorded during the survey.



Open maquis arbustif at site B2.



Dense maquis arbustif at site B2.

2.2 Field methods.

The study in 2008 (Sadler & Swan, 2009) to assess the diversity and abundance of lizard species in canopied maquis habitats showed that strategically placed glue-traps were equally (or more) effective at detecting the presence and providing a measure of abundance of most day active species, and even more effective at detecting the presence of secretive species when placed at the entrance to likely sheltering sites where logs and rocks rest on the ground. For these reasons this technique was employed as the primary method to detect lizard species in the present study at the seven sites surveyed. Records were also kept of lizards encountered opportunistically on transects during the course of checking glue-traps.

For detecting the presence of secretive species and diurnal surface dwelling species of skink, glue-traps were strategically placed at each station (5-8 metres apart) located along each transect line for each replicate. Traps were placed in the crevices and cracks created where outcropping cuirasse boulders contact the ground, under and next to logs, and in areas of litter or amongst surface debris. For each trap placed at each station along a transect line the basic microhabitat attributes of the station were recorded with regard to potential sheltering sites:

- located within or at the edge of a crevice between the rock and the forest floor (1).
- located next to an outcropping piece of rock/cuirasse (2).
- under vegetation and/or debris on the forest floor (3).
- in the open with no obvious cover or proximity to a sheltering site (4).
- under a log where there is a gap between the forest floor and log, or in an opening in a fallen log (5).
- at the base of a tree (6).

Geckos are usually the less diverse of the two lizard groups present, and are usually encountered active at night foraging in low shrubs, small trees, or the forest canopy, or sheltering by day in vegetation or under cover on the ground. Nocturnal searches were usually undertaken in the first three hours after sunset. The method used to

search for geckos detects the reflection from the eye when a beam of light is directed towards the lizard or, by scanning vegetation with a powerful light at closer range to observe geckos moving along twigs or branches. Binoculars modified to carry a torch and emit a light beam from below the eyepieces of the binocular were used to detect eye reflection. This method readily detects both the larger and smaller geckos, but to be effective it generally requires a minimum search distance of 10 -15 m., and a co-worker is required to collect the gecko for positive identification while the first observer keeps the animal in sight from a distance. Night searches were run along a 100 metre transect through forest habitat with a relatively open understory.

A previous study in 2008 of the 5-10 year plan of development trialed the effectiveness of glue-traps placed around the trunks of trees to detect the presence of arboreal skinks and geckos active at night – the results were considered to be of limited success and for this reason were not employed in the present study.

Search effort and conditions: Each site had three transects, each representing a site replicate. At each replicate one glue-trap was laid at each of the 10 stations along the transect line. A total of 180 trap stations were operational throughout the survey period for a period of three full days and nights after being established, representing approximately 540 trap days/night in total. The distribution of traps by habitat along transects in each replicate is given in Table 2.

Timed nocturnal searches consisted of walking the road edge in the general vicinity of each major site. Three persons participated in night searches of sites, and in all a total of ~11 hours of person search hours were undertaken primarily along road verge habitat as follows: site **A** 1 hour and thirty minutes; sites **D** and **F** each 3 hours per site (total 6); site **E** 3 hours and thirty minutes. Night searches of sites **B** and **C** were not undertaken. The temperature on the two nights during which night searches were conducted ranged from 26-27°C, the humidity was consistently high at 74-87% ($\bar{x}$ 79.8%), and cloud cover was 100% on two nights, and 20% or less on the final night - rain prevented searches on one night.

Sites & replicates	open maquis arbustif	dense maquis arbustif	dense arbustif/ paraforest	paraforest	paraforest/ preforest	preforest
A1 (10)				10		
A2 (10)						10
A3 (10)						10
B1 (10)				10		
B2 (10)	5	5				
B3 (10)		10				
C1 (10)				10		
C2 (10)						10
C3 (10)						10
D1 (10)				10		
D2 (10)		3		4		3
D3 (10)		10				
E1 (10)				10		
E2 (10)				1		9
E3 (10)				3		7
F1 (10)				10		
F2 (10)		2	4	4		
F3 (10)		1		2		7
Count 180	5	31	4	74	0	66
%	2.8	17.2	2.2	41.1	0	36.7

Table 2: Number of ground traps placed in each habitat in each replicate – bracketed number is traps per replicate.

The number of individual lizards encountered at each station was recorded and voucher specimens taken of each species for future taxonomic studies.

3. RESULTS

A total of 11 species of lizard are recorded for the survey period for all sites combined - 8 species of skinks and 3 geckos. Three species of skinks *Caledoniscincus cf. atropunctatus*, *Marmorosphax tricolor* and *Sigaloseps deplanchei*, and the geckos *Bavayia septuiclavis* and *Rhacodactylus auriculatus* were widespread across the study area and constituted >85% of records for the survey.

3.1 Distribution and abundance.

Four species, the skinks *Marmorosphax tricolor*, *Caledoniscincus cf. atropunctatus*, *Sigaloseps deplanchei* and the gecko *Bavayia septuiclavis* were equally widespread across the study area, being recorded from all six survey sites. The skink *Marmorosphax tricolor* constituted ~55% of records for this group, *Caledoniscincus cf. atropunctatus* 16% of records and *Sigaloseps deplanchei* 16% of records. *Marmorosphax tricolor* is a secretive species only rarely seen active by day, and all records are from captures on glue-traps, with more than half (69%) of the total number of individuals recorded in the first 24 hours of trapping. The species was recorded in both tall and low canopied maquis habitats, including dense maquis arbustif and more open maquis arbustif habitat. Although moderately widely distributed across the study area *Caledoniscincus austrocaledonicus* was infrequently recorded, constituting only 5% of records for the group with no clear pattern as to distribution by habitat type.

The skinks *Lioscincus nigrofasciolatum* and *Tropidoscincus variabilis* were also infrequently recorded but are still expected to be widespread in canopied maquis habitat across the study area. The absence of records for *Tropidoscincus variabilis* from some sites and the low numbers recorded at others most likely reflects genuinely low densities for this species in canopied maquis habitats. *Lioscincus nigrofasciolatum* is primarily arboreal in habits and extremely wary, it has only rarely been observed during earlier surveys and the majority of records are from glue-trap captures. Hence, the distribution and abundance of this species across the whole mine site is difficult to interpret other than it has been consistently trapped in low numbers indicating that while it is widespread in distribution and capable of occupying a range of habitat types it is also probably present in relatively low densities.

Sigaloseps deplanchei is largely fossorial in habits, though it is occasionally observed active in leaf litter in forest habitats. The species is widely distributed

across the study area but was generally recorded in low densities, except site E from which half the total number of individuals were recorded.

Table 3: Distribution of species by site across the study area within the 20 and 30 year mine plan boundaries – numbers represent total records for each species from all detection methods combined – sites A to C

		Site A1	Site A2	Site A3	Site B1	Site B2	Site B3	Site C1	Site C2	Site C3
SKINKS	<i>Caledoniscincus cf. atropunctatus</i>	1	-	- (2)	1	3	-	-	-	2
	<i>Caledoniscincus austrocaledonicus</i>	-	-	-	-	3 (1)	-	1	-	-
	<i>Graciliscincus shonae</i>	1	1	-	-	-	-	-	-	1
	<i>Lioscincus nigrofasciolatum</i>	-	-	-	-	-	-	-	-	-
	<i>Marmorosphax tricolor</i>	11	7	11	2	4	2	1	7	6
	<i>Phoboscincus garnieri</i>	-	-	-	-	-	-	-	-	-
	<i>Sigaloseps deplanchei</i>	1	1	-	1	-	1	-	1	2
	<i>Tropidoscincus variabilis</i>	-	-	-	1	-	-	-	-	1
GECKOS	<i>Bavayia septuiclavis</i>		2		not surveyed at night				(2)	
	<i>Eurydactylodes symmetricus</i>	-----			not surveyed at night			not surveyed at night		
	<i>Rhacodactylus auriculatus</i>	-----			not surveyed at night			not surveyed at night		
No. Species		5			5			7		

NB: - For skinks the numbers represent captures from ground glue-traps, except for those in brackets which represent observations. For geckos numbers represent night observations except for those in brackets which represent captures from ground glue-traps.

Table 3 cont'd: Distribution of species by site across the study area within the 20 and 30 year mine plan boundaries – numbers represent total records for each species from all detection methods combined – sites D to F.

Site D1	Site D2	Site D3	Site E1	Site E2	Site E3	Site F1	Site F2	Site F3		
2	5	-	2	1	4	-	4	1	<i>Caledoniscincus cf. atropunctatus</i> n = 28	SKINKS
-	-	-	2	-	-	-	1	1	<i>Caledoniscincus austrocaledonicus</i> n = 9	
-	-	-	-	-	-	1	-	-	<i>Graciliscincus shonae</i> n = 4	
-	1	-	-	-	-	-	-	-	<i>Lioscincus nigrofasciolatum</i> n = 1	
5	2	1	2	7	7	8	2	5	<i>Marmorosphax tricolor</i> n = 90	
1	-	-	-	-	-	-	-	-	<i>Phoboscincus garnieri</i> n = 1	
1	1	-	1	7	5	1	3	1	<i>Sigaloseps deplanchei</i> n = 27	
1 (1)	2	-	-	-	1 (1)	-	-	-	<i>Tropidoscincus variabilis</i> n = 8	
	3			6			6		<i>Bavayia septuiclavis</i> n = 19	GECKOS
-----			-----				2		<i>Eurydactylodes symmetricus</i> n = 2	
	4			2			3		<i>Rhacodactylus auriculatus</i> n = 9	
	8			7			8		198	

NB: - For skinks the numbers represent captures from ground glue-traps, except for those in brackets which represent observations. For geckos numbers represent night observations except for those in brackets which represent captures from ground glue-traps.

The skink *Graciliscincus shonae* was recorded from canopied maquis habitat for the first time during this survey. The species had previously only been recorded in the region from humid forest habitat at Pic du Grand Kaori, Forêt Nord and Pic du Pin

The skink *Phoboscincus garnieri* was recorded for the first time from the area of mine development. It has previously only been recorded from Camp Geologie, the ranges at the northern edge of Lac Huit and in forest habitat at Pic du Grand Kaori.

Two gecko species, *Bavayia septuiclavis* and *Rhacodactylus auriculatus*, were widespread in distribution across the study area, each being recorded from most of the four sites surveyed by night. *Eurydactylodes symmetricus* was recorded from a single site, the edge of tall canopied maquis habitat at site F.



The small burrowing skink *Graciliscincus shonae*, a species endemic to the southern ultramafic region.

3.2 Distribution by habitat.

Three species of skink, *Caledoniscincus cf. atropunctatus*, *Marmorosphax tricolor* and *Sigaloseps deplanchei* were moderately abundant and were recorded across the two major habitat types surveyed (low canopied maquis arbustif and the taller canopied maquis paraforestier and preforestier – see Table 4). The skink *Tropidoscincus variabilis* was recorded primarily from paraforestier and preforest habitats and also from maquis arbustif, but is also likely to be widespread in the region and to occur in more open maquis habitats. The small burrowing skink *Graciliscincus shonae* was only recorded from tall canopied maquis habitat (see Table 4).

The return of captures per unit area from glue-traps gives a proportional estimate of the occurrence of each of the more widespread species of skink in each of these broad habitat types (no. of records as a proportion of effort for each habitat, where effort equates to the number of transect stations for a particular habitat type as a % of total number of stations assuming equal duration of trap effort at all stations – see below), although the representation of habitats was highly biased toward tall canopied maquis (paraforestier and preforestier) constituting approximately 78% of habitat surveyed compared to maquis arbustif through to transitional ‘maquis arbustif/paraforestier habitat that constituted only ~22% of the habitat sampled.

The occurrence of *Marmorosphax tricolor* in maquis arbustif was proportionally lower than that recorded in tall canopied maquis paraforest and preforest (0.35 vs 1.05 records per unit area), as was the occurrence of *Sigaloseps deplanchei* (0.09 vs 0.37 records per unit area), whereas the occurrence of *cf. atropunctatus* in maquis arbustif and tall canopied maquis paraforest and preforest was proportionally similar (0.31 vs 0.27 records per unit area).

Proportion of individuals per unit area of habitat surveyed =	number of individuals recorded from a habitat type
	proportion of survey effort for that habitat
Where survey effort for a particular habitat equates to the number of transect stations for that habitat as a percentage (%) of the total number of stations across all habitat types ie. the proportion of survey effort for the habitat maquis paraforest and preforest combined was 78% of the total survey effort across all habitat types – see Table 2. As such, the proportion of individuals recorded per unit area for <i>Marmorosphax tricolor</i> from maquis paraforest and preforest combined (1.05) is derived from the number of individuals recorded (33+49=81) /proportion of survey effort for this particular habitat type (78%).	

Table 4: Distribution of lizard species by habitat.		MA-O maquis arbustif - open MA O/D maquis arbustif open/dense MA-D maquis arbustif -			MA/PAR. maquis arbustif/paraforestier PAR. paraforestier PAR./PRE. paraforestier/preforestier PRE. preforestier				
		MA-O	MA O/D	MA-D	MA / PAR.	PAR.	PAR. / PRE.	PRE.	Total
SKINKS	<i>Caledoniscincus aff atropunctatus</i>	1	-	4	2	10	-	11	28
	<i>Caledoniscincus austrocaledonicus</i>	1	-	3	-	4	-	1	9
	<i>Graciliscincus shonae</i>	-	-	-	-	2	-	2	4
	<i>Lioscincus nigrofasciolatum</i>	-	-	-	-	1	-	-	1
	<i>Marmorosphax tricolor</i>	4	-	4	-	33	-	49	90
	<i>Phoboscincus garnieri</i>	-	-	-	-	1	-	-	1
	<i>Sigaloseps deplanchei</i>	-	-	2	-	8	-	18	28
	<i>Tropidoscincus variabilis</i>	-	-	1	-	5	-	2	8
Total skinks		6	-	14	2	64	-	83	168
GECKOS	<i>Bavayia septuiclavis</i>		-		9		9(1)		19
	<i>Eurydactylodes symmetricus</i>		-		-		1		1
	<i>Rhacodactylus auriculatus</i>		-		7		2		9
Total geckos			0		16		13		29

NB: - For skinks the numbers represent captures from ground glue-traps. For geckos numbers night observations except for those in brackets which represent captures from ground glue-traps.

	Rock crevice [11.7%]	Next to rock [24.7%]	Under veg. [20.3%]	In open [11.9%]	Under log [16.4%]	Next to tree [15%]	Total
<i>M. tricolor</i>	14 (1.2)	30 (1.2)	12 (0.59)	5 (0.4)	20 (1.22)	9 (0.6)	90
<i>S. deplanchei</i>	-	10 (0.40)	2 (0.1)	8 (0.7)	4 (0.24)	4 (0.27)	28
<i>C. cf. atropunctatus</i>	1 (0.1)	7 (0.28)	6 (0.68)	5 (0.4)	4 (0.24)	1 (0.06)	24
<i>C. austrocaledonicus</i>	1 (0.08)	1 (0.04)	2 (0.29)	3 (0.26)	1 (0.06)	-	8
<i>T. variabilis</i>	1 (0.08)	3 (0.12)	1 (0.05)	-	-	1 (0.06)	6
<i>L. nigrofasciolatum</i>	-	-	-	-	-	1 (0.06)	1
<i>G. shonae</i>	1 (0.08)	1 (0.08)	1 (0.05)	-	1 (0.06)	-	4
Total	18	52	24	21	30	16	161

Table 5: Number of individuals of each species recorded from glue-trap stations on transect lines through all replicates – numbers in brackets are the proportion of individuals recorded per unit of area as expressed by the number of records as a proportion of effort for each micro-habitat.

$$\text{Proportion of individuals per unit area of microhabitat surveyed} = \frac{\text{number of individuals recorded from a microhabitat type}}{\text{proportion of survey effort for each microhabitat}}$$

Where survey effort for a particular microhabitat equates to the number of transect stations for that microhabitat as a percentage (%) of the total number of stations across all microhabitat types ie. the proportion of survey effort for the microhabitat 'rock crevice' was 11.7% of the total survey effort across all microhabitat types. As such, the proportion of individuals recorded per unit area for *Marmorosphax tricolor* from 'rock crevice' microhabitat (1.2) is derived from the number of individuals recorded (14) /proportion of survey effort for this particular habitat type (11.7%).

Placement of glue-traps at the stations with respect to proximity of microhabitat or sheltering sites had several clear impacts on rate of detection of the secretive skink species *Marmorosphax tricolor* and *Sigaloseps deplanchei* (Table 5):

- ∞ proportionally the highest number of *Marmorosphax tricolor* per unit area were recorded from glue-traps placed at sheltering sites, with traps placed in rock crevices, next to rocks or under logs recording twice the number of captures than traps placed in the open (including next to a tree) or under vegetation.
- ∞ proportionally as many *Sigaloseps deplanchei* were recorded from glue-traps placed under overhanging vegetation, next to a tree or in the open as were recorded from traps placed next to rock sheltering sites.
- ∞ proportionally nearly twice as many *Sigaloseps deplanchei* were recorded from traps placed in the open as were recorded from traps placed next to rock

sheltering sites or under logs or under vegetation, and none were recorded from the entrance of a rock crevice.

- ∞ proportionally more *Caledoniscincus cf. atropunctatus* per unit area were recorded from traps placed in the open (including next to a tree) or under vegetation as from traps placed next to objects on the forest floor (rock or tree trunk).

3.3 Comparison with previous preforest surveys.

The surveys of canopied maquis on the area of the mine plan were of approximately the same duration and undertaken at the same time of year at the end of the dry season around November or December. Conditions during the 2008 survey of the 5-10 mine plan were considered to be optimal, with extensive periods of cloud free weather conditions, conditions during the 2009 survey of the 10-20 mine plan were less favourable with a number of days with extensive cloud cover and several periods of rain, and those on the 20-30 mine plan similar to the previous year with a number of days with extensive cloud cover and periods of rain.

The diversity of lizards recorded from maquis paraforestier and preforestier during the survey of the 20-30 mine plan (11 species) was similar to that recorded during the surveys of canopied maquis on the area of the 5-10 mine plan in 2008 (9 species) and 10-20 mine plan in 2009 (10 species). The overall diversity of lizard species recorded from the all surveys of canopied maquis combined is 14, indicating that each individual survey records ~2/3rds of the potential lizard diversity for this habitat type.

Six species of skinks were recorded during all three surveys. Four of these, *Marmorosphax tricolor*, *Caledoniscincus cf. atropunctatus*, *Caledoniscincus austrocaledonicus*, and *Sigaloseps deplanchei* were relatively widespread and moderately (*C. austrocaledonicus*, *S. deplanchei*) to very abundant (*M. tricolor*, *C. cf. atropunctatus*) overall, while the two large species (*Lioscincus nigrofasciolatum* and *Tropidoscincus variabilis*) were infrequent (<10 records/survey). A further three species of skink have been recorded from the surveys of canopied maquis habitat:

Simiscincus aurantiacus, recorded from a single individual in both the survey of the 5-10 mine plan (2008) and 10-20 mine plan (2009); *Phoboscincus garnieri* from a single individual in the survey of the 20-30 mine plan (2010); and *Graciliscincus shonae* from a four individuals in the survey of the 20-30 mine plan (2010).

The geckos *Bavayia septuiclavis* and *Rhacodactylus auriculatus* were recorded during all three surveys and are considered to be widespread in the region. The distribution of the other three species of geckos recorded from the surveys of canopied maquis habitat is more difficult to interpret. *Eurydactylodes symmetricus* was infrequently encountered, being recorded from just a few individuals in the survey of the 10-20 mine plan (2009) and 20-30 mine plan (2010). It is known from other sites in the region but usually only from a few individuals at each. *Bavayia goroensis* was also infrequently encountered being recorded only from a few individuals during the 2009 survey. It too is known from other sites in the region but again only from a few individuals at each of these. The distribution and abundance of *Bavayia cf. sauvagii* in canopied maquis in the region appears to be linked to the presence of broken cuirasse. It was abundant and widespread across the sites on the 10-20 mine plan, restricted in distribution and in low abundance in the area of the 10-20 mine plan, and apparently absent from sites surveyed in the area of the 20-30 mine plan. The peculiar nature of the distributions of several gecko species makes it difficult to assess the potential distribution of this group at any one site. The apparent absence of *Bavayia cf. sauvagii* from sites on the 20-30 mine plan is difficult to explain other than that these sites generally lacked the extent of broken cuirasse cap present on the area of the 10-20 mine plan – that is this latter site is exceptionally good for this species.

3.4 Significant species recorded.

Significant species are those of particular conservation significance by virtue of having one or more aspects of their biology (habitat preferences, diet, home range, etc.) specialised, and which in combination with their extent of occurrence can determine the ability of the species to persist into the future.

The skink *Graciliscincus shonae* has recently been categorised as ‘Vulnerable’ under IUCN conservation criteria (IUCN/CI – in prep), with the greatest threat to *Graciliscincus shonae* is ‘the further loss and fragmentation of habitat from clearance of closed forests.....and from wildfires in maquis shrublands damaging forest margins’. It is known only from forested habitats on ultramafic surfaces of the Grande Sud and adjacent ranges of the chaine centrale. The species is moderately widespread across the Grand Sud, but was previously only known from humid forest habitat, the records obtained from tall canopied maquis during the 2010 survey of the 20-30 year mine plan (three separate sites) are the first from this habitat type. As such, canopied maquis may provide an extension of suitable habitat to this species which is otherwise be largely reliant on the scattered humid forest patches found in the Grand Sud. The extent of occurrence of *Graciliscincus shonae* in maquis preforestier habitat is most likely dependent on the suitability of the subterranean microhabitat produced by the cuirasse cap that underlies much of the canopied maquis habitat on the Goro Plateau.

4. ASSESSMENT

4.1 Canopied maquis on the Vale Nouvelle-Calédonie mine site.

Surveys of canopied maquis habitat located within the Vale Nouvelle-Calédonie mine plan during 2008, 2009 and 2010 have examined a total of 20 individual sites in the area proposed for development of the mine. From these and other studies a total of 15 lizard species have been recorded in tall canopied maquis paraforest and preforest habitat. This is a diversity approaching that found in humid forest (~20 species expected - Sadlier, 2006) - nearly all the species recorded from canopied maquis also occur in humid forest. Included are a number of moisture sensitive species (*Graciliscincus shonae*, *Marmorosphax tricolor*, *Sigaloseps deplanchei*; *Simiscincus aurantiacus*, *Nannoscincus mariei* and probably *Caledoniscincus cf. atropunctatus*) that would otherwise be regarded as primarily forest dependant species, that is, they do not usually occur in open maquis habitat over their range (except where suitable microhabitat offers moist sheltering sites and then usually in maquis in close proximity to forest). As such, tall canopied maquis habitat in the Grand Sud provides a significant extension of suitable habitat to a number of species

(many of which are only known to occur in the far south of the southern ultramafic region) that would otherwise be largely reliant on the scattered humid forest patches found in the Grand Sud and adjacent ranges of the chaine centrale. The widespread distribution (and abundance) of these species across canopied maquis habitats on the Goro Plateau, is most likely due to the presence of suitable moist microhabitat in canopied maquis which has a thick leaf litter layer logs and rocks on the forest floor. In particular the cuirasse cap that underlies much of the canopied maquis habitat on the Goro Plateau provides a cool and humid subterranean environment that the microhabitat that buffers desiccation and is likely to benefit the carrying capacity (availability) of invertebrate prey. It is these properties of the cuirasse cap that allow certain moisture dependant species (*Marmorosphax tricolor*, *Sigaloseps deplanchei*) to extend into adjacent open maquis habitats.

For the skinks *Marmorosphax tricolor*, *Sigaloseps deplanchei*, *Graciliscincus shonae* and *Simiscincus aurantiacus* in particular tall canopied maquis on cuirasse not only extends the overall distribution of these otherwise primarily humid forest inhabiting species, but also provides a degree of connectivity between populations in the scattered and isolated humid forest patches in the region. The connectivity provided by canopied maquis could facilitate gene flow between populations in different humid forest patches, and assist in re-colonization of humid forest patches in the event of localized extinction or population crashes, such as it might occur with infestation by the Little Red Fire Ant or other invasive species.

Canopied maquis also provides habitat for two species of gecko, *Bavayia goroensis* and *Bavayia cf. sauvagii* which are so far only known from the Grand Sud, and a further two species, *Bavayia septuiclavis* and *Eurydactylodes symmetricus*, which are restricted to the southern ultramafic region. *Bavayia goroensis*, *Bavayia septuiclavis* and *Eurydactylodes symmetricus* are also known to occur in humid forest habitat and less frequently in open maquis shrubland. In this respect canopied maquis again provides a habitat that contributes significantly to the overall distribution of these species in the Grand Sud. The distribution of *Bavayia cf. sauvagii* on the Goro Plateau and generally within the Grand Sud seems to be linked with the availability

of surface rock which provides sheltering sites. The extensive cuirasse broken cap on which much of the canopied maquis on the Goro Plateau sits provides optimal habitat for this species (note the high densities recorded in the 2008 survey of canopied maquis habitat on the 5-10 year mine plan).

The importance of the humid forest and canopied maquis on the Goro Plateau for the conservation of the lizard fauna assumes a higher level of significance when viewed in a broader regional context. The humid forest and canopied maquis in the region are generally free of the introduced invasive Little Red Fire Ant that has infested much of the coastal forest in southern New Caledonia. The presence of this ant appears to have a significant negative impact on lizards (Jourdan et al., 2001). The lizard populations in the numerous canopied maquis fragments in the region represent a number of independent populations separated by areas of suboptimal (open maquis) habitat. While discontinuity of canopied maquis habitat in the region can be viewed in a negative context in limiting gene flow between populations, it may conversely reduce the potential for widespread infestation of the Little Fire Ant in the region, and leave some lizard populations unaffected. As such the tall canopied maquis habitats of the Goro Plateau operate to provide an extension of forest habitat and connectivity with and between humid forest patches, but in other cases isolated patches of canopied maquis can provide ‘island’ areas in which the lizard fauna may persist in the face of widespread impacts in the region by virtue of being refugia (though this also makes them very vulnerable to catastrophic events). In this way a mosaic of both interconnecting and discontinuous canopied maquis on the Goro Plateau can collectively contribute to the long-term conservation of forest-dependant lizards in the south of the island. In this respect maintaining a network of well managed canopied maquis habitat on the Goro Plateau may significantly enhance the overall ability of forest habitat in the region to maintain lizard diversity, and is likely to have similar benefits to other fauna.

5. RECOMMENDATIONS.

The recommendations below for the re-establishment of canopied maquis habitat on mined sites and a regional reserve system for canopied maquis habitat on the Grand

Sud are reiterated from the report for the 2009 survey of the 10-20 mine plan (Sadler and Swan, 2010).

5.1 Re-establishment of canopied maquis habitat on mined sites.

The field studies in canopied maquis on the mine site have identified the importance of a diversity of sheltering and foraging sites on the ground floor utilised by secretive skink species *Marmorosphax tricolor*, *Sigaloseps deplanchei* and *Simiscincus aurantiacus*. In particular the broken cuirasse cap of the forest floor most likely plays a major role in providing sheltering sites buffered from extended periods of dryness. This microhabitat also provides sheltering sites for the locally restricted gecko *Bavayia cf. sauvagii* and for *Bavayia septuiclavis*. Re-establishment of canopied maquis or forested habitat on mined areas should also include re-establishment of sheltering sites at ground level for these re-vegetated sites to be suitable for re-colonization by lizard species from adjacent areas. Further, re-establishment of lizard populations on re-habilitated areas of the mine plan will require suitable source populations from habitat adjacent to the mine area. Such key sites need to be identified and a system of reservation, protection and management put in place to ensure that source populations persist and can be linked with re-habilitated sites in the future. To maintain viable source populations the sites selected should be monitored for invasive species and control measures put in place in the case of infestation. Also, corridors between source populations and designated for re-establishment of canopied maquis habitat on the mine site will be required to allow the movement of moisture dependent species to the areas to be re-colonised.

5.2 A regional reserve system for canopied maquis habitat.

Canopied maquis habitats are poorly represented in the existing Provincial reserve system in the Grand Sud. Conservation of this habitat would assist in maintaining overall lizard biodiversity within the region, and in particular enhance the distribution and abundance of humid environment dependent species. A network of well managed canopied maquis habitat on the Plaine des Lacs/Goro Plateau would also provide similar benefits to other fauna. Surveys of canopied maquis throughout the Grand Sud are required to identify key areas suitable for reservation to maintain

species diversity and abundance of the lizard fauna in the region. These surveys need to be accompanied by comparative studies on the key invertebrate resources in canopied maquis habitat, particularly with respect to habitat with, and without, a broken cuirasse surface.

6. SUMMARY

Survey work on the canopied maquis of the Vale Nouvelle-Calédonie year mine site and adjacent areas has identified a moderately rich lizard fauna of 15 species, including several regionally significant species and one of high conservation concern. Most species found in canopied maquis will also be found in the interior of humid forest in the region, likely at similar or greater densities. In this sense canopied maquis extends the distribution of a large portion of the lizard fauna found in humid forest, and provides some connectivity between forest patches for these species. Nearly all the species of lizards found in canopied maquis on the Vale Nouvelle-Calédonie mine area have also been recorded from humid forest on reserves in the Grand Sud; however, these reserves are small and separated, and reservation of intervening areas of canopied maquis would provide a greater potential for some level of connectivity between forests and potentially a more effective reserve system for forest dependent lizard species. Conservation and long-term management of areas of canopied maquis adjacent to areas to be re-habilitated is required to provide source populations for successful re-establishment of lizards on the mine area at the cessation of mining activities.

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