Tamahere Reserve Restoration Project

Long-tailed Bat Survey II

January – February 2014

KesselsEcology

SURVEY, ASSESSMENT AND RESTORATION

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Cover Photo courtesy of Project Echo

Prepared by: Hannah Mueller & Gerry Kessels

Reviewed by: Dr Jennifer Price

Version:WKDC 00192 Tamahere Reserve Pine Removal Bat Survey 2 Final 1 040413

PWF Ref: WKDC.00192

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Executive Summary

Waikato District Council, on behalf of the Tamahere-Mangaone Restoration Trust (TMRT), commissioned Kessels Ecology to conduct an assessment of ecological effects on long-tailed bats (*Chalinolobus tuberculatus*) at Tamahere Reserve as part of an ecological restoration project. The TMRT proposes to establish a kahikatea swamp forest and requires the stand of pines be removed to facilitate ecological restoration of the gully slopes in this locality. This survey is the second survey for bats at the site; the first was completed in October/November 2013. Following a stakeholder meeting it was agreed that Kessels Ecology undertake the initial October survey for long-tailed bats at Tamahere Reserve to determine if bats were present and if so, what the relative activity and patterns of habitat usage of bats were. In the initial survey bats were found to utilise the area at moderate to high level of activity. Consequently, a further assessment was agreed upon to clarify the role of this habitat to bats and recommend how to proceed with the restoration project, in particular taking into account the request of the TMRT to fell pine trees within the reserve.

In this second survey, as well as automated bat detectors, observers surveyed the area using hand held bat detectors. Bats were heard and seen by observers during all of the surveys and were also detected by the automated detectors. Moderate levels of feeding and social calling, as well as the frequent occurrence of multiple bats, indicate that the site provides significant foraging and roosting habitat. It is likely that a number of bats are utilising the area of the reserve throughout the night for foraging. Population size is unable to be determined by these survey techniques, but up to six individual bats were observed at any one time at two of the observer stations. The survey also conclusively determined that bats are roosting in at least one mature pine tree within the reserve.

This survey confirms that the pine trees in the reserve provide habitat for a number of bats, including roosting and foraging habitat. The reserve may thus be an important component of habitat for bats in the Southern Hamilton locality, and possibly for bats within the peri-urban fringes of Hamilton City as a whole.

Bats may be under pressure in Hamilton, with a range of threats likely pushing their habitat utilisation to less favourable areas. For example, rats and possums likely predate on bats and occupy potential roost sites and cats are known to predate on bats. There are also a large number of development pressures on bats in southern Hamilton at present such as large roading projects and new subdivisions. All of these activities are removing or altering bat habitat and the cumulative impacts of these activities are largely unknown. If there is no pressing need to destroy or alter long-tailed bat habitat, then it is our opinion that that habitat should be left, or even better, actively managed so as to improve the opportunities for long-tailed bats to persist there. Because long-tailed bats are a nationally threatened species and an iconic species for the wider Hamilton community, restoration work, in this particular portion of the Managone Gully at least, should focus on maintaining and enhancing habitat for them. The TMRT is already enhancing bat habitat by the animal pest control work that they do, and there are opportunities to broaden this restoration work (e.g. placement of artificial bat roost houses and planting cavity bearing native trees).

Our recommendation therefore is that no pines (or partially fallen branches of pines) are to be felled in the immediate future, unless specific individual trees are considered to pose an immediate safety risk by an appropriate expert. It is acknowledged that many of the pines in this stand will fall over in time and will need to be managed. We also acknowledge that retaining a stand of exotic trees is counter-intuitive to usual best practice ecological restoration. However, the precarious state of long-tailed bats in New Zealand mean that retaining and enhancing any known bat habitat, even exotic, should take precedence over conventional restoration measures. How that process is managed requires further thought and discussion by the regulatory authorities and stakeholder groups.

1 Introduction

Waikato District Council, on behalf of the Tamahere-Mangaone Restoration Trust (TMRT), commissioned Kessels Ecology to conduct an assessment of ecological effects on long-tailed bats (*Chalinolobus tuberculatus*) at Tamahere Reserve as part of an ecological restoration project. The location of the reserve is within the well vegetated Mangaone gully/stream system. The TMRT proposes to establish a kahikatea swamp forest and is seeking the removal of a stand of pines in order to facilitate further ecological restoration of the gully slopes in the reserve.

This survey is the second survey for bats at the site; the first was completed in October/November 2013. Following this initial survey, where bats were found to utilise the area at moderate to high level of activity (Mueller et al., 2013), a further assessment was agreed upon to clarify the role of this habitat to bats and recommend how to proceed with the restoration project.

Previous surveys of this gully system show that utilisation by bats is widespread throughout the year. In addition, the mature pine trees in the reserve and directly adjacent to the gully may also be roosting habitat, as confirmed in studies of this gully and other similar gully systems around Hamilton (e.g. Le Roux & Le Roux, 2012) and elsewhere (Borkin & Parsons, 2010).

2 Methodology

Two types of survey methods were employed in this second survey, conducted from 30 January until 4 February 2014:

- Visual and acoustic surveys by observers using hand held detectors; and
- Automated surveys using automated 'heterodyne' bat detectors (ABMS).

A survey using handheld bat detectors for aural and visual observation was conducted over four evenings (30/1/2014, 2-4/2/2014) for about an hour from sunset (approximately 20.45–21.45) at four observer stations (Figure 1). All calls heard on the hand held detectors and/or actually seen were logged on a survey sheet (refer to Appendix I). The detectors used were 'Batbox' IIID or 'Magenta Bat 5', and both models were set at 40 kHz. Flying behaviour of bats, flight height, flight direction, flight behaviour, numbers and call types were recorded wherever possible.

The six ABM detectors were calibrated to have the same time and date settings (NZST) and were pre-set to start monitoring 30 minutes before sunset until 30 minutes after sunrise (refer to locations as shown in Figure 1). At each site, the distance between detector locations was at least 25 m to increase the chance of independent bat monitoring. How the ABMs operate, were deployed and the data analysed set is detailed in the previous Tamahere Reserve survey report (Mueller et al., 2013).

Weather conditions during the survey were suitable for bat emergence, activity and detection; minimum dusk temperatures during the survey were above 10°C (see Table 1 for a detailed overview). There was no rainfall during the survey. Wind speeds were low to moderate within the survey site, as it is largely sheltered from wind.

Table 1 Temperatures (Celsius), wind speed and precipitation (mm) over the survey period. (Data source: Metservice for Hamilton Airport)

Date	Temperature (°C)		Wind (km/h)	Precipitation (mm)
	Min	Max		
30/01/2014	9	24	54	0
31/01/2014	12	27	44	0
1/02/2014	11	27	44	0
2/02/2014	7	27	31	0
3/02/2014	9	27	0	0
4/02/2014	11	25	31	0

Figure 1 **Map showing ABM (circle) and observer locations.** Arrows indicate main directions of bat movements observed at dusk. Green circles indicate bat recordings with ABM. Red circle indicates equipment failure (no data available).

3 Results and Discussion

3.1 Results from the ABM Survey

The results from the ABM showed high levels of long-tailed bat activity throughout the survey period, as well as throughout the night at the five locations where the ABMs operated (ABM K9 failed because of a timer malfunction). These results are similar to those of the first survey (Mueller et al., 2013).

A high level of bat activity was recorded in particular at detector locations K1 and K2 (see Figure 2 for an overview of monitoring results for each of the detectors). Appendix II provides a more detailed summary of activity patterns recorded by individual ABMs.

Figure 3 shows activity patterns throughout the night. All monitored locations showed increased activity in the early morning hours, between 8 and 10 hours after sunset. Activity was generally low just after sunset, which is interesting given the observer data showed perceived higher levels of activity at dusk (refer to section 3.2), but noting that the observation surveys only ran for an 1 hour around dusk.

Recorded bat activity included searching, feeding and social calls. Calls of multiple bats (multi) were also recorded at all locations except ABM K4. Moderate levels of feeding and social calling, as well as the frequent occurrence of multiple bats, indicate that the site provides significant foraging and possible roosting habitat. This was confirmed by observations at dusk using handheld detectors.

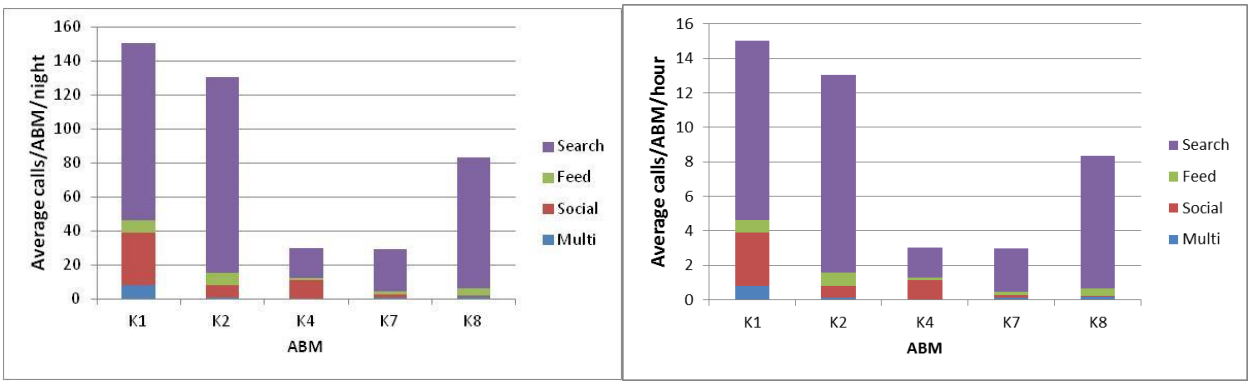


Figure 2 (a & b) Summary of bat activity for each ABM over the survey period. (a) average calls per detector per night; (b) average calls per detector per hour.

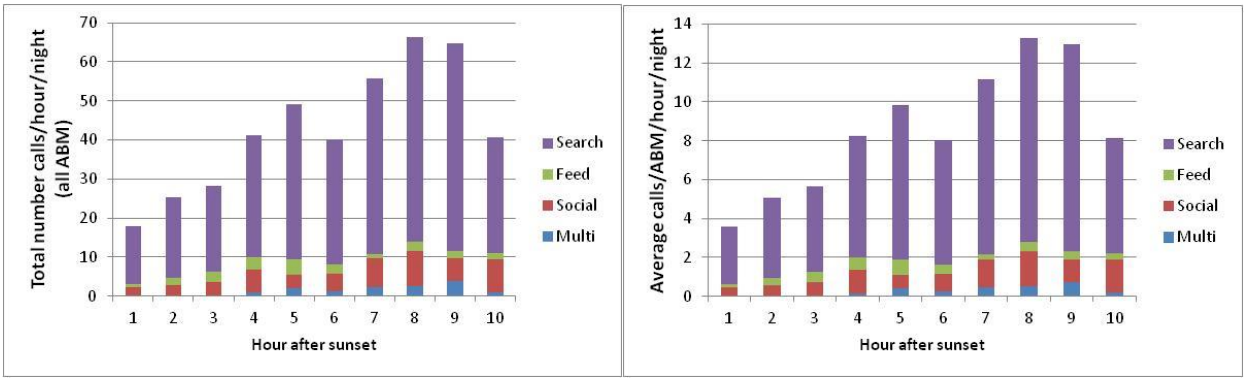


Figure 3 (a&b) Summary of types of activity recorded throughout the night. (a) Total number of calls detected in each hour across all ABMs; (b) calls per ABM per hour per night.

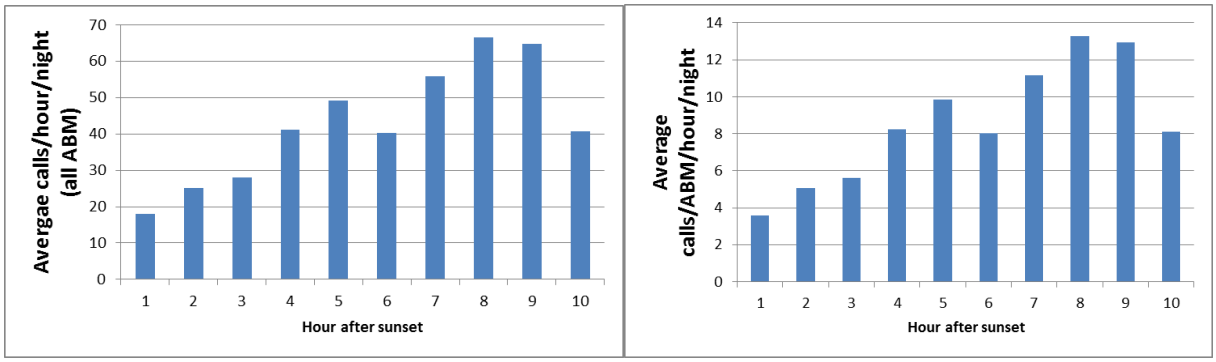


Figure 5 (a & b) Average number of calls recorded throughout the night. (a) total calls measured across all ABMS per hour per night; (b) average calls per ABM per hour per night.

3.2 Results from the Observer Surveys

Bats were heard and seen on every night surveyed by all observers. There was a distinct pattern of activity observed, whereby bats were seen or heard at K1 and K2 sites just before sunset, then often observed a minute or so later at the other sites. The most observations

and detections were at the K1 and K2 stations. By 21.15, activity appeared to drop away and generally only one or two, if any bats were heard. By this time it was too dark to see the bats.

The bats were seen to emerge from a partially fallen branch of a large pine tree at the K2 site, confirming that at least one roost site is present in the reserve. After emerging from this roost site they were often seen to fly out over the other pines at a height of some 20 m, into the gully wetland (the TMRT restoration area). Sometimes the bats then dropped in height and flew over the gully wetland and K1, appearing to feed on flying insects. After this activity they often appeared to fly upstream (southerly direction) to be observed by the observer at the K9 station. However, a few also flew over the road and were then detected by the observer at K4. At the K2 site, bats gave social calls before emerging from the roost site, while sometimes flying around the truck stop immediately to the east of K2, appearing to display foraging activity. As described above, bats were also seen flying across Tauwhare Road as well as up and down the stream, and across the edge of the pine trees and wetland. All of the calls heard at the K4 station were commuting calls, and the bats seen were all flying downstream (in a northerly direction) and not displaying any foraging activity.

The white arrows on Figure 1 provide an indication of the main directions observed during one hour after sunset. Figure 5 (a-d) provides an overview of recordings made during the handheld observations at the four different observer stations (note that the call scales are cumulative and do not represent number of bats). Up to six individual bats were seen flying at any one time around detector K2, and at the wetland location close to detector K1. These observations correspond to that described by a survey carried out in January by the TMRT (Gibbs, 2014; Appendix III).

Figure 5 (a-d) Summary of bat recordings during handheld survey for the four observer stations (30/1-4/2 2014)

4 Conclusions and Recommendations

This survey supports and adds to our knowledge of how bats are utilising the habitat features of the Tamahere Reserve. It confirms that a number of bats (at least six) are present for several months and least over the over the spring/summer seasons for feeding, commuting and roosting. They may be breeding at this site too, but there is insufficient evidence at this point in time to ascertain this. The reserve may thus be an important component of habitat for bats in the Southern Hamilton locality, and possibly for bats within the peri-urban fringes of Hamilton City as a whole.

The fact that activity levels, as recorded by the ABMs, were lowest at the time of the observer surveys, suggests that activity observed and heard by observers is under-estimating activity throughout the nights surveyed. Nonetheless, activity during the first hour after sunset was observed to be relatively high compared to similar 'high quality' bat habitats within the Waikato basin (e.g. Hammond Park – H. Mueller, pers. obs.). Activity also increased throughout the night to high levels, as seen in the ABM survey results, suggesting that this site is at least equally important habitat for long-tailed bats as Hammond Park. Activity recorded during this second survey was also on average higher than during the first survey conducted in October 2013, which would be expected due to seasonal changes in weather and animal behaviour.

Based on the results of this survey, those found by the TMRT January 2014 survey and our first survey (Mueller et al., 2013), it is our opinion any proposal to fell the pine trees in the Tamahere Reserve could result in adverse effects on this bat population. Of particular concern would be any proposal to clear large areas of pines. Furthermore, even removing a discrete area of pines could have adverse effects. This is not only because there is a risk of death or injury of bats during any such operation, which can be minimised by appropriate pre-felling protocols. It is primarily because the bio-physical conditions at this site appear to be ideal as they can be in this peri-urban locality for bat foraging and roosting at the present time. The data conclusively shows that the locality is an important foraging site. It is also possible that the roost tree found is a maternity roost site, though we have no strong evidence for this at present. Removal of the pines would likely affect these favourable conditions and may cause the bats to vacate the site.

Bats may be under pressure in Hamilton, with a range of threats likely pushing their habitat utilisation to less favourable areas. For example, rats and possums likely predate on bats and occupy potential roost sites and cats are known to predate on bats. There are also a large number of development pressures on bats in southern Hamilton at present such as road development and new subdivisions. All of these activities are removing or altering bat habitat and the cumulative impacts of these activities are largely unknown. If there is no pressing need to destroy or alter long-tailed bat habitat, then it is our opinion that that habitat should be left, or even better, actively managed so as to improve the opportunities for long-tailed bats to persist there. Because long-tailed bats are a nationally threatened species and an iconic species for the wider Hamilton community, restoration work, in this particular portion of the Managone Gully at least, should focus on maintaining and enhancing habitat for them. The TMRT is already enhancing bat habitat by the animal pest control work that they do, and there are opportunities to broaden this restoration work (e.g. placement of artificial bat roost houses and planting cavity bearing native trees).

Our recommendation therefore is that no pines (or partially fallen branches of pines) are to be felled in the immediate future, unless specific individual trees are considered to pose an immediate safety risk by an appropriate expert. It is acknowledged that many of the pines in this stand will fall over in time and will need to be managed. We also acknowledge that retaining a stand of exotic trees is counter-intuitive to usual ecological restoration best practice. But as explained above, the precarious state of long-tailed bats in New Zealand mean that retaining/enhancing any known bat habitat, even exotic, should take precedence over conventional restoration measures. How that process is managed requires further thought and discussion by the regulatory authorities and stakeholder groups.

5 Acknowledgments

The authors would like to thank a number of people and organisations for invaluable assistance during the surveys and for assistance the reports. Firstly, and foremost, to the member a big thanks to the Tamahere-Mangaone Restoration Trust members and adjacent landowners, who provided a huge amount of assistance during the surveys. Thanks to staff of the Waikato District Council and Department of Conservation for providing support for the surveys, as well as comment and feedback on the reports. Dr David Pattemore and Gerard Kelly provided voluntary help for two of the observer nights and also used the opportunity to test out newly built infra-red camera equipment (built using funds from the Department of Conservation). We are hopeful that when this video footage is fully analysed there will be video evidence of bats at the roost site. Dr Stuart Parsons of the University of Auckland, one of the world's leading bat experts, provided assistance throughout in terms of survey design, site visits to determine the implications and consequences of the survey's findings and review of the reports.

6 References and Bibliography

Borkin, K. M. 2010. Ecology of New Zealand's long-tailed bat (*Chalinolobus tuberculatus*) in exotic plantation forest. Unpublished PhD thesis, University of Auckland.

Borkin, K.M., Parsons, S. 2010. The importance of exotic plantation forest for the New Zealand long-tailed bats (Chalinolobus tuberculatus). New Zealand Journal of Zoology, 37: 35-51.Borkin, K. M. and Parsons, S. 2009. Long-tailed bats' use of a *Pinus radiata* stand in Kinleith Forest: recommendations for monitoring. New Zealand Journal of Forestry 53: 38-43.

Borkin, K. M. and Parsons, S. 2011. Home range and habitat selection by a threatened bat in exotic plantation forest. Forest Ecology and Management 262: 845-852.

Dekrout, A. 2009. Monitoring New Zealand long-tailed bats in urban habitats: ecology, physiology and genetics. PhD Thesis, University of Auckland, Auckland.

Environment Waikato and Wildland Consultants Ltd. 2002. Areas of significant indigenous vegetation and habitats of indigenous fauna in the Waikato Region. Guidelines to apply regional criteria and determine level of significance. Environment Waikato Technical Report TR2002/15. Waikato Regional Council, Hamilton.

Floyd, C. and Dekrout, A. 2009. Review of submissions to proposed variation no. 14 – Peacocke Structure Plan. Report prepared by Kessels & Associates for Hamilton City Council. Kessels & Associates, Hamilton.

Griffin, D. R., Webster, F. A., and Michael, C. R. 1960. The echolocation of flying insects by bats. Animal Behaviour 8: 141-154.

Harding, M. 1997. Waikato Protection Strategy – A Report to the Heritage Fund Committee. Forest Heritage Fund, Wellington.

Hitchmough, R., Bull, L., and Cromarty, P. (comp.) 2007. New Zealand Threat Classification System Lists 2005. Department of Conservation, Wellington.

Leathwick, J. R.; Clarkson, B. D.; Whaley, P. T. 1995. Vegetation of the Waikato Region: Current and Historical Perspectives. Landcare Research Contract Report: LC9596/022. Waikato Regional Council, Hamilton.

Le Roux, D.S. 2012. Waikato Expressway: Hamilton Section. Long-Tailed Bat Survey – Final Report. Client report, Opus International Consultants Ltd, Hamilton.

Le Roux, D and Le Roux, N. 2012. Hamilton Bat Survey 2011-2012. Kessels & Associates and Project Echo, Hamilton.

Mickleburgh, S. P., Hutson, A. M. and Racey, P. A. 2002. A review of the global conservation status of bats. Oryx 36: 206-211.

Mueller, H., Robb, M., Brandes, U., and Blair, J. 2013. Assessment of Ecological Effects (2013): Tamahere East-West Link NOR. Client report, Kessels Ecology, Hamilton.

Mueller, H., Stewart, P., Kessels, G. and Blair, J. (2013). Tamahere Reserve Restoration Project. Long-tailed Bat Survey Results & Recommendations for Future Management. Kessels Ecology, Hamilton.

O'Donnell, C. F. J. 2001. Advances in New Zealand mammalogy 1990-2000: Long-tailed bat. Journal of the Royal Society of New Zealand 31: 43-57.

O'Donnell, C. F. J. 2000. Conservation status and causes of decline of the threatened New Zealand long-tailed bat *Chalinolobus tuberculatus* (Chiroptera: Vespertilionidae). Mammal Review 30: 89-106.

O'Donnell, C. F. J., and J. A. Sedgeley. 1999. Use of roosts by the long-tailed bat, *Chalinolobus tuberculatus*, in temperate rainforest in New Zealand. Journal of Mammalogy 80: 913-923.

Parsons, S. 2001. Identification of New Zealand bats in flight from analysis of echolocation calls by artificial neural networks. Journal of Zoology (London) 253: 447-456.

Parsons, S. and Szewczak, J. 2009. Detecting, recording and analysing the vocalisations of bats. In Ecological and Behavioural Methods for the Study of Bats (eds. T.H. Kunz and S. Parsons). Johns Hopkins University Press. 91-111.

Russ, J. M. & Montgomery, W. I. 2002. Habitat associations of bats in Northern Ireland: implications for conservation. Biological Conservation 108: 49-58.

Sedgeley, J. A., O'Donnell, C.F.J. 1999. Factors influencing the selection of roost cavities by a temperate rainforest bat (Vespertilionidae: *Chalinolobus tuberculatus*) in New Zealand. Journal of Zoology (London), 249: 437-446.

Sedgeley, J. A., and O'Donnell, C. F. J. 2004. Roost use by long-tailed bats in South Canterbury: examining predictions of roost-site selection in a highly fragmented landscape. New Zealand Journal of Ecology 28: 1-18.

Thomas, D.W. 1998. The distribution of bat in different ages of Douglas-fir forests. Journal of Wildlife Management 52: 619-626.

Verboom, B. and Spoelstra, K. 1999. Effects of food abundance and wind on the use of tree lines by an insectivorous bat. *Pipistrellus pipistrellus*. Canadian Journal of Zoology 77: 1393-1401.

Appendix I Hand Held Detector Survey Forms

Hand Held Bat Survey Form

GPS coordinates:_____ **Date:**_____

Site:_____

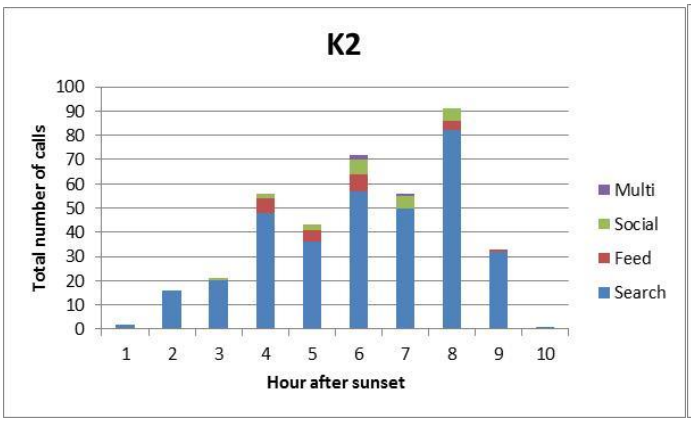
Observer:_____ **Start Time:**_____ **Finish Time:**_____

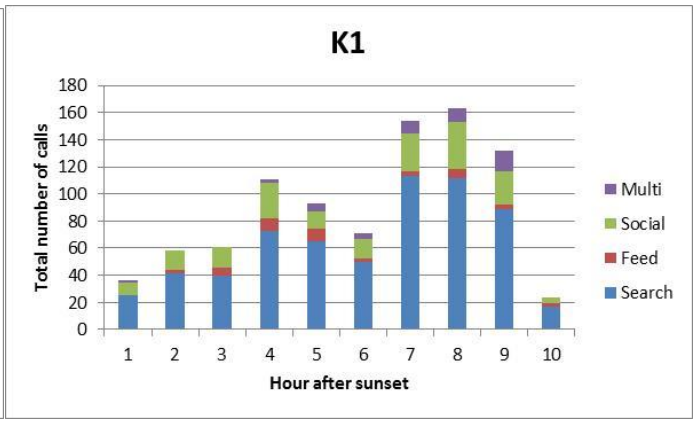
Sunset Time:_____

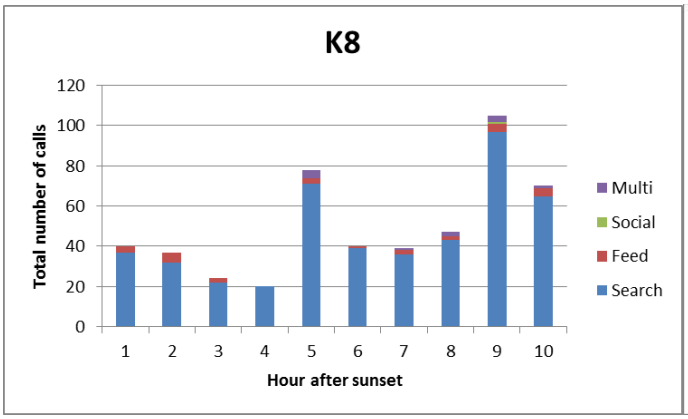
Temperature:			**Precipitation value:**		
1	Freezing	<0°C	0 None		**Other noise:**
2	Cold	0-5°C	1 Misty		**Not important**
3	Cool	5-11°C	2 Drizzle		**0**
4	Mild	11-16°C	3 Light rain		**moderate**
5	Warm	16-22°C	4 Moderate rain		1
6	Hot	>22°C	5 Heavy rain		**loud**
Wind Direction:____			**Precipitation type:**		2
Wind Speed:			Brief showers	(B)	Mist (M)
1		Calm	Occasional rain (O)		Rain (R)
2		Light wind	Steady rain (S)		Hail (H)
3		Moderate wind	**Cloud cover (%):**_____		
4		Strong wind			
5		Gale	**Unit Frequency Setting:**		

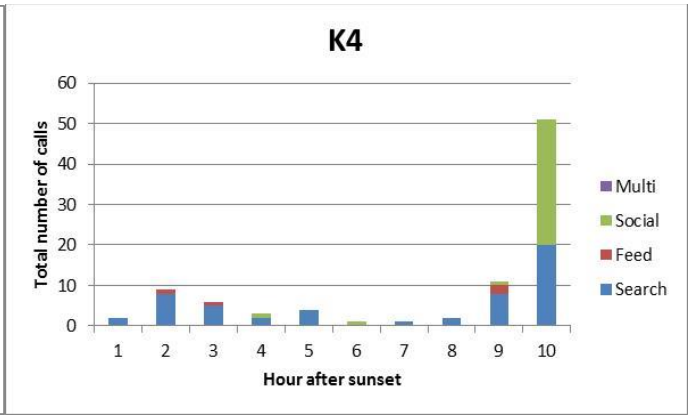
Time Heard	Call No:	Call Type*	Number of Bats	Height	Flying behaviour	Notes
*Call Type:	Search - S	Feed - F	Social - SC			

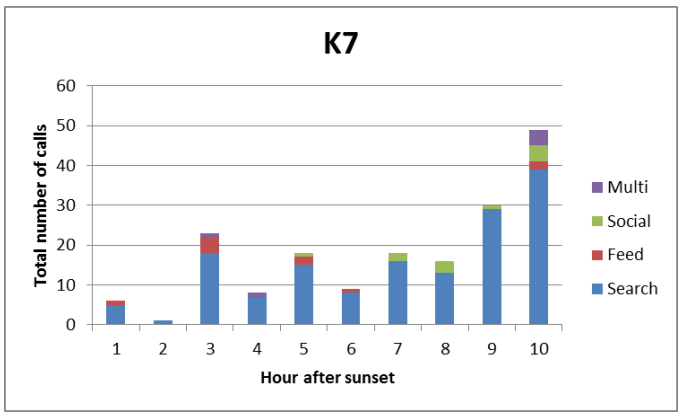
Appendix II Summary of bat activity for each ABM











Appendix III TMRT Report of Bat Monitoring in the Mangaone Gully System

By: Russell Gibbs
Tamahere Mangaone Restoration Trust, Trustee.
Date: 20th January 2014

I undertook a survey of the bat activity in the Tamahere-Mangaone Gully system in the location immediately South of the Tauwhare Road and in the immediate area being restored by the Tahahere Mangaone Restoration Trust.
This is the second survey to be completed and this survey also included two other members of the Trust to ensure a greater area could be covered and additional observations recorded.

As with the previous survey the reason for the survey was to establish the degree of bat activity in the gully first hand but more importantly to establish the most likely bat roosting places in the reserve .

As previously monitoring was achieved using a handheld Magenta Bat 5 digital bat detector manufactured by Magenta Electronics, England www.magenta2000.co.uk . Two additional devices were kindly loaned to the Trust for the duration of the monitoring by Kessels Ecology.

General Observations
We spent 13 days monitoring bat activities in the gully system typically for one hour after sunset on each day. The time spent each day in the gully was mostly in the same geographic area identified in the attached map. We moved within the boundaries as shown, collecting the bat data as outlined in the attached schedule using the bat monitoring instruments together with visual observation [until darkness prevented the visual detection]. This has provided the basis for an opinion as to the degree of bat activity in the area.
From the data provided on page 2 the following information is available:

1. There was a total of 650 observation minutes for bewteen 40 – 70 minutes after the official sunset time on each of the observation days.

2. Total number of bats observed at one time was 5. This was on a single occasion only.

3. Bat flight paths were often observed to be in a North West – South East direction as shown on the attached map

The bat activity was observed within the area shown on the attached area location map with the yellow boundary.
More specifically the significant number of bat passes and observations made were confined to the area identified with the red boundary.
Bat fly zones are indicated with the arrows. Arrow size equals activity.
The numbered circles identify the most likely roosting locations. These three locations are the sites of very old pine trees which because of their age have deteriorated and made available many large cracks and crevices.
Based on the data we collected, of these three sites only one site had the potential for current roosting. This is location #1 [green circle]. Over the times of the observations bats were seen and heard to be flying from and returning to this site on a frequent basis. Location # 2 had little activity. Location 3 was not observed as it is across the stream in private land owned by Titoki sands.
The data presented by Kessels Ecology in the October 2013 report, specifically the data gathered from the AMR station W011 totally supports our findings.

Based on our observations we maintain the opinion that the bat population is small and roosting contained to a very specific area of the reserve. The observed flying patterns support this notion.

To be read in conjunction with Leo's report attached.

Bat Monitoring Summary

DATE	START TEMP	END TEMP	CLOUD COVER	WEATHER	WIND	INSECTS	BAT COUNTS START TIME	FINISH TIME	FIRST OBSERVED	TOTAL MINs	BAT PASSES	BATS SEEN	MAX BATS	FLIGHT PATH	LOCATION OBSERVED	OFFICIAL SUNSET
Dec-13																
16	22	18	2	Fine	Light	Occasional	8.10pm	9.20pm		70	12	5	**2	NW-SE	B & C	8.38pm
17	18	16	2	Fine	Light	Occasional	8.40pm	9.30pm		50	16	10	*2	NW-SE	B & C	8.38pm
23	16	16	2	Fine	Light	Occasional	8.40pm	9.25pm		45	32	24	*4	NW-SE	B & C	8.41pm
27	18	17	1	Fine	Light	Occasional	8.50pm	9.30pm	9.05pm	40	31	21	**3	NW-SE	A & B	8.43pm
Jan-14																
5	17	15	1	Fine	Light	Occasional	8.50pm	9.30pm	9.00pm	40	21	15	*3	NW-SE	A, B & C	8.44pm
8	19	17	0	Fine	Light	Occasional	8.40pm	9.35pm	9.03pm	55	18	12	*2	NW-SE	B & C	8.44pm
9	15	13	4	Fine/showers	Moderate	Occasional	8.40pm	9.20pm	8.55pm	40	34	14	***1	NW-SE	B & C	8.44pm
10	19	18	1	Fine	Light	Occasional	8.40pm	9.40pm	9.03pm	60	13	5	**2	NW-SE	B & C	
12	16	15	3	Fine	Light	Occasional	8.30pm	9.30pm	9.00pm	60	24	11	*2	NW-SE	B & C	8.44pm
13	19	17	3	Fine	Calm	Occasional	8.40pm	9.35pm	9.05pm	55	32	6	2	NW-SE	B & C	8.43pm
14	16	15	0	Fine	Calm	Occasional	8.45pm	9.40pm	8.57pm	65	33	14	**1	NW-SE	B & C	8.43pm
15	19	17	0	Fine	Calm	Common	8.50pm	9.35pm	8.56pm	45	29	24	*5	NW-SE	B & C	8.43pm
16	17	16	3	Fine	Moderate	Occasional	8.55pm	9.20pm	9.00pm	25	8	4	*2	NW-SE	B & C	8.42pm
										650	303	165				

General observations:

1. An estimation of the total number of bats present in the area from visual observations are 2-5
2. Bats are typically active and visual from 9.00pm till 9.20pm
3. Flight pattern generally always NW - SE
4. Bat flight path in open space above wetland area and at various heights.

Notes:

1. * Observed on a single occasion only
2. ** Observed on two occasions only
3. *** Observed on three or more occasions

Additional observation minutes should be added to the final figure to include two other trust members who were also present. I estimate this to be an additional 320 minutes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