7 Bat Surveys & Analysis

7.1 Summary

Long-tailed bats (*Chalinolobus tuberculatus*) were found throughout the proposed reservoir (inundation) area during ultrasonic surveys completed between November 2011 and February 2012 (Figure 12), and in early 2013. Data summaries indicate that bats were foraging about the sheltered areas of the valley floor throughout the survey periods.

Simultaneous surveys of the reservoir area and the wider landscape surrounding the site during February 2012, as well as January/February 2013, showed that it is likely that long-tailed bats are resident within the reservoir area, and that they may roost in close proximity to the monitoring stations within the reservoir area. Evidence for this are the high levels of activity within the reservoir area shortly after dusk, and before dawn. Activity levels are also higher within the reservoir area compared to the wider landscape surrounding the site, which demonstrates the importance of the reservoir area as habitat for the resident long-tailed bat population. Long-tailed bats resident within the reservoir area are also likely to move between it and the wider landscape surrounding the site during times of flight activity.

Within the reservoir area, bat activity was higher in February 2012 compared to November/December 2011. The increase in activity is likely due to the presence of newly flying young of the year and the warmer and more consistent weather conditions.

The ‘reservoir population’ is likely not the only one in the region, but survey results show that it is possibly the largest of those detected (i.e. with highest number of recorded passes per ABM) and thus is a population of importance.

A potential lesser short-tailed bat (*Mystacina tuberculata*) pass was also detected in the reservoir area during February 2012. However, no further activity of a similar nature was detected in intensive monitoring early in 2013 meaning this is extremely unlikely the species is present.

7.2 Bat Survey Objectives

1. To confirm the presence of bats throughout the proposed dam and reservoir footprint area; and
2. To determine relative levels of bat activity throughout the dam and reservoir footprint area, and the wider landscape, including the possibility of populations discrete from that occupying the reservoir area.

7.3 Methodology

7.3.1 Survey Techniques and Analysis Parameters

Department of Conservation-designed and built ultrasonic automatic bat monitoring recorders (ABM) were set up at monitoring sites within and outside the proposed reservoir area. ABMs record the ultrasonic echolocation calls emitted by bats and convert them to frequencies audible by humans (Parsons & Szewczak, 2009). Long-tailed bat (peak frequency 40 kHz; Parsons, 2001) and lesser short-tailed bat (peak frequency 28 kHz; Parsons, 2001) echolocation calls are recorded simultaneously on two separate channels making identification of species present possible. Each echolocation pass (a series of calls separated from another series of calls by at least 1 second of silence; Thomas, 1988) is time (hour/minute/second) and date (year/month/day) stamped providing timing information for activity.

ABMs were placed at sites where bat activity was expected to be high. Potential sites include waterways, tree-lines, and within or on the edge of gullies (Borkin, 2009; O’Donnell, 2000; Dekrout, 2009).

Detectors were calibrated to have the same time and date settings (NZST) and were pre-set to start monitoring from 30 minutes before sunset until 30 minutes after sunrise. In addition, all data cards were cleared prior to deployment, and ABM noise switches were set to slow. Each site was surveyed in warm, settled weather, with no large rainfall events. At each site, the distance between detector locations was at least 25 m to increase the chance of independent bat monitoring. All detectors were secured at least 1 m above the ground and orientated upward at an angle of 30-45° to the horizon.

Prior to deployment all ABMs were checked overnight (pm & am) and were found to be in good working order. Despite this, during the November 2011 survey several ABMs failed due to undetected faulty batteries causing early shutdown. These sites were resurveyed in December 2011.

Bat call sequences were identified from the ABM sound files using the DOC software programme "Bat Search" (v1.02). The time/date stamped data was subsequently collated in "Bat Search" and exported for analysis. Detected bat calls were classified into one of three categories (after Le Roux, 2010):

- Search (or commuting/flyover) phase calls: calls emitted by bats moving from one location to another. A rapid fly-over echolocation call, dominating the 40 kHz channel;
- Feeding buzzes: a rapid series of calls, with components on both 28 and 40 kHz channels, produced by bats as they attempt to feed or as they approach objects in their path; and,
- Other or 'Social calls': lower frequency calls, which are likely to be used for intra-specific communication when bats are flying in group or near a roost site. Calls dominating the 28 kHz zone, but with some 40 kHz components.

7.3.2 Survey 1 - Reservoir Area

Between 22 - 30 November 2011, 19 ABMs were deployed in the reservoir area along forest and river margins (Figure 12). A subsequent supplementary survey was conducted between 2-14 December 2011 (9 ABMs), to cover sites where ABMs failed during the November 2011 survey.

7.3.3 Survey 2 – Reservoir Area and Wider Landscape

From 2 - 9 February 2012, 21 ABMs were deployed (Figure 13, Figure 14, and Figure 15) to determine bat presence and relative levels of activity across the greater Wakarara landscape.

To determine the relative importance of the reservoir area as bat habitat compared to the surrounding landscape, an additional seven ABMs were deployed from 2 - 9 February 2012 at monitoring sites within the reservoir area. The seven additional sites within the reservoir area were chosen based on activity levels that were highest during the November/December 2011 survey (Figure 13 and Figure 14).

7.3.4 Surveys 3 and 4 – Reservoir Area and Wider Central Hawke's Bay Landscape

From 11 – 22 January and 3 – 10 February 2013, 24 ABMs were deployed at monitoring sites within the reservoir area, and across the greater Hawke's Bay landscape (Figure 16). In addition to placing ABMs in areas where high levels of activity were detected in 2011/12 we also investigated the possibility that bats were:

1. Utilising habitat across the greater landscape between the eastern Ruahine foothills and Highway 50, between the settlements of Takapau and Kereru.
2. Whether the timing of activity indicated that bats were roosting in areas outside of the reservoir area.

In addition to the reservoir area we deployed the ABMs in another 3 distinct strata (Table 9). We selected these areas based on the maximum known range span of long tailed bats in modified landscapes of the North Island (7 km; Borkin, 2010, Dekrout, 2009) in an effort to understand if bats found across the landscape were likely to have originated within the reservoir area or from other roosts across the landscape.

The 21 ABMs were deployed across the landscape within an area 20 km x 45 km (or approximately 90,000 ha; Figure 16).

Table 9 Surveys 3 and 4 – Stratification distances across the greater Central Hawke's Bay landscape from the Reservoir margins; ABM IDs in 2013 same as in 2011/12; * = deployed in the same location as in 2011/12

Distance from reservoir	ABMs	Note
Reservoir area	9*, 10*, 12*.	Bats detected may originate from within the reservoir footprint.
< 3.5km from reservoir	2, 4*, 5, 11, D*.	
> 3.5k < 7km from reservoir	1, 6, 7, L*, Q*.	
> 7km from reservoir margin	8, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22.	Bats unlikely to reside within the reservoir footprint.

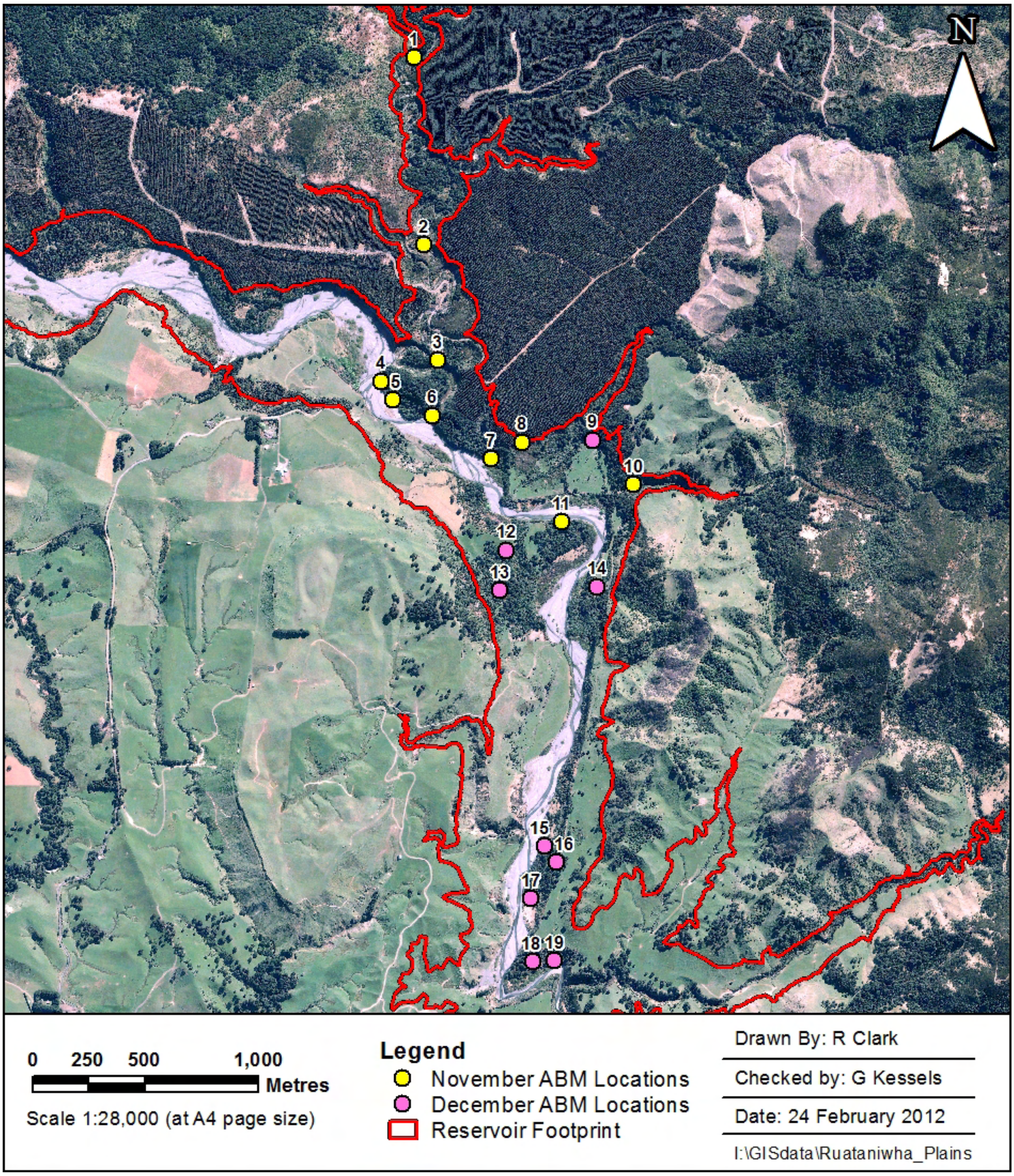

Figure 12 Automated bat monitoring (ABM) locations at Makaroro River in November (circles filled yellow) and December (circles filled pink) 2011.

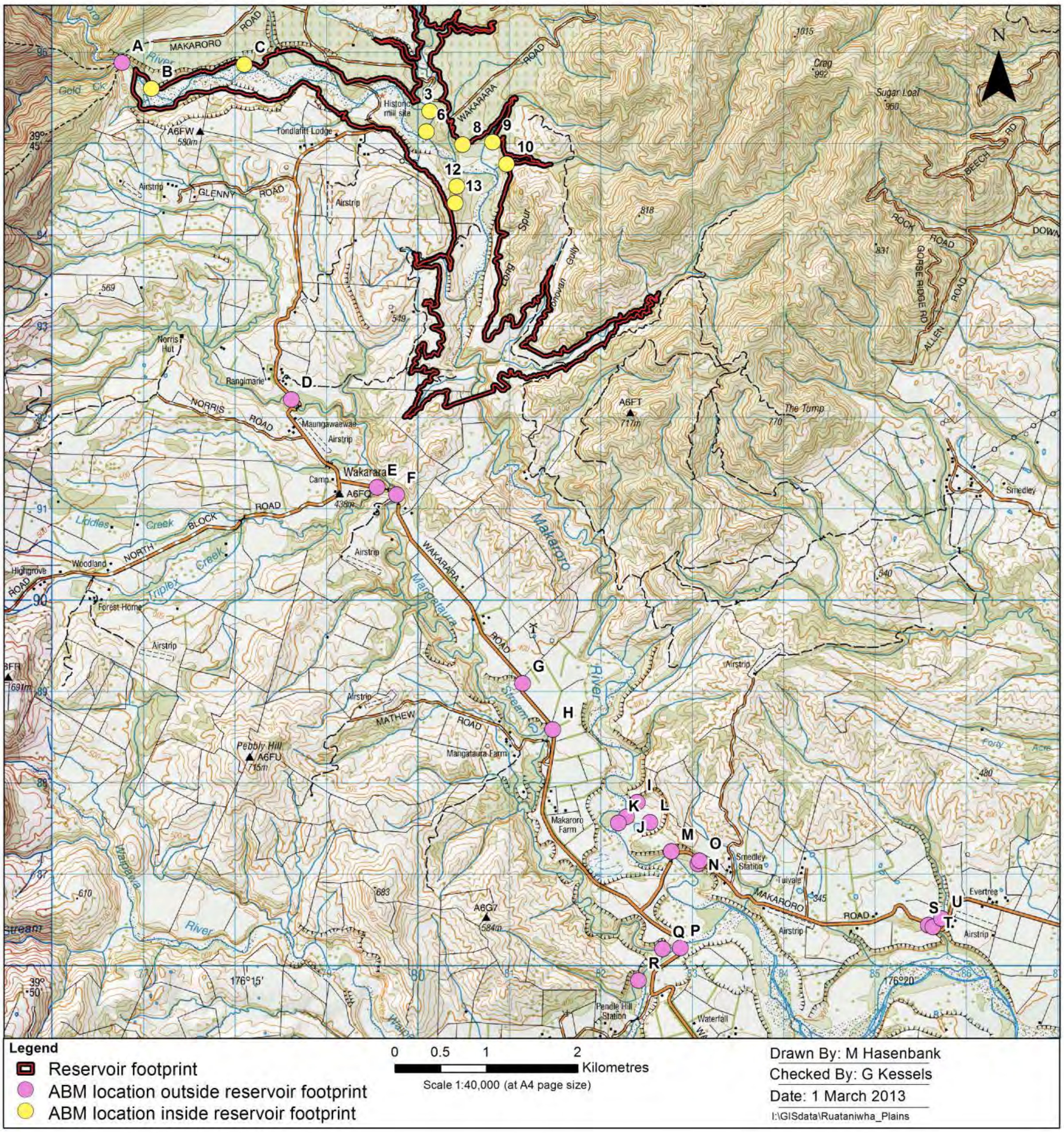

Figure 13 Location of landscape ABM locations in the vicinity of the Mangataura Stream and the Makaroro/Waipawa River confluence, February 2012. Yellow filled circles indicate ABMs within reservoir area, while pink filled circles indicate ABMs outside reservoir area

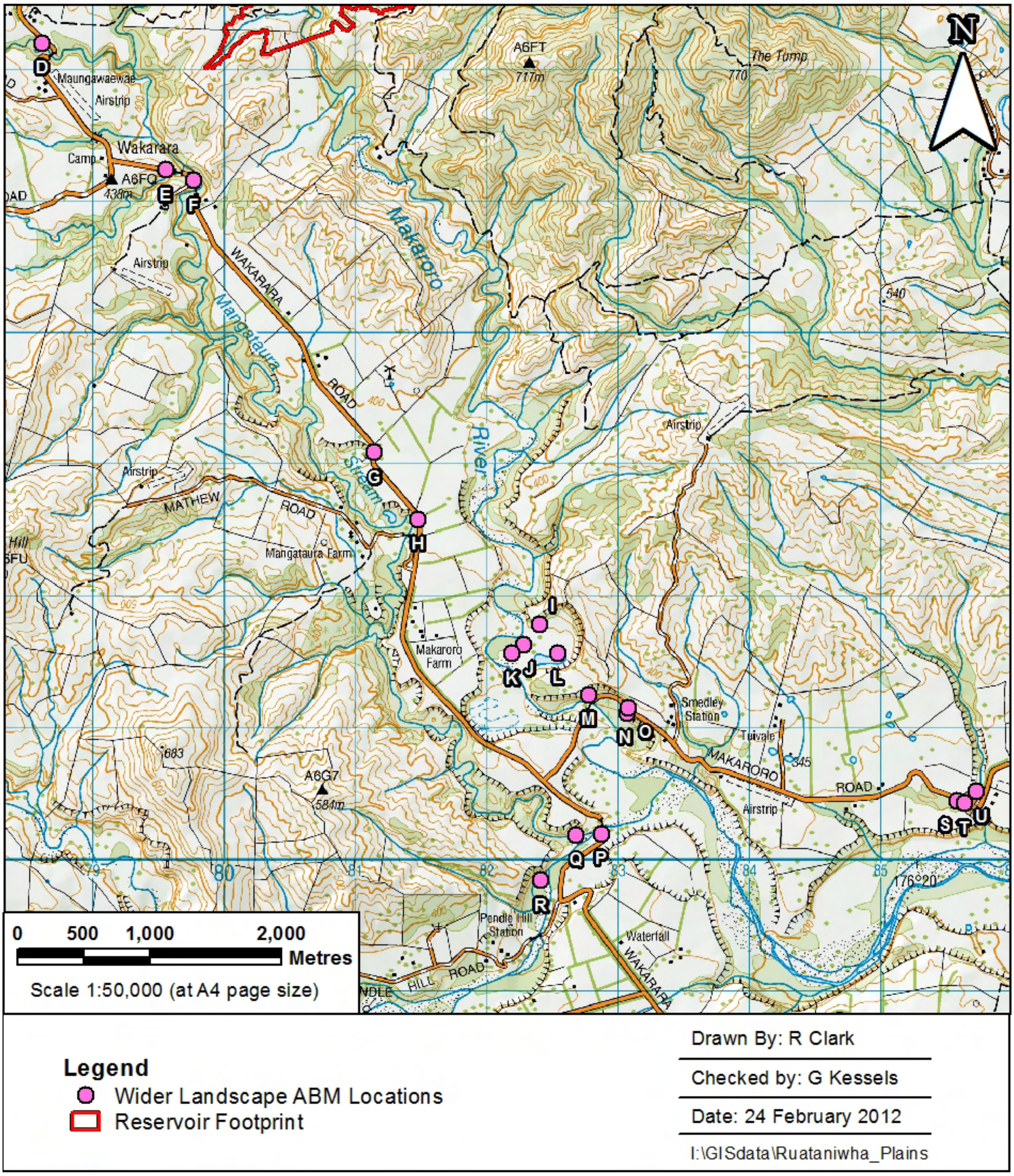

Figure 14 Close-up view of the southernmost (D – U) of the wider landscape ABM locations, February 2012 survey. Locations A-C (not shown, see Figure 15 below) are to the north-west of the reservoir area

Figure 15 Automated bat monitoring locations Makaroro River, February 2012. Pink filled circles indicate locations of ABMs outside reservoir area, while yellow filled circles indicate ABMs within reservoir area

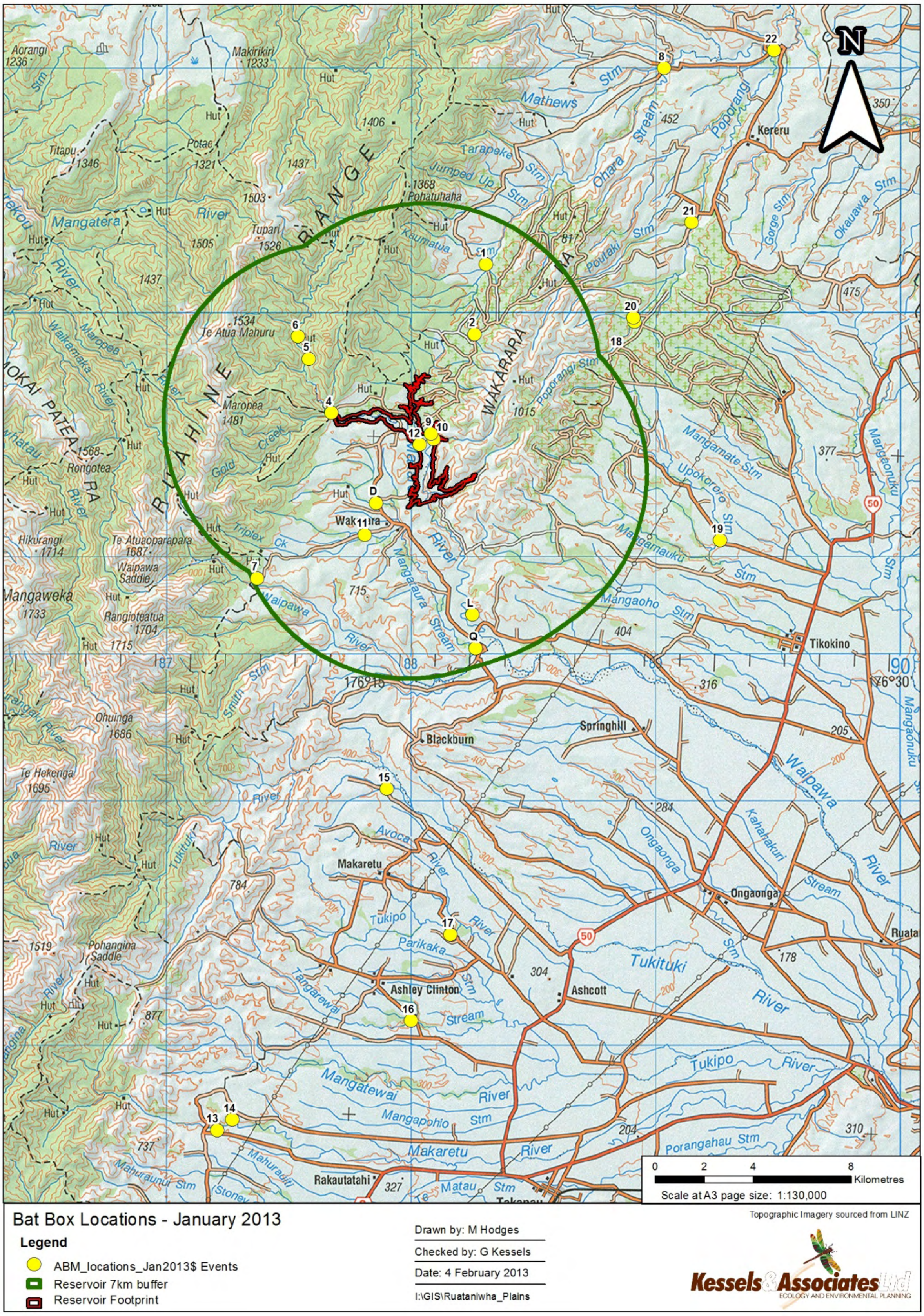

Figure 16 Automated bat monitoring (ABM) locations during January and February 2013 (Surveys 3 and 4). ABMs 4, 9, 10, 12, D, L and Q were deployed at the same locations as in 2011/12. ABM 6 was 300 m further downstream during Survey 3 but moved upstream due to river interference for Survey 4

7.4 Results

7.4.1 Survey 1 – Proposed Reservoir Area

ABM's operated for a total of 253.5 effective nights during the November 2011 survey. A total of 542 bat passes were recorded over nine nights (an average of 5.5 passes/ABM night) (Table 10 and Figure 17). Of these passes 95% were search phase bat passes; 3% were social; 1% were feeding buzzes; <1% of all calls were recorded when two or more bats were flying at the same time.

Table 10 Summary of bat activity, Makaroro River 22 – 30 November 2011

ABM station	1	2	3	4	5	6	7	8	9	10
Effective nights/ABM	9	9	9	9	9	9	9	3	5	2
Total passes/ABM	23	33	47	9	8	42	30	194	67	6
Mean passes/ABM night	2.6	3.7	5.2	1.0	0.9	4.7	3.3	64.5	13.4	0.6
Standard Error	0.9	1.1	3.3	0.5	0.4	1.2	1.1	19.9	12.2	N/A
ABM station	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	
Effective nights/ABM	4	1	Failed	1	Failed	2	9	Failed	9	
Total passes/ABM	9	19	N/A	0	N/A	2	15	N/A	38	
Mean passes/ABM night	2.3	19.0	N/A	N/A	N/A	0.2	1.6	N/A	4.2	
Standard Error	1.1	N/A	N/A	N/A	N/A	N/A	0.9	N/A	1.2	

There were two wind events during the initial 9 night survey period. Although bats were detected on these nights, the weather may have affected activity levels. Although activity levels across sampling sites was generally low, moderate levels of bat activity were recorded about stations 8, 9 and 12 (Table 10). Nine of the ABMs in the lower reaches of the site did not function adequately in November 2011, so a supplementary survey of this area was conducted in December 2011.

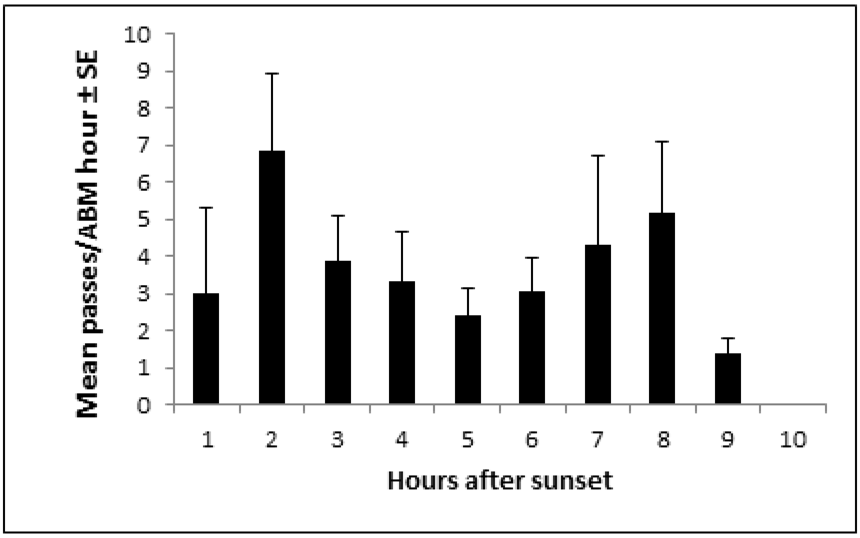

Figure 17 Mean passes ABM hour at at stations 1 to 19 (excluding ABMs 13, 15 and 18, which malfunctioned), reservoir area, 22 – 30 November 2011. Error bars show 1 standard error

The December 2011 Scheme area supplementary survey detected a total of 969 bat passes over 12 nights (an average of 9.6 passes/ABM night). Of these passes 97% were search phase bat passes; <1% were social; <1% were feeding buzzes; and <1% of all calls were recorded when two or more bats were flying at the same time (Table 11, Figure 18).

Table 11 Bat activity summary, supplementary survey Makaroro River 2 – 14 December 2011

ABM station	9	12	13	14	15	16	17	18	19
Effective nights/ABM	5	12	12	12	12	12	12	12	12
Total passes/ABM	64	578	73	32	Noise	0	25	100	97
Mean passes/ABM night	12.8	48.2	6.1	2.7	N/A	N/A	2.1	8.3	8.1
Standard error	6.7	12.0	0.9	1.0	N/A	N/A	0.5	2.4	1.8

In early December, bats were active throughout the night, with a noticeable peak in the second and third hour after sunset. A secondary, more dispersed peak in activity was detected in the 2 hours prior to sunrise (Figure 18).

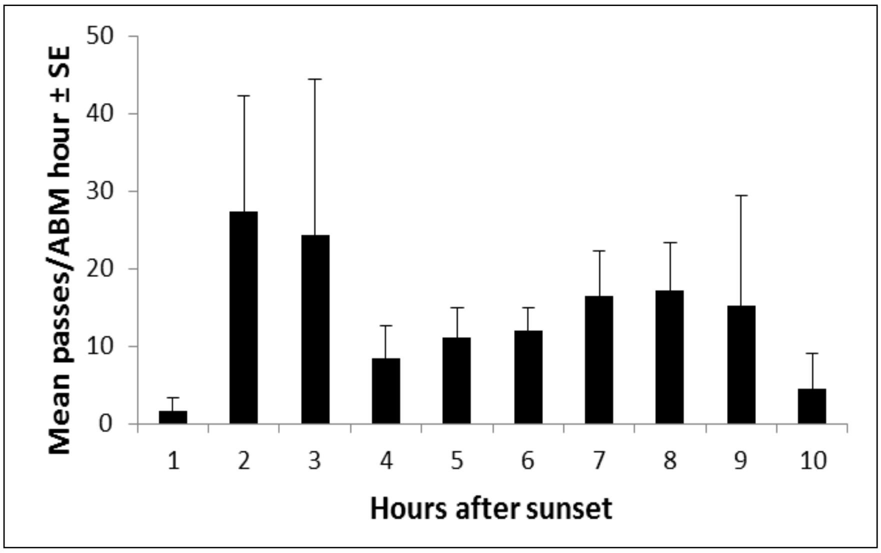

Figure 18 Mean passes per ABM hour at stations 9, 12, 13, 14, 17, 18 and 19, reservoir area, 2 – 14 December 2011. Hour 10 represents only 15 minutes prior to sunrise. Error bars show 1 standard error

7.4.2 Survey 2 - Repeat Sampling in the Reservoir Area and Wider Landscape Survey

Higher levels of bat activity were detected from ABM locations within the reservoir area during the February 2012 survey compared with the November/December 2011 surveys, and compared with areas outside the reservoir (Figure 19 and Figure 20). Within the reservoir area, a total of 1,693 bat passes were recorded over the 7 night period (an average of 34.2 passes/ABM night). Of these passes 93% were search phase bat passes; 1% were social; 6% were feeding buzzes; and <1% of all calls were recorded when two or more bats were flying at the same time (Figure 19 and Table 12).

Table 12 Summary of hourly bat activity within the reservoir area, February 2012

ABM station	3	6	8	9	10	12	13	B	C
Effective nights/ABM	7.0	6.0	6.0	6.0	5.5	7.0	Failed	6.0	6.0
Total passes/ABM	245	112	92	104	535	599	Failed	6	0
Mean passes/ABM night	35.0	18.7	15.3	17.3	97.3	85.6	N/A	1.0	N/A
Standard Error	15.7	2.5	3.0	5.1	36.0	13.7	N/A	0.4	N/A

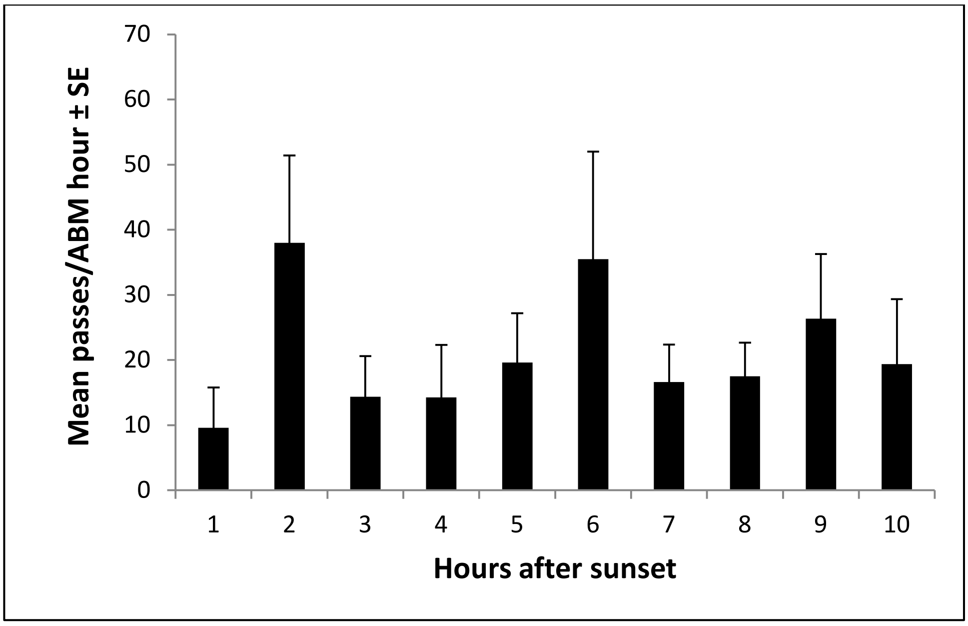

Figure 19 Results of the repeat survey of the reservoir area showing mean passes per ABM hour after sunset, Makaroro, 2 – 9 February 2012

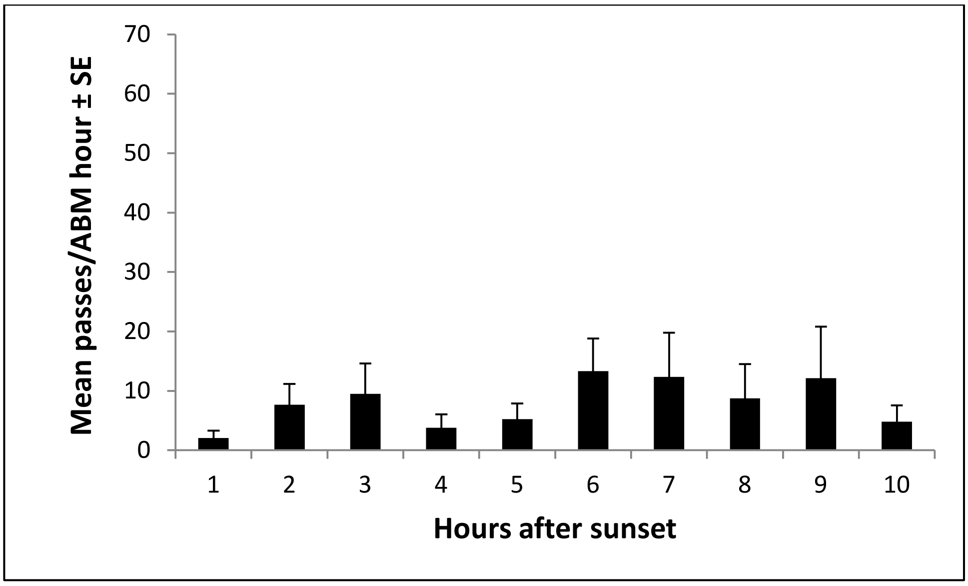

Figure 20 Results of the wider landscape survey showing mean passes per ABM hour after sunset, Makaroro and Waipawa Rivers 2 – 9 February 2012

Table 13 Summary of bat activity outside of the reservoir area, February 2012

ABM station	A	D	E	F	G	H	I	J	K	L
Effective nights/ABM	6	7	7	7	7	7	7	7	7	7
Total passes/ABM	1	34	23	19	24	115	53	115	10	679
Mean passes/ABM night	0.2	4.9	3.3	2.7	3.4	16.4	7.6	16.4	1.4	97
Standard error	N/A	0.4	1.1	0.6	1.3	7	1.1	6.7	0.8	17.1
ABM station	M	N	O	P	Q	R	S	T	U	
Effective nights/ABM	Failed	4	8	8	8	7	Failed	8	8	
Total passes/ABM	N/A	0	4	1	159	7	N/A	5	33	
Mean passes/ABM night	N/A	0	0.8	0.1	19.9	1	N/A	0.6	4.1	
Standard error	N/A	N/A	0.5	N/A	6.6	0.5	N/A	0.3	1.3	

The February 2012 (Wakarara) survey outside of the reservoir area collected a total of 120 effective ABM nights data. A total of 1,282 bat passes were recorded over the 8 night period (an average of 10.6 passes/ABM night). Of these passes 97% were search phase bat passes; <1% were social; 2.7% were feeding buzzes; and <1% of all calls were recorded when two or more bats were flying at the same time (Figure 20, Table 13). Fifty-three percent of all landscape activity was recorded from ABM "L", which was positioned on the edge of a 2 ha pond approximately 200 m from the Makaroro River (Table 13, Figure 14 and Figure 21). Only seven passes in total were detected from the three ABM's (A, B and C) in the Upper Makaroro area near the upstream end and above the reservoir area (Figure 15 and Figure 21).

A single pass displaying a staccato rhythmic pattern and tone similar to that produced by the lesser short-tailed bat (*Mystacina tuberculata*) was detected from ABM 9 at 04:26 on 8/02/2012 within the reservoir area. This sample site borders an area of mature native bush. The single pass is noteworthy, but until further work is completed the observation should be considered "possible" unless confirmed by repeat observations. The record does not visually resemble known patterns of long-tailed bat social calls, which also fall within the frequency range of short-tailed bat calls. Subsequent surveys failed to detect any similar calls and so this record is highly unlikely to represent the presence of lesser short-tailed bats.

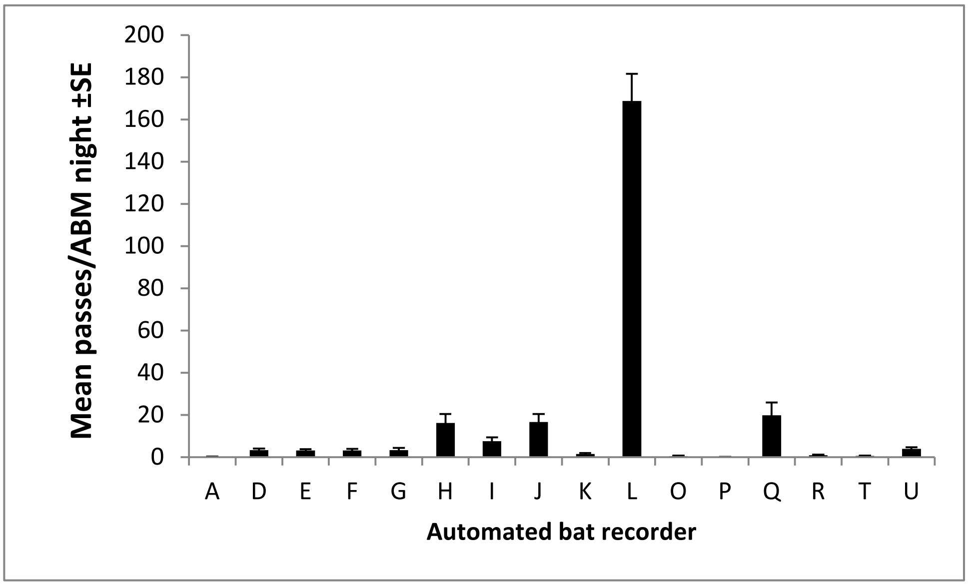

Figure 21 Mean passes/ABM night detected at the 16 ABM stations outside of the reservoir area (excluding ABMs M and S which failed), Makaroro and Waipawa Rivers 2 – 9 February 2012. Error bars show 1 standard error. For locations of monitoring stations, see Figure 13 and Figure 14, and Figure 15

7.4.3 Surveys 3 and 4 - Repeat Sampling in the Reservoir Area and Wider Landscape Survey, January and February 2013

Weather conditions were very good during the survey in January 2013, and mostly very good for the survey in February 2013. Activity over the entire sampled area was similar during both surveys. A total of 1071 passes were recorded in January 2013, and a total of 1131 passes in February 2013. The mean number of passes per ABM during January was 48.7 (± 15.3) c.f. 47.1 (± 19.2) for February (Standard error in brackets). Activity in the reservoir area was considerably higher than in the other areas of interest (Table 16). Of note is the reduction in activity at ABM 10 (within the Scheme area) from January to February surveys.

Only five passes in total were detected from the two ABM's (5 and 6) deployed in the Upper Makaroro River on Public Conservation Land upstream of the Scheme area.

Table 14 Survey 3 - Summary of ABM efficacy and bat activity; Reservoir and greater Central Hawke's Bay landscape, January 2013

ABM station	**1**	**2**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Effective nights/ABM	7	7	7	7	Noise	4	7	7	5	7	6	7
Total passes/ABM	36	12	16	0	N/A	0	0	119	279	21	206	1
Mean passes/ABM night	5.1	1.7	2.3	N/A	N/A	N/A	N/A	17	56	3	34	0.1
Standard error	1.9	1	0.8	N/A	N/A	N/A	N/A	4	20	1.1	6.2	N/A
ABM station	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**D**	**L**	**Q**
Effective nights/ABM	7	7	7	7	6	4.5	0	7	7	7	7	7
Total passes/ABM	34	38	103	78	40	0	N/A	10	4	38	0	36
Mean passes/ABM night	4.9	5.4	15	11	5.7	N/A	N/A	1.4	0.6	5.4	N/A	5.1
Standard error	3.1	1.7	3.9	3.1	2.4	N/A	N/A	0.6	0.3	2.4	N/A	1.7

Table 15 Survey 4 - Summary of ABM efficacy and bat activity; Reservoir and greater Central Hawke's Bay landscape, February 2013

ABM station	**1**	**2**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Effective nights/ABM	7	7	7	4	7	4	7	7	3	7	7	7
Total passes/ABM	13	14	16	0	5	1	1	151	1	0	446	62
Mean passes/ABM night	1.9	2	2.3	N/A	0.7	0.3	0.1	22	0.3	N/A	64	8.9
Standard error	0.9	0.8	0.6	N/A	0.6	0.2	0.1	7	0.3	N/A	26	6.4
ABM station	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**D**	**L**	**Q**
Effective nights/ABM	7	7	7	7	6	4.5	7	7	7	7	4	7
Total passes/ABM	114	46	94	44	10	7	6	0	2	15	25	58
Mean passes/ABM night	16.3	6.6	13	6.3	1.4	1.4	0.9	N/A	0.3	2.1	6.3	8.3
Standard error	5.9	1.6	2.5	1	0.4	0.7	0.5	N/A	0.2	1.1	2.7	2.0

Table 16 Summary of bat activity per ABM over 7 night deployments in four strata, January and February 2013. Figures in brackets show data from the February survey

Strata	Passes	ABMs	Passes/ABM
Reservoir	604 (585)	3 (3)	201.3 (195.0)
<3.5km	87 (45)	5 (5)	17.4 (9.0)
>3.5<7km	72 (103)	4 (5)	18 (20.6)
>7km	309 (398)	10 (11)	30.9 (36.2)
Totals	1072 (1131)	22 (24)	48.7 (47.1)

Activity at the three reservoir stations was high over both survey periods (Figure 22). ABM 10 did not record the last 3 hours during January 2013 due to a switch error, and so it is possible that the hours 8 -10 results (January), underestimate the actual onsite activity about that ABM. The increased variability in the February 2013 data is mainly due to the elevated activity levels about ABM 12, where 75% of all February 2013 activity was recorded.

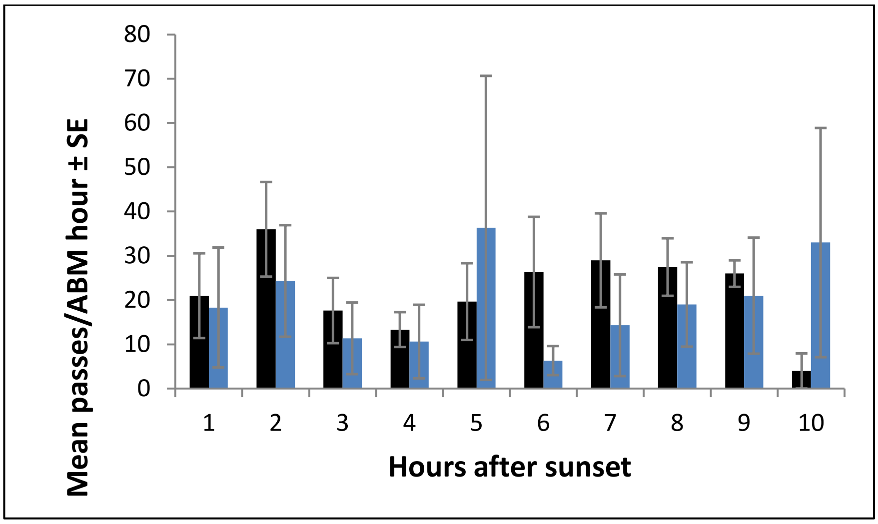

Figure 22 Summary of hourly bat activity at ABM stations 9,10 and 12 (10 did not record for the last 3 hours each morning during January), Reservoir site, January (black) and February (blue) 2013. Error bars show 1 standard error

Activity at ABMs within 3.5 km of the reservoir area was low in both months. There was only occasional activity within the two hours after sunset and two hours preceding sunrise (Figure 23).

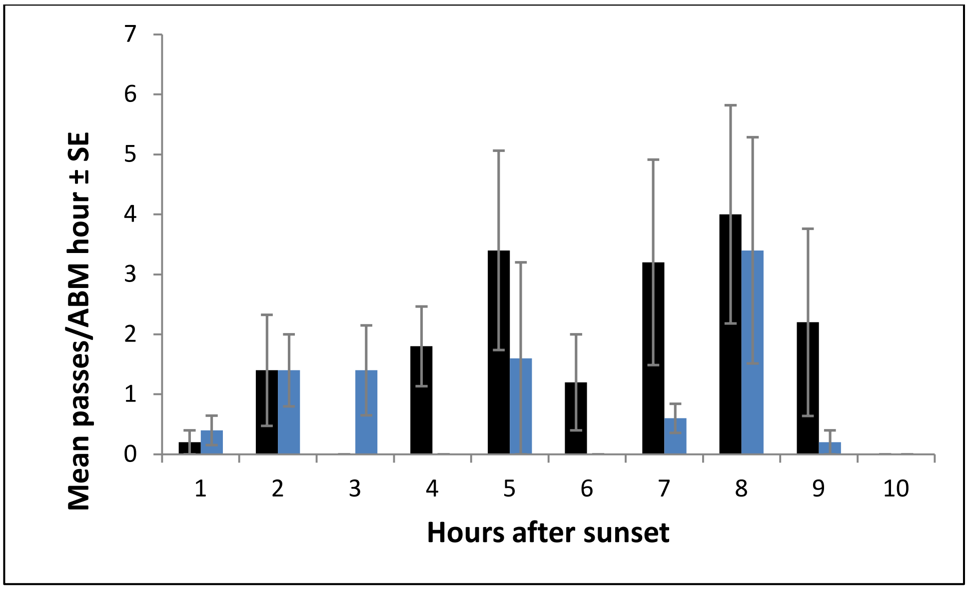

Figure 23 Summary of hourly bat activity at ABM stations 2, 4, 5, 11 and D, <3.5km from the Reservoir site, January (black) and February (blue) 2013. Error bars show 1 standard error

Activity at ABMs within the <3.5km <7km strata was relatively low during both survey periods (Figure 24). Bats were found to be more active during the second hour of darkness (ABM 6 was adversely affected by river noise during January 2013).

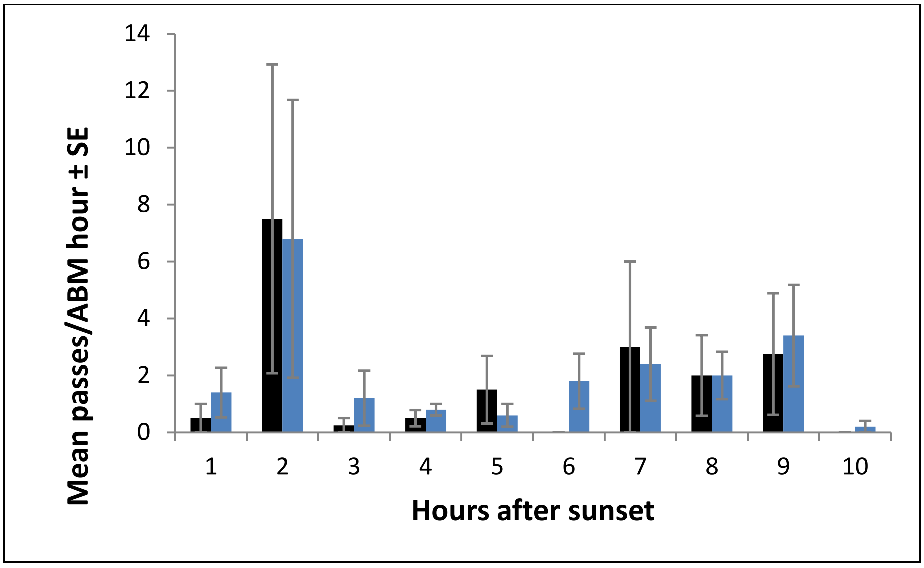

Figure 24 Summary of hourly bat activity at ABM stations 1, 7, L and Q (ABM 6 shut down in January (noise), <3.5km<7km from Reservoir site, January (black) and February (blue) 2013. Error bars show 1 standard error

ABMs 13 – 17 were all at least 10 km south of the reservoir area. A large proportion (91%) of all February 2013 activity in the wider landscape surrounding the reservoir area was detected from this cluster of ABMs. Early evening activity was observed during both months indicating that bats were roosting somewhere nearby, in the greater landscape outside of the reservoir area.

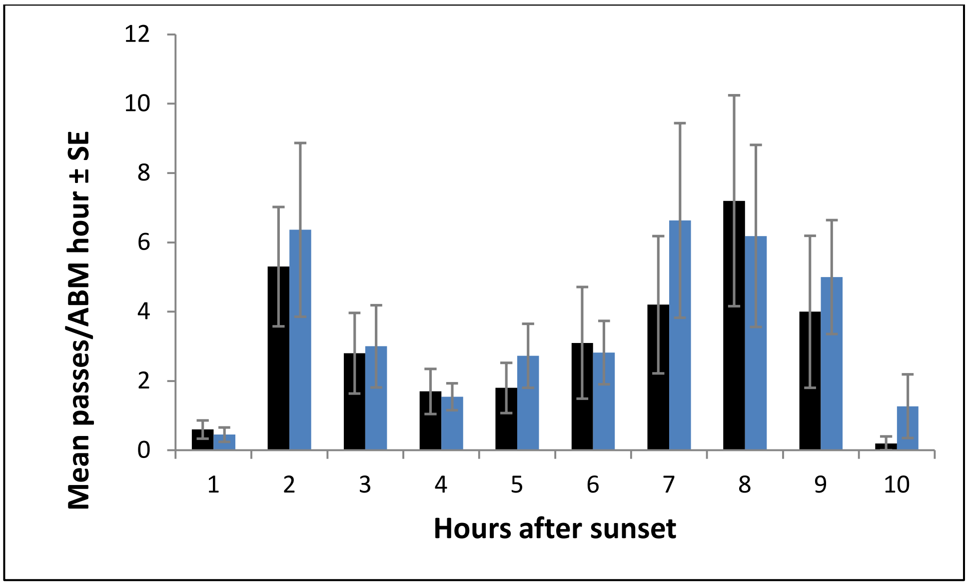

Figure 25 Summary of hourly bat activity at ABM stations 8, 13, 14, 15, 16, 17, 18, 19, 21 and 22 (ABM 20 failed in January), >7km from Makaroro Reservoir site, January (black) and February (blue) 2013. Error bars show 1 standard error

7.4.4 Habitat Utilisation

Surveys conducted in late November 2011 confirmed that long-tailed bats were present. Activity was generally low across the reservoir area, with the exception of three sampling sites (8, 9 and 12), all of which were located in close proximity to mature stands of trees; sites 9 and 12 bordered native beech and podocarp-broadleaf forest while site 8 was along the margin of a mature pine plantation. Generally low levels of activity detected by this survey made it difficult to determine if long tailed bats were roosting within the reservoir area. However, long tailed bats were found to be active throughout the night, indicating that the reservoir area represents an important habitat for them.

In February 2012 bats were detected at all surveyed localities outside the reservoir area, to a maximum of 8 km down river. Only seven passes were detected up river of the reservoir area (one monitored outside reservoir area, and six monitored inside reservoir area), suggesting that bats were not coming past the monitoring stations from the Ruahine Ranges during the 9 night period. Activity was much higher in the reservoir zone compared with the wider landscape (mean 34.2 passes/ABM night vs. 10.6).

There were clear peaks in activity in the first three hours after dusk, and then again shortly before dawn. This pattern is most obvious for monitoring stations 3, 6, 10 and 12. Of particular interest is the activity within the first hour at stations 10 and 12, which began only 20 minutes after official sunset. This indicates that long-tailed bat roosts may be in the immediate vicinity of these monitoring stations. In contrast, activity outside the reservoir area rarely began within the first hour after sunset, and if then only a small number of calls were detected (i.e. less than an average of 3 in the hour, vs. more than 20 per hour in the reservoir area). The only exception to this was monitoring station L, which had nearly 20 calls per hour in the first hour after sunset. Where long-tailed bat activity was high outside of the reservoir area, it occurred in the middle of the night, indicating that these individuals likely had come into this area from somewhere else; possibly from the reservoir area.

Surveys conducted in January and February 2013 showed that long-tailed bats are present within the wider central Hawke's Bay area surrounding the reservoir area. However, it is clear that the reservoir area has a relatively large amount of activity and thus is likely an important habitat for bats in the region. Interestingly, the second highest area of activity was greater than 7 km from any margin of the reservoir area. Radio-telemetry studies of long-tailed bat movement within modified landscapes (plantation forest and an agricultural/urban mosaic) showed that the maximum range-span (maximum distance flown across a home range) was approximately 7 km (Dekrout 2009, Borkin 2010). Thus, it is likely that bats detected > 7 km from the reservoir belong to a population discrete from those living in the reservoir area. Activity (passes/ABM) in areas <3.5 km and >3.5<7km from the reservoir were just over half that recorded >7km from the reservoir. It is interesting to note that activity levels were low at monitoring stations 4, 5 and 6 in the Ruahine Ranges. This result confirms that bats are unlikely to be moving in from the conservation land into the reservoir area, or vice versa, along the river. Bats were recorded in the plantation forest on the north-east margins of the reservoir, but few passes were detected. Timing of activity shows that long-tailed bats are likely to roost in close proximity to the monitoring stations within the reservoir area. Outside of this region the pattern is less clear making it difficult to assess where the bats are roosting.

Despite extensive resampling in January and February 2013, no other calls similar to those produced by lesser short-tailed bats were recorded. Thus it is safe to conclude that they are extremely unlikely to be in the area.

8 Herpetofauna Surveys & Assessment

8.1 Introduction

For a temperate country New Zealand has a large number of lizard species, many of which are restricted in distribution and/or rare as a result of habitat changes, particularly associated with introduced mammalian predators. Lizards can play a variety of ecological roles, including pollination, seed dispersal, predation of invertebrates and provision of food for birds, such as moreporks and kingfishers.

In order to assess the lizard populations of the proposed reservoir site a field survey was conducted from 8 February to 10 February 2012. This followed a nocturnal survey on 20 and 21 December 2011. Artificial Cover Objects (ACOs) and tracking tunnels were also placed at several sites and monitored for the presence of lizards (see Sections 8.3 and 8.4).

8.2 Potential Lizard Species Present within the Study Area

Eleven species of lizard are known from the southern Hawke's Bay region or neighbouring areas of the southern North Island (Jewell, 2008). Four of these species are considered likely to be present within the footprint of the proposed reservoir. The others, while unlikely to be present (either through being rare or with distributions that are either highly localised or not known to include southern Hawke's Bay) could potentially occur there. Taxonomy and conservation status follow Hitchmough *et al*. (2010) – note that the gecko genus *Hoplodactylus* has since been revised, with the creation or resurrection of five new genera (Nielsen et al., 2011).

1. Common skink (*Oligosoma polychroma*): Not threatened

A common species in the southern North Island though few records from southern Hawke's Bay. Occurs in a wide range of open country habitats and scrub. Forbes *et al*. (2011) recorded 11 common skinks in ACOs in the Smedley Station/Wakarara Range area. Likely to be present in this area.

2. **Speckled skink (*Oligosoma* aff. *infrapunctatum* 'Southern North Island'): Threatened – Nationally Vulnerable**

Sparsely distributed on the mainland, though can be locally common, mostly from open country habitats including open forest. Few Hawke's Bay records. Unlikely to be present in this area.

3. **Small-scaled skink (*Oligosoma microlepis*): At Risk – Declining**

Has a very restricted distribution from Taupo through inland Rangitikei to northern Ruahines. Most southerly recorded sites are approximately 20km north-west of this location. Can be abundant but very localised in open, rocky habitats. Unlikely to be present in this area.

4. **Spotted skink (*Oligosoma lineoocellatum*): At Risk – Relict**

Sparse and localised in southern North Island, in open habitats. Known from coastal sites near Napier and inland sites in the southern Wairarapa. Unlikely to be present in this area.

5. **Brown skink (*Oligosoma zelandicum*): Not threatened**

Widespread in southern North Island in wide range of habitats west of the main ranges. Recorded from western side of Ruahines. Unlikely to be present in this area.

6. **Copper Skink (*Oligosoma aeneum*): Not threatened**

Widespread in northern North Island and near Wellington (including southern Wairarapa) in a wide range of habitats, with one recorded population near Cape Turnagain. Not known from Hawke's Bay and unlikely to be present in this area.

7. **Ornate skink (*Oligosoma ornatum*): At Risk – Declining**

Widespread in North Island in a wide range of habitats but largely absent from Hawke's Bay. Recorded from southern Ruahines but unlikely to be present in this area.

8. **Common gecko (*Hoplodactylus maculatus*): Not threatened**

A reasonably common species in south-eastern North Island. Occurs in a range of habitats, including rock fissures, boulder piles and trees. Forbes *et al*. (2011) recorded 5 common geckos in ACOs in the Smedley Station/Wakarara Range area, and there is a herpetofauna database record from a tributary of the Makaroro River in the Wakarara Range. Likely to be present in this area.

9. **Wellington green gecko (*Naultinus elegans punctatus*): At Risk – Declining**

Widespread but sparse in south-eastern North Island, although can be common in suitable habitat. Occurs in forest and shrubland, including manuka and kanuka. There is a herpetofauna database record from the Eastern Ruahine State Forest (Forbes *et al*., 2011). Likely to be present in this area.

10. **Southern North Island Forest Gecko (*Hoplodactylus* aff. *granulatus* 'southern North Island'): Not threatened**

Recorded sparsely from the southern North Island, in forest and shrubland habitats, usually arboreal. There is a herpetofauna database record from the Gwavas Conservation Area in the Wakarara Range (Forbes *et al*., 2011). Confirmed as present within the reservoir footprint, from atypical habitat (see Section 4.1).

11. **Pacific gecko (*Hoplodactylus pacificus*): At Risk – Relict**

Uncommon in southern North Island and not recorded from Hawke's Bay mainland, though present on Portland Island off Mahia Peninsula (Forbes *et al*., 2011). Unlikely to be present in this area.

8.3 Methodology

Surveys of lizards within the proposed reservoir footprint aimed to identify the species, which are present to provide estimates of their relative abundance and to identify, which habitats are of particular significance to lizard species.

A variety of methods were used to search for lizards, as described below.

8.3.1 Artificial Cover Objects (ACOs)

Artificial Cover Objects (ACOs), each consisting of stacks of three 400mm x 400mm sheets of Onduline® separated by small wooden spacers (see Photo 13), were deployed in areas considered most likely to support lizards during November and December 2011. They were deployed in groups of five stacks per cluster about forest, scrub and shrubland margins at the 10 locations shown in Figure 26. To date the ACOs have been checked on six occasions from January 2012 until February 2013.

8.3.2 Tracking Tunnels

A total of 18 tracking tunnels (see Photo 14) were deployed in tandem with 2 or 3 of the ACO stacks per cluster, at 6 of the ACO clusters (see 8.3.1 above for ACO placement rationale). The tunnels were deployed at ACO clusters B1, B3, L1, L2, L3 and K9. To date three tracking rounds have been completed.

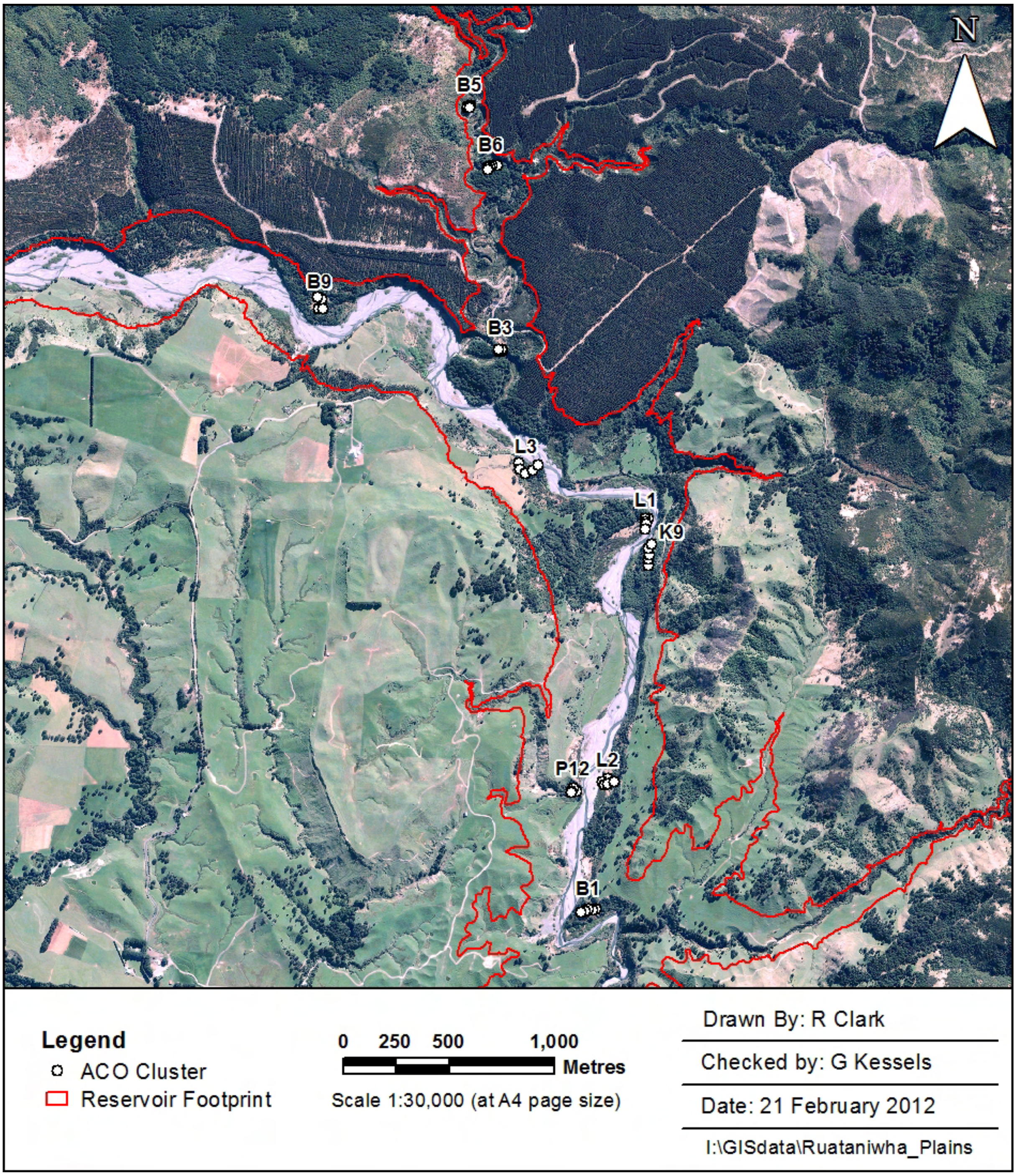

Figure 26 Location of ACOs and tracking tunnels

Photo 13 ACO station

Photo 14 Tracking tunnel (right) and weta 'motel' used in invertebrate surveys (left)

8.3.3 Habitat Searches

By day areas considered to be potential lizard habitat were searched actively and passively. Active searches involved inspecting lizard retreats, e.g. tree bark, rocks, logs, standing dead trees, vegetation, leaf litter, or fissures in cliff faces and rock outcrops, for presence of lizards or their droppings or cast skins.

Passive searching by day involved walking slowly through potential lizard habitat, looking and listening for sun-basking diurnal species. The canopies of manuka and other shrub/small tree species were checked with naked eye or binoculars for Wellington green geckos. Areas of rocky habitat where the depth of rocks was too deep for active searching (because lizards would be able to retreat beyond practical search range) were watched in sunny weather through binoculars for presence of sun-basking individuals.

Nocturnal arboreal species (particularly forest geckos and common geckos) were searched for during December 2011 and February 2012 resulting in a combined total of 11.75 hours effort. On December 2012 20 and 21 two field workers searched for a total of 6 hours. In February 2012 searches were completed from 45 minutes after sunset (9pm) using LED headlamps and binoculars in areas of mature forest and adjacent scrub. Light from headlamps reflected in geckos' eyes shows up as bright points of light, revealing the location of these cryptic, highly camouflaged species. Three field workers searched for 1 hour on the evening of 8 February 2012, and two searched for 1 hour on the evening of 9 February 2012.

The areas searched are shown in Figure 27 overleaf.

8.4 Results

8.4.1 Southern North Island Forest Gecko

Only one lizard was found during the field survey. This was a southern North Island forest gecko (*Hoplodactylus* aff. *granulatus* ‘southern North Island’), found in a rock pile among pasture, with a few scattered shrubs (5593788 1880511 NZTM). This is very atypical habitat for this species, which is mostly arboreal (though known from fissures in clay banks), and generally recorded from forest or scrub habitats. The specimen was a male, with a snout-vent length of 78mm. The species typically ranges from 75-85mm (Jewell, 2011).

Two field workers spent approximately 1 hour searching rocks in this area (Catch Per Unit Effort 0.5 lizards/person/hour). The main pile, where the gecko was found, was worked over from bottom to top, with each searcher working from the outside to the middle, excavating into the pile to a depth of 30 cm or more to reach a firm substrate. The gecko was found near the end of the search (at the top centre of the pile) and had probably been retreating ahead of the searchers.

8.4.2 ACOs and Tracking Tunnels

No lizards were recorded from ACOs, and no lizard tracks were recorded from tracking tunnels including in February 2013.

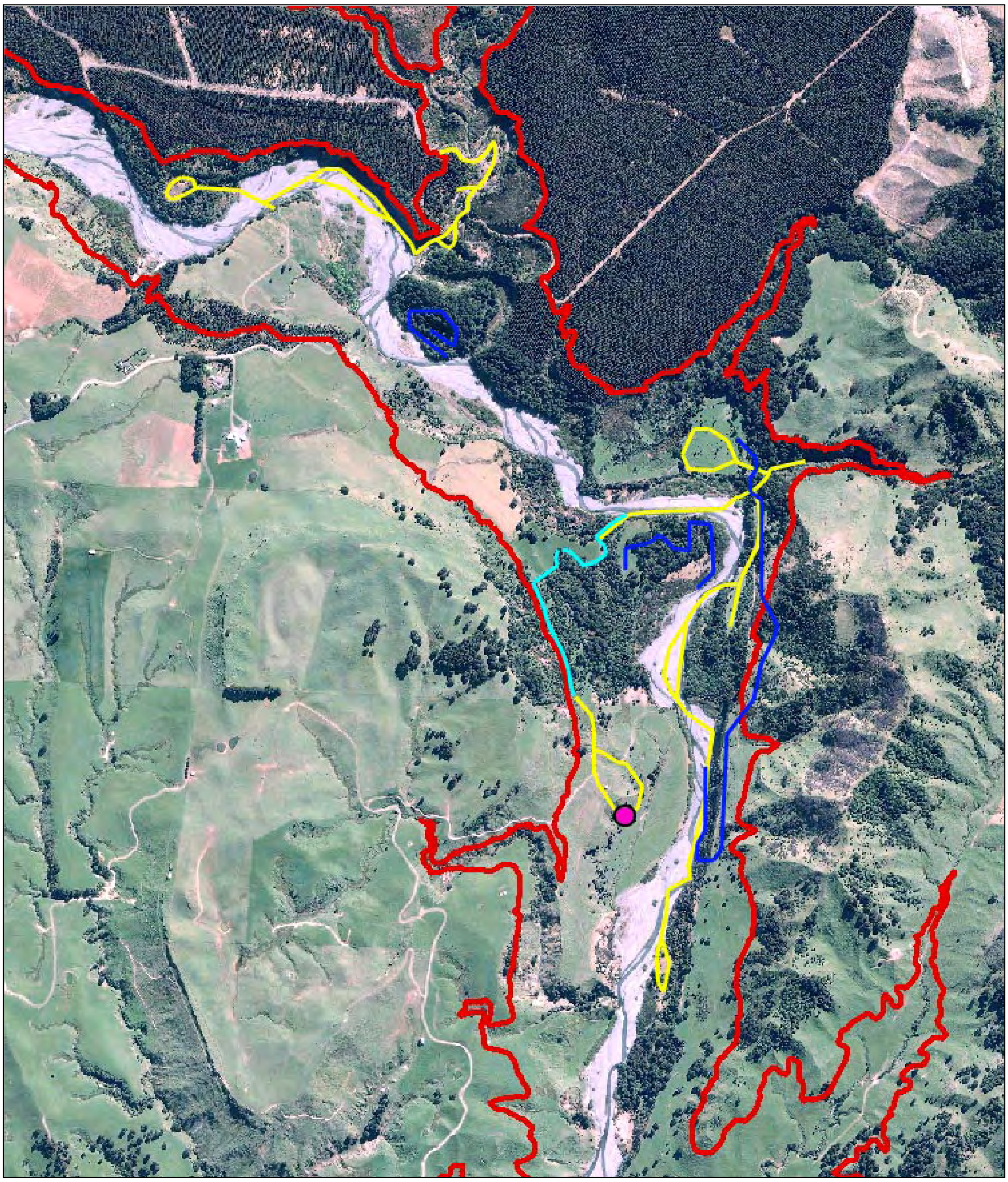

Figure 27 Areas searched during lizard surveys. Yellow: diurnal searches. Dark blue: December nocturnal searches. Pale blue: February nocturnal searches. Red: proposed reservoir shoreline. Pink circle: location of forest gecko specimen (Section 8.4.1)

Photo 15 Southern North Island forest gecko from rock pile, upper Makaroro River

Photo 16 Southern North Island forest gecko habitat (rock pile, centre)

9 Terrestrial Invertebrate Surveys & Assessment

9.1 Summary

Targeted rapid biodiversity surveys for terrestrial invertebrates were undertaken within the reservoir area in December 2011 and again in January 2012. In addition, passive detection devices (i.e. weta boxes and tracking tunnels – for lizards as well) have been deployed and checked throughout the site from November 2011 until recently in February 2013.

Hymenoptera were used as surrogate for determining insect species richness, following the rapid biodiversity assessment (RBA) method (Ward & Larivière, 2004). Results showed a relatively rich diversity of Hymenoptera species, which suggests an equally high level of diversity at lower trophic levels, as well as in other invertebrate groups. However, less than what could be defined as average number of terrestrial Gastropod species was found in litter samples and searches.

The Hawke's Bay tree weta, *Hemideina trewicki*, was the only terrestrial invertebrate species found that was listed 'At Risk' in Hitchmough *et al*. (2007).

Following outcomes of the peer-review process (see Appendix XV), a literature study on the potential presence of Threatened or At Risk beetles, spiders, moth or butterflies within the Scheme or wider area was undertaken (see Appendix XVI). This study resulted in a primary list for Data Deficient, At Risk, or Threatened beetle and moth species, which includes the Threatened species of *Mecodema atrox* (Coleoptera), the At Risk species of *Tatosoma agrionata* (Lepidoptera), *Meterana pictula* (Lepidoptera) and *Pyrgotis pyramidias* (Lepidoptera), as well as the Data Deficient species of *Izatha caustopa* (Lepidoptera).

9.2 Introduction

Invertebrates perform a range of key roles needed for an ecosystem to function, be it pollination, litter decomposition, predation, herbivory, or else. Many vertebrate species also rely on invertebrates as a food resource.

In order to improve the knowledge around the diversity of resident terrestrial invertebrate communities at the proposed reservoir site, a rapid biodiversity assessment (RBA) of terrestrial invertebrates (Ward & Larivière, 2004) was conducted between the 20th and 31st of December 2011. The survey focused on providing a measure of species richness as a way of characterizing the diversity of terrestrial invertebrates at the study site. The complexities of ecological systems, as well as the paucity of taxonomic knowledge around many invertebrate groups in New Zealand, are two of the main challenges when attempting to 'capture' the biodiversity within a certain area. A trade-off between completeness and feasibility is presented by the use of surrogate taxa, which can be used to estimate the species richness in a given community without knowledge of all its building blocks. However, the usefulness of different surrogate taxa and related methodologies is still discussed widely (i.e. Grantham *et al.*, 2010; Sauberer *et al.*, 2004). With the study objective in mind, certain aspects have to be considered when choosing surrogate taxa. For example, ideally surrogate taxa are present at all links in the trophic chain, have a relatively high abundance, respond to disturbances in their environment in a sensitive and analysable way, and have a relatively well understood taxonomy (Hutcheson *et al.*, *1999*). For this study the order of Hymenoptera was chosen to act as a surrogate for the terrestrial invertebrate communities encountered within the study area. Hymenoptera species are represented at different trophic levels and Hymenoptera species richness has been shown to reflect diversity in other groups, such as Lepidoptera, for example (Anderson *et al*., 2011; Kerr *et al*., 2000). Other studies in New Zealand, such as Ward (2011), have also included Hymenoptera as indicator species for determining the diversity of invertebrates.

In addition to sampling Hymenoptera, the potential occurrence of any rare or threatened taxa, particularly large native land snail species known to occur within the region, was investigated. Following outcomes of the peer-review process (see Appendix XV) a literature study investigating the potential occurrence of At Risk or Threatened beetle, spider, butterfly and moth species within, or near the Scheme area was also conducted (included as Appendix XVI). Results of this study are presented under 9.5.4.

9.3 Objectives

The first objective of the terrestrial invertebrate survey was to provide a measure of species richness for the insect community encountered at the study site. The sampling focused, in particular, on two representative vegetation fragments, lowland black beech forest and lowland indigenous scrub, encountered along the braided river system. The order Hymenoptera is a diverse group represented at different trophic levels, encompassing nectar feeding bees, gall-forming and parasitic wasps, as well as hyperparasitoides, and was used as a surrogate to assess species richness at the study site. In addition, within the Hymenoptera sample any rare, threatened, or ecologically significant species were identified.

It is known that larger land snail species, such as *Powelliphanta marchanti*, occur in parts of the Ruahine Ranges, and anecdotal evidence from conversations with landowners suggests native land snails being present "within affected forest on true right of river" (MWH, 2011). Therefore, searches were conducted to investigate their potential occurrence at the study site. In addition, at one site within a representative lowland black beech forest fragment smaller land snails were sampled[12], and the resulting species list was used to identify any rare, threatened, or ecologically significant species present. From these samples a measure of species richness was determined.

We acknowledge that by not extending the search for threatened invertebrates to other groups, such as Coleoptera or Lepidoptera, this study can only come to confined conclusions regarding the presence of threatened invertebrate taxa within the study area.

9.4 Methodology

9.4.1 Study Sites

The invertebrate sampling focused on the central part of the proposed reservoir. Here, a greater amount of indigenous vegetation was present compared to the northern or southern part of the proposed reservoir (Figure 29). Sampling of terrestrial invertebrates from all habitat types encountered within the study area was beyond the scope of this survey. Lowland black beech, intermingled with podocarp and broadleaf vegetation, was chosen as a representative forest type for the study area, and a suitable sampling area was selected based on its shape, size and proximity to other areas of similar vegetation. A similar selection process applied to a second vegetation type, manuka floodplain that was chosen to represent indigenous shrubland for the study area (refer to Figure 28 for a representative photo of each vegetation type). Areas of primarily exotic vegetation were excluded from the selection process as they are likely to contain introduced species and therefore modified invertebrate communities.

Figure 28 Indigenous forest/treeland (left) and indigenous shrubland (right)

Woody vegetation present at the indigenous forest site consisted mainly of mahoe, horopito, mapou, kanono and black beech. Different fern species (i.e. *Asplenium*, *Blechnum* and *Microsorum* species), as well as seedlings from a range of woody plants made up the groundcover (see RECCE Plot 2 in botanical section for a more detailed list). The vegetation at

[12] Samples of leaf litter were taken, which were dried and searched for small land snails.

the indigenous shrubland site consisted of a range of native and introduced shrub and tree species, including manuka, lemonwood, karamu, flax, lancewood, as well as bitter willow and buddleia. A range of introduced and native species formed a relatively dense groundcover. Apart from exotic grasses, indigenous groundferns (i.e. *Blechnum* and *Pteridium* species), as well as *Carex secta* were present (refer to Table X.2 in Appendix X for a more detailed list).

Canopy cover was measured using a concave densitometer[13] at 1 m above ground at each Malaise trap[14] site. In addition, at each corner of the Malaise traps leaf litter depth was measured down to the F horizon[15]. While canopy was six times denser at the indigenous forest site compared to the shrubland site, average litter depth was marginally higher at the indigenous shrubland site (Table X.1 in Appendix X).

9.4.2 Survey Design

Rapid Biodiversity Assessment of Insect Fauna

Taxonomic knowledge is poor for the majority of New Zealand terrestrial invertebrate groups, which is why a **r**apid **b**iodiversity **a**ssessment (RBA) was performed. Collected specimens were sorted first to family level and then to **r**ecognizable **t**axonomic **u**nits (RTUs), rather than taxonomic species (Ward & Larivière, 2004). This technique, while not a full replacement for the taxonomic method, has the advantage of providing a measure of species richness where proper taxonomic identification is not feasible. For the reasons explained in section 9.2, the order of Hymenoptera was chosen to act as a surrogate for the terrestrial invertebrate communities encountered within the study area.

Sampling of Hymenoptera focused on flying species that were caught using Malaise traps (Photo 17). When insects encounter the vertical mesh of a Malaise trap they usually fly or climb upwards, where they are being funnelled into a collection jar. The collection jar contains a trapping liquid, in this case 100 ml of the non-toxic propylene glycol. At the indigenous forest and shrubland site one Malaise trap was set up each (M1 & 2, Figure 29). Subsequently, all Hymenoptera specimens were sorted to families and then to RTUs, using different taxonomic keys/descriptions for identification where appropriate (Berry, 2007a,b; Berry, 1995; CSIRO, 2012; Donovan, 2007; Harris, 1994; Harris, 1987; Naumann, 1988; Noyes & Valentine, 1989a,b; Noyes, 1988; Ward, 2010).n Sorting to RTUs was conducted by Dr. Marc Hasenbank (invertebrate ecologist, Wellington, New Zealand).

Besides samples collected from Malaise traps any casual observations of invertebrates were also included in this report (Tables IX.4 and IX.9 in Appendix IX).

Weta Boxes

The search for terrestrial invertebrates present within the reservoir area also included a survey of the resident weta population. Of particular interest hereby was the potential presence of the Hawke's Bay tree weta, *Hemideina trewicki*, in the reservoir footprint (see *H. trewicki* profile in Appendix IX for more details), which is listed as 'At Risk' in Hitchmough *et al.* (2007). A total of 23 weta boxes (see Photo 14 in Herpetofauna Section 8.3.2), a common tool for monitoring weta populations (Sherley, 1998), were permanently installed in native forest and shrubland by early December across the study area (Figure 30). Site selection was done by choosing locations with suitable habitat, while aiming to generate a reasonable spread of weta box locations across the study site. Distribution and movements of weta can be fairly localized, therefore some of the weta boxes were set up in small clusters once a suitable location in forest or shrubland was identified. Following instalment occupancy of the boxes was surveyed after two and 14 months (8 February 2012, and 2 February 2013 respectively). However, at the 14-month check-up conditions prohibited the full set of boxes being surveyed: occupancy was only surveyed for 12 out of the 23 weta boxes (Table IX.8, Appendix IX). The number of hours spent surveying weta box occupancy were eight hours at the two month check, and five hours at the 14 montch check.

[13] a device for measuring percentage of canopy cover. Consists of a concave mirror with segments for estimating percentages of canopy cover.

[14] a large, tent-like structure used for flying insects. Insects fly into the tent wall and are funnelled into a collecting vessel attached to the highest point.

[15] Organic soil horizon, consists of partly decomposed leaves, twigs etc. Some original structures are hard to discern. In contrast to L horizon where original structures are clearly visible, and leaves, for example, are not or only slightly decomposed.

The weta boxes are likely to monitor only a small local area, and uptake of weta boxes by weta may be slow. Trewick and Morgan-Richards (2000) discovered that it took two to three years for weta boxes to reach their highest occupancy level during their five year study. At two sites, though, weta boxes where rapidly occupied (during the first year of their study) by *H. trewicki* and *H. thoracica*. Trewick and Morgan-Richards (2000) suggest that occupancy may be more rapid in cases where boxes are placed on trees that are occupied by weta already. While not an ideal length, the 14 months since the installation of the weta boxes as part of this study is considered to be a sufficient length of time for at least low-level occupation to have happened.

Photo 17 Malaise trap set up in indigenous shrubland

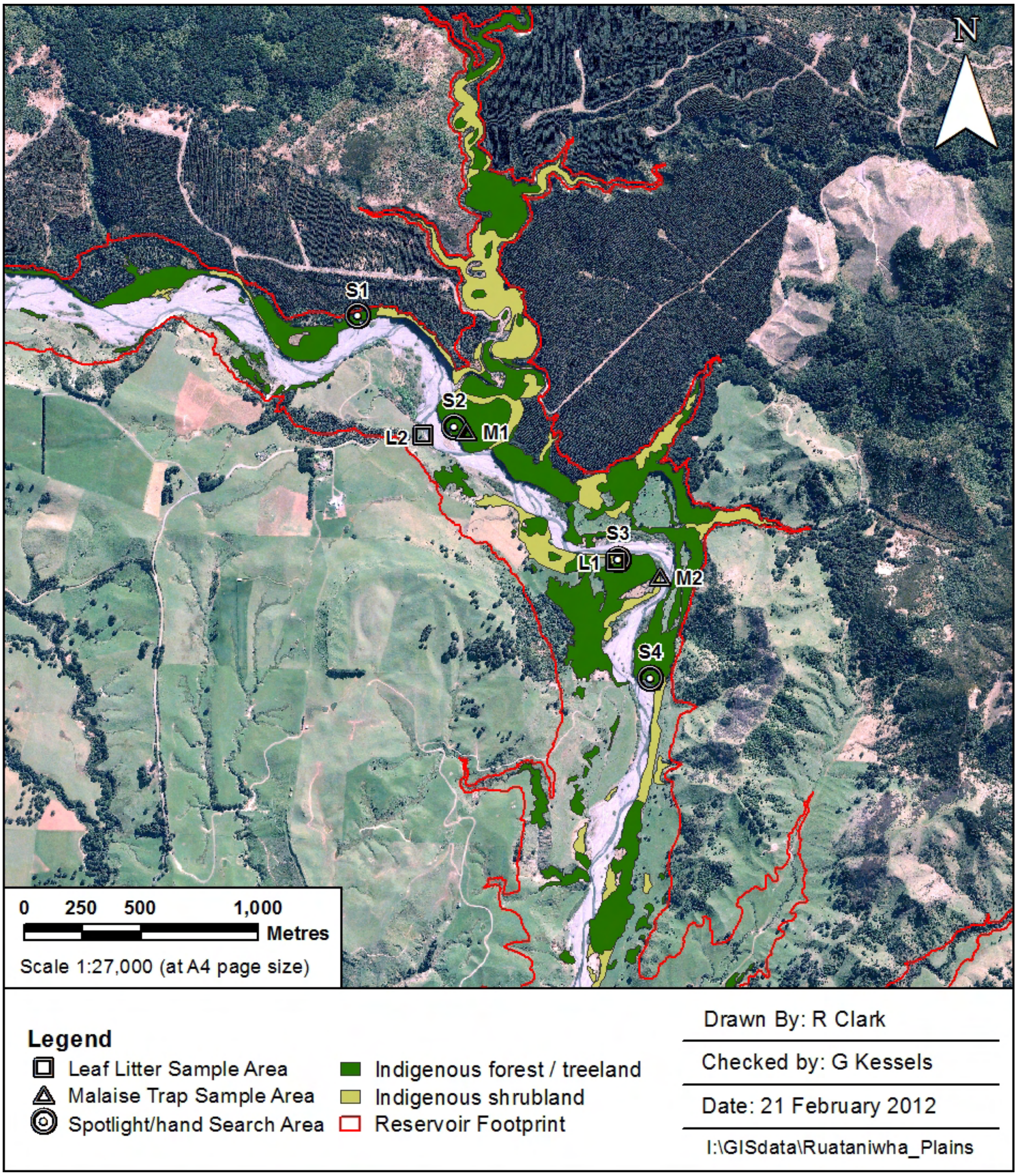

Figure 29 Location of Hymenoptera and Gastropoda sampling sites relative to indigenous vegetation (indigenous vegetation based on LCDB2 and simplified to shrubland and forest/treeland); M = Malaise traps, L = leaf litter sampling, S = entry points into forest fragments for spotlight/hand searches for land snails

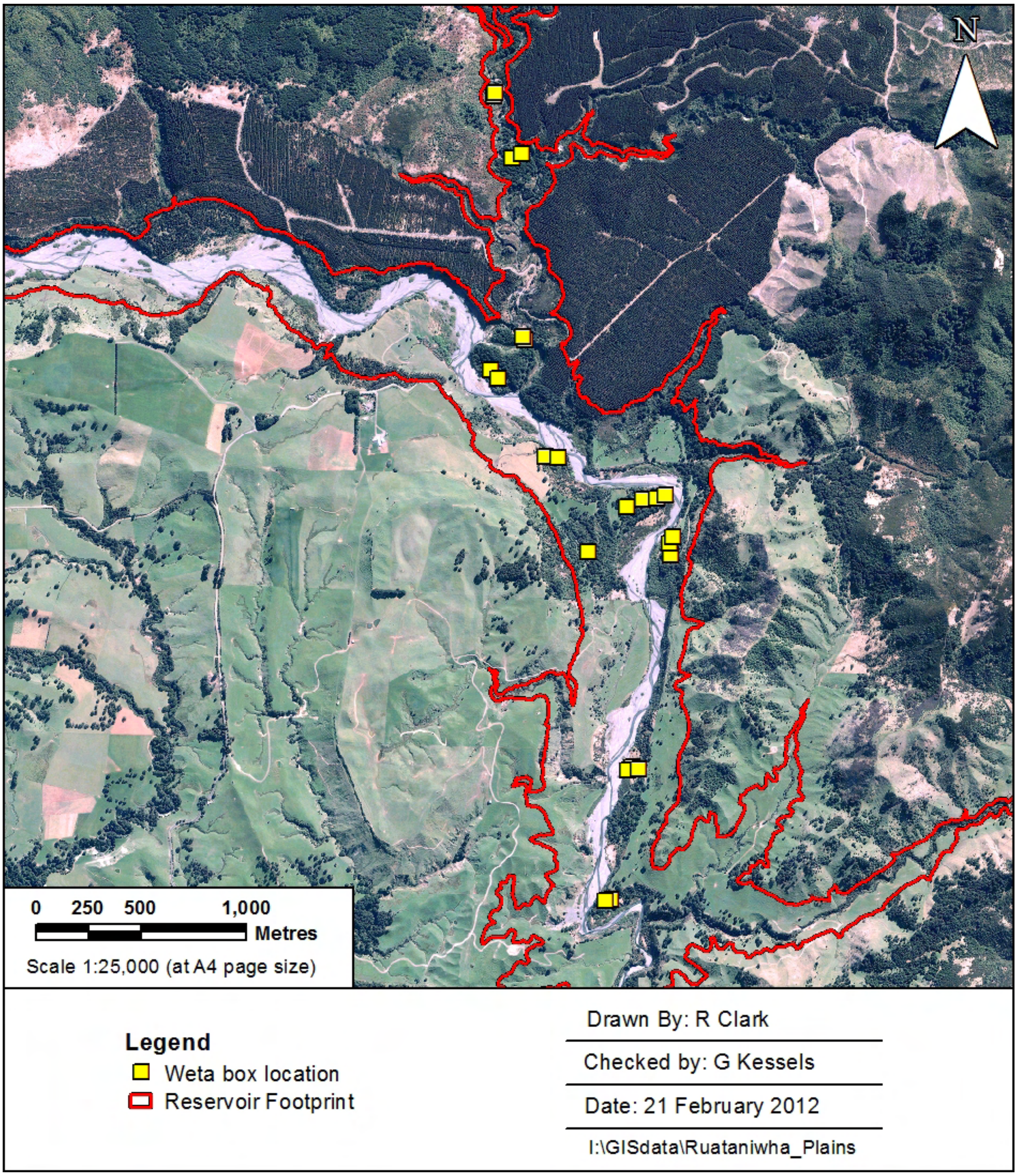

Figure 30 Locations of weta boxes within the reservoir footprint

9.4.3 Surveying Terrestrial Gastropods

The Ruahine Ranges are home to *Powelliphanta marchanti*, an endangered New Zealand land snail species. While *P. marchanti* is generally found above 900 m (Meads *et al*., 1984), the potential occurrence of it or any other large land snail species was investigated. *Powelliphanta* snails usually stay hidden under logs or leaf litter during the day and only come out at night to forage and mate when conditions are favourable. Their relatively large size (up to 90 mm across) makes it possible to detect them by searching the forest floor at night with a spotlight.

Spotlight searches were conducted at night at four different locations (S1 – S4, Figure 29), including sampling by occasional vegetation beating, for a total of 20 search hours. Sites were selected on the basis of shape, size and proximity to similar vegetation cover, following the Makaroro river bed. This was done to ensure searches could be performed at least 10 metres away from forest edges, and within the core area of the indigenous forest at the study site.

In addition to the spotlight searches, five leaf litter samples were taken in black beech forest (L1, Figure 29) every five metres along a 20 metre transect (sampling from dry top litter down to damp, broken down fraction, volume of roughly 10 litres per sample), and a further two from a moss covered limestone river bank (L2, Figure 29). Those samples could potentially yield different species of New Zealand micro snails that live on or among the different fractions of leaf litter. The site L1 was randomly assigned to a spotlight search site (S), and moved 10 metres into the forest and away from the entry point of the chosen spotlight search site (in this case S3). From a predetermined set of numbered random bearings, the first bearing would be used, which would move the transect start location away from the forest edge and further into the forest fragment. While moss was sampled as part of the forest litter samples, moss beds were also found on the limestone river banks. Some species of New Zealand's micro snails find shelter among moss beds, and therefore two moss samples from a limestone river bank were included. The site for L2 was chosen, because a larger than average moss covered area was discovered here, which could provide a large area with diverse vegetation for snails to shelter in.

All snails collected were identified to species level by Dr Frank Climo (malacologist, Wellington, New Zealand).

9.5 Results

9.5.1 Hymenoptera Species Richness

A total of 1,299 individual Hymenoptera specimens comprising 177 different RTUs were collected between the two sampling sites (M1 & M2, Figure 29). The two Malaise trap samples had 41 RTUs in common. With 25 versus 13 families the indigenous shrubland sample was more diverse at the family-level compared to the indigenous forest sample (Table IX.1 in Appendix IX). Further, the RTU-based species richness of the indigenous shrubland sample (M2) was 10% higher than that of the indigenous forest sample (M1). However, the abundance of Hymenoptera individuals was 23% lower in the indigenous shrubland sample compared to the indigenous forest sample (Table 17).

Table 17 Hymenoptera species richness (number of RTUs) and abundance (number of individuals) collected in Malaise traps

Trap	Species Richness	Abundance
M1	104	733
M2	114	566

The majority of Hymenoptera collected in the indigenous forest sample did belong to the Hymenoptera families Ichneumonidae, Braconidae, Diapriidae, Platygastridae and Mymaridae, with only 14% of the RTUs belonging to other families (M1, Figure 31). Compared to the other main Hymenoptera families, Braconidae and Mymaridae were represented in lower numbers relative to their species richness, while Platygastridae, though relatively low in the number of RTUs, were caught in comparatively larger numbers (M1, Figure 31). The same five Hymenoptera families also formed the majority among the specimens sampled at the indigenous shrubland site; however, here 31% of the RTUs belonged to other families (M2, Figure 31). Individual abundances showed a similar pattern as in M1, though Braconidae and Platygastridae had a more even relation between number of RTUs and abundance than found for the indigenous forest sample.

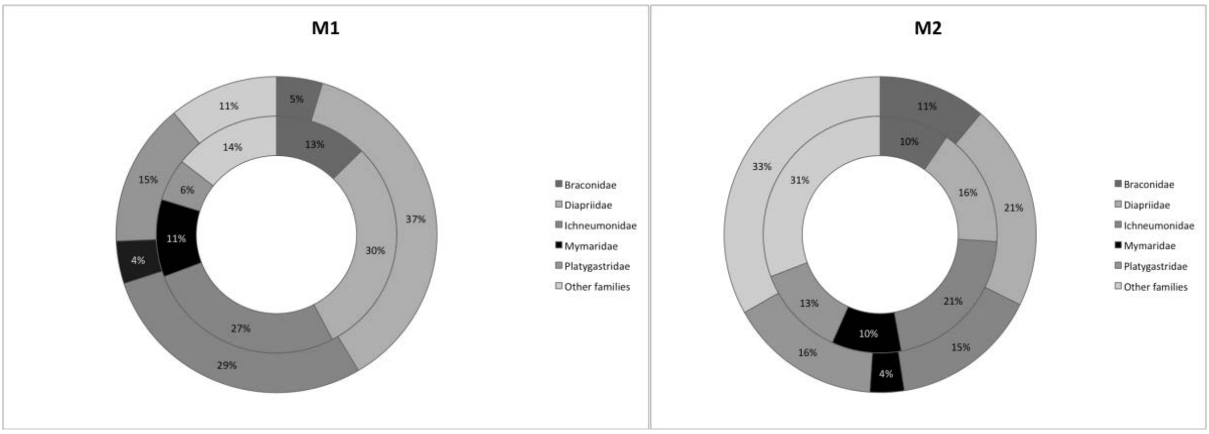

Figure 31 Percentages for RTUs (inner ring) and individual abundances (outer ring) for top four Hymenoptera families collected in both Malaise traps (left = indigenous forest, right = indigenous shrubland)

With 177 different RTUs the rapid biodiversity assessment indicated a relatively rich diversity of Hymenoptera taxa present in the reservoir area (in comparison with 104 species of Coleoptera caught in Malaise traps (Watts, 2010); or 100 species of Hymenoptera from Malaise traps (Schnitzler, 2008)). While the Hymenoptera community was mainly dominated by five families in both the indigenous forest and shrubland samples, RTU composition varied between sampling sites. In general, differences in parasitoid community composition have been attributed to differences in vegetation and habitat complexity (Fraser *et al.*, 2007; Lassau & Hochuli, 2005). Further, the colonisation of habitat fragments by parasitoids has not only been linked to the presence of the host insect, but also to the availability of the plant species the insect host was using (Van Nouhuys & Hanski, 1999). Higher trophic levels, such as occupied by most Hymenoptera species, are thought to be more readily affected by changes at lower trophic levels (Steffan-Dewenter & Tscharntke, 2000). From that, one can infer that large diversity in higher trophic levels, such as among Hymenoptera species, can only be supported by a diverse base at lower trophic levels. While parasitoids may rely on host insects as resource for their larvae, they themselves may feed on nectar gathered from flowers. These differences in life history between adult and larvae can have important implications for foraging in a fragmented landscape that may be further complicated by similar differences in their host insects. The actual species-specific structure of the Hymenoptera community at the two sampling sites remains unknown, and would require further work. Additional identification work could provide an insight into the potential level of modification the Hymenoptera community suffered from introduced insect species, for example.

While this survey mainly focused on Hymenoptera, earlier investigations into the invertebrate diversity of the Tukituki and Karamu catchments by Ward (2011) also indicated a high diversity of Lepidoptera associated with tussock grasslands in the Tukituki catchment area. The diversity of invertebrates in native forest within the Tukituki catchment was comparably higher than in pine forest or riparian planting, or grassland. In general, the different habitat types sampled by Ward (2011) had well defined invertebrate communities. In comparison with Tukituki, the Karamu catchment forest seemed to be in an earlier state of recovery from human land-use activities. None of the invertebrate species explicitly mentioned in Ward (2011) were listed on the NZ threat classification list (Hitchmough *et al.*, 2007) (see Tables IX.5 and IX.6 in Appendix IX); however, some rare and endemic Lepidoptera species were found.

9.5.2 Land Snail Species Richness

A total of 826 land snails were collected in the five leaf litter samples (L1, Figure 29), which were found to belong to 25 species (Appendix IX, Table IX.2). The 25 different species belonged to the families Punctidae and Charopidae. There was some strong variation between samples in the number of species and the number of individuals collected (Table 18). Between the five leaf litter samples 14 species appeared in more than one sample, while 11 of the land snail species collected in the litter samples were only found in one of the samples, thus suggesting that the actual number of species present in forest patch is higher than currently observed. No land snails were found in the two samples from the limestone river bank (L2, Figure 29). However, six individuals were found during searches at site S2 (Figure 29), these belonged to two species that had not previously been recorded from the leaf litter samples (Appendix IX, Table IX.3). In addition, ten individuals of the introduced garden snail, *Helix aspersa* (Helicidae), were discovered during searches (at S1, S3, S4).

Many species of the New Zealand land snail fauna are 'At Risk' through habitat loss and disturbance, as well as predation through introduced birds and mammals (McGuinness, 2001). While no large indigenous land snails, i.e. *Powelliphanta* species, were found, a great number of smaller native land snails were encountered during this survey, but no 'At Risk' species. The New Zealand land snail fauna, while represented with only a relatively low number of families, is incredibly diverse on the genera and species level (Marshall & Barker, 2007). A forest patch where 35 – 40 land snail species are encountered can be considered as a 'good bush' (Solem *et al*., 1981). Thus, the number of 25 species discovered in litter samples falls slightly below this range. As shown by this survey, different sampling techniques may be necessary in order to collect the full range of habitats that land snails inhabit.

Table 18 Gastropoda species richness (number of species) and abundance (number of individuals) collected in leaf litter samples (L1); no snails were found in samples 6 and 7 (L2) which have therefore been omitted

Leaf litter sample	Species richness	Abundance
1	15	138
2	7	30
3	13	470
4	6	78
5	15	116

Photo 18 Native New Zealand land snail, *Allodiscus conopeus*, spotted during night-time search in black beech forest (at search site S2, see Figure 29)

9.5.3 Weta Species

Casual observations of weta during the terrestrial invertebrate survey included several unidentified species of ground, cave as well as three tree weta (see Table IX.4 in Appendix IX). During the two-month check of the weta boxes one female Auckland tree weta, *Hemideina thoracica*. (Photo 19 , not listed as 'At Risk' in Hitchmough *et al*., 2007; Table IX.7, Appendix IX) was found. A further check of the weta boxes after 14 months uncovered the presence of *Hemideina trewicki* within the reservoir footprint (listed as 'At Risk' in Hitchmough *et al*., 2007; Table IX.8, Appendix IX). The low occupancy of the weta boxes following the two months after their installation could be explained by the time it takes for a resident weta population to colonize new refuges. Trewick & Morgan-Richards (2000), for example, indicated that full occupancy of weta boxes may take between three to five years and can also vary seasonally. Follow up checks of the weta boxes combined with additional night searches may therefore be necessary to expand the investigation into the presence of the 'At Risk' Hawke's Bay tree weta (Hitchmough *et al*., 2007) within the reservoir area.

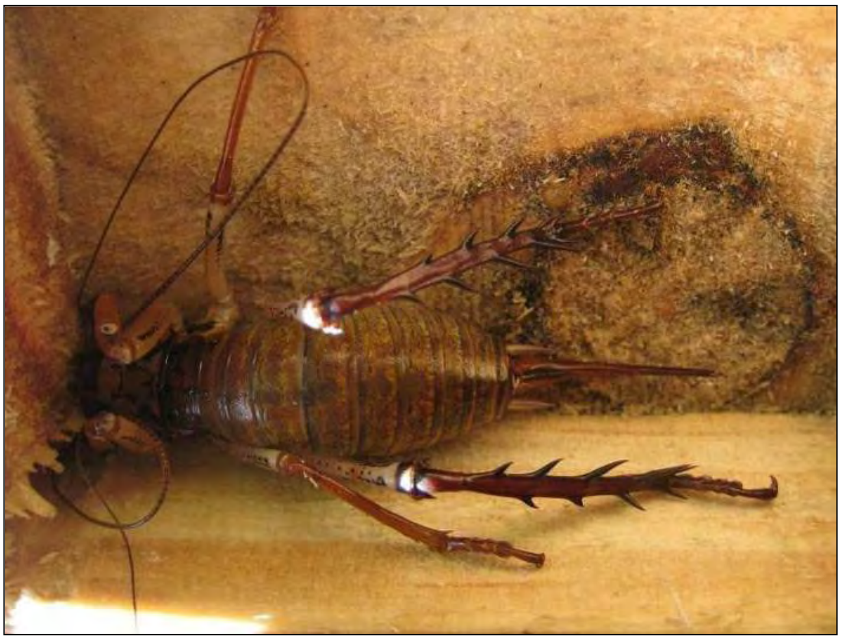

Photo 19 Female Auckland tree weta (*Hemideina thoracia*) found in a weta box (8 February 2012)

9.5.4 Threatened Species

The main identification effort was put into Hymenoptera and Gastropod taxa collected during the survey, and none of the identified taxa were listed as rare, or threatened in Hitchmough *et al*. (2007). The 14 casual observations of invertebrates (Table IX.4, Appendix IX) also included three tree weta (*Hemideina sp*., all at S2) that could potentially represent the 'At Risk' species *Hemideina trewicki*, or Hawke's Bay tree weta (Hitchmough *et al.,* 2007). Two individuals of *H. trewicki* were found occupying one of the weta boxes during the 14 month check (Table IX.8, Appendix IX). While this observation confirms the presence of the 'At Risk' *H. trewicki* (as in Hitchmough *et al*., 2007) within the reservoir area, the spatial distribution and size of the local population, as well as its relationship to populations outside the Scheme area, remains unknown.

A literature study (see Appendix XVI) did not identify any At Risk or Threatened spider species to potentially occur within, or near the Scheme area. However, a primary list for Data Deficient, At Risk, or Threatened beetle and moth species that could potentially be encountered within the Scheme area, or within the wider region, includes the Threatened species of *Mecodema atrox* (Coleoptera), the At Risk species of *Tatosoma agrionata* (Lepidoptera), *Meterana pictula* (Lepidoptera) and *Pyrgotis pyramidias* (Lepidoptera), as well as the Data Deficient species of *Izatha caustopa* (Lepidoptera).