Auckland Council
Te Kaunihera o Tāmaki Makaurau

16 May 2018

LGOIMA No. 8140002938
(Please quote this in any correspondence)

[redacted]

[redacted]

Dear [redacted]

Local Government Official Information And Meetings Act 1987 (LGOIMA)

Population study data, Hunua Ranges

I refer to your official information request for population study data for a number of species, which was included in the response to the questionnaire sent to landowners and occupiers within the Hunua Ranges area in March 2018.

Please accept our apologies for not officially acknowledging your request at the time that you returned your questionnaire. The request has now been logged and the reference number is 8140002938.

The details of your request are as follows:

1. **Please supply raw data for rat, possum and mustelid tracking for 2017 and 2018.**

Please refer to Attachments 1-3 which include relative abundance measure information, Residual Trap Catch (RTC) data for possums and Rat Tracking Index (RTI) for rats, for the period February 2014 to April 2017.

To provide some context, further details on the monitoring undertaken over this period are provided below.

Pre-control

In February 2014 (prior to the 2015 application of sodium fluoroacetate (1080) in the Hunua Ranges) we undertook RTC monitoring to determine the pre-control relative abundance of possums within the control area. This returned a 9.35% residual trap catch measure. This RTC monitoring report, showing the line by line summary results, along with the location of the monitoring lines is included in Attachments 1-A and 1-B.

In May 2015 (prior to the 2015 application of 1080 in the Hunua Ranges) we undertook Residual Tracking Index (RTI) monitoring to determine the pre-control relative abundance of rats within the control area. This returned a 91.6% tracking index.

<u>Post-control</u>

The application of 1080 occurred in July and August 2015.

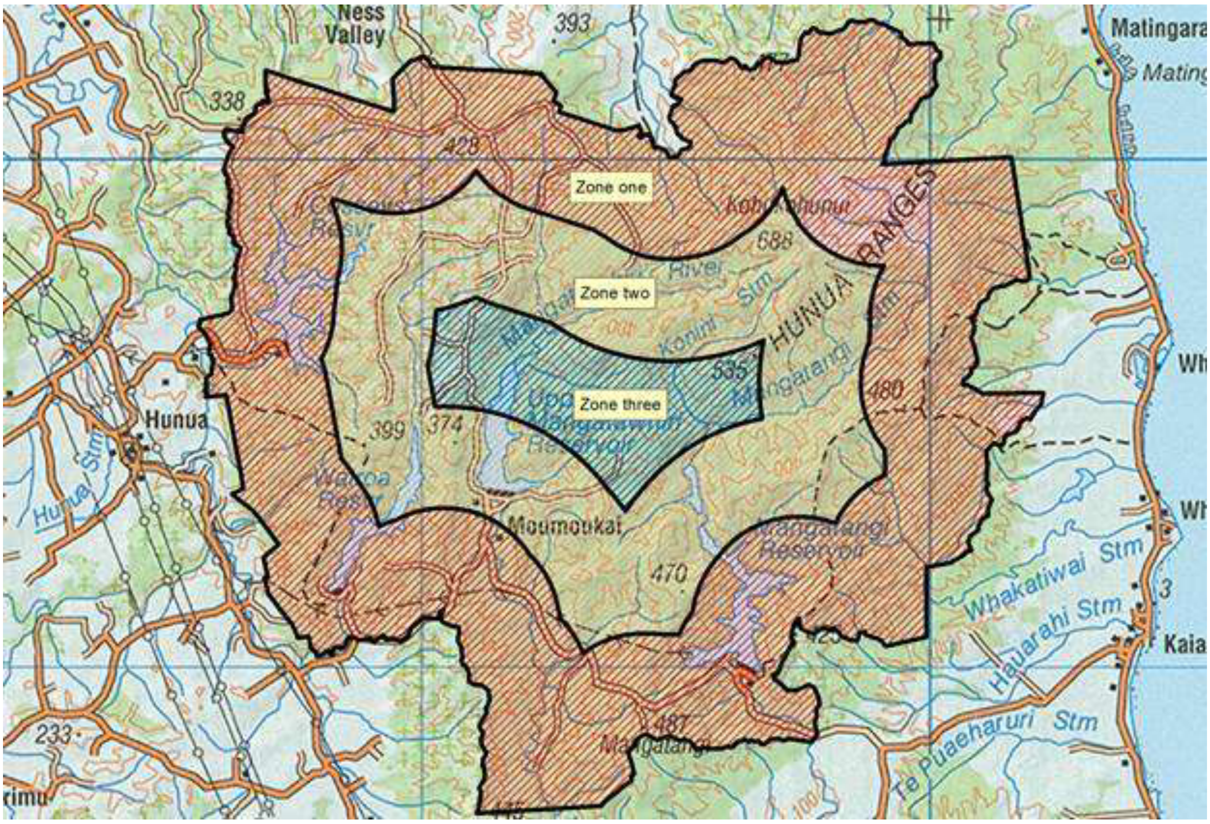
In October 2015 we undertook RTC monitoring to determine the post-control relative abundance measure of possums within the control area, to assess the effectiveness of the operation. This returned an overall result of 1.25%. The RTC report, showing the line by line results and the location of the monitoring lines, is included in Attachments 2-A to 2-D.

A table summarizing the RTI results for rats pre and post control is shown below. The zones in the table below relate to the map shown on the next page.

Table 1: Raw data from 6 monitoring intervals throughout the Project Hunua operational area.

Monitoring station	% rats Feb 15	% rats May 15	% rats Aug 15	% rats Feb 16	% rats May 16	% rats Apr 17
🟥 1	60	100	0	0	80	90
🟥 2	60	100	0	0	20	100
🟥 3	20	90	0	0	40	100
🟨 4	50	90	0	0	0	
🟥 5	10	90	0	0	10	80
🟥 6	30	100	0	0	100	100
🟥 7	60	100	0	0	60	100
🟥 8	50	100	0	0	70	100
🟩 9	10	70	0	0	50	
🟩 10	80	100	0	0	70	
🟩 11	50	60	30	0	20	
🟩 12	50	90	0	10	80	
🟩 13	60	100	0	10	100	
🟩 14	60	100	0	20	60	
🟩 15	40	100	0	10	80	
🟩 16	80	100	0	0	70	
🟩 17	0	70	0	0	30	70
🟩 18	100	100	0	0	70	
🟩 19	90	100	0	50	90	
🟩 20	0	80	0	10	40	80
🟩 21	50	90	0	10	90	
🟩 22	40	90	0	0	70	
🟩 23	10	80	0	0	40	
🟩 24	20	80	0	40	50	90
🟩 25	70	100	30	10	100	
🟨 26	90	100	0	0	30	100
🟥 27	40	100	0	0	70	100
🟨 28	60	100	0	30	0	20
🟨 29	0	80	0	0	100	100
🟨 30	80	90	0	0	60	90
Average per monitor	47.3	91.6	1.04	6.6	58	88

Green = zone 1, Red = zone 2, Yellow = zone 3



Note that in April 2017 we monitored lines that showed less than 70% RTI from the last monitoring check, as we knew these lines would not show a reduction. It was considered to be a better use of resources only to monitor those lines with less rat RTI results.

We have not undertaken any relative abundance measures for mustelids in 2017 or 2018. Mustelids are hard to detect and formulate a relative abundance measure for using traditional monitoring methods, and more effective monitoring methods are still being developed nationally.

Pre-2018 operation

In May 2018 we are planning to undertake a RTI measure of rats within the Hunua Ranges, which will start in the middle of May and take approximately three weeks to complete.

In late April 2018 we undertook another RTC monitoring of possums in the Hunua Ranges. Please refer to Attachment 3 for the location of monitoring lines.

At the time of writing this letter we are awaiting the interpretation of results from this report, as interference from rats needs to be factored into the RTC outcome.

2. **Please supply raw data for population density studies for the following species (pre-2015 drop and post 2015 drop, plus counts for 2016, 2017 and 2018.**

- **Ruru morepork**
- **Harrier hawk**
- **Hochstetter's frog**
- **North Island robin**
- **Kōkako**
- **Long tailed bat**
- **Kaka**
- **Tomtit**
- **Kingfisher**

Please refer to Attachments 4-7 and the notes below for the information requested in Question 2 above:

i. Ruru morepork

No counts were undertaken for morepork, however information from elsewhere shows that moreporks survive 1080 applications – please refer to the articles in Attachments 5-1 to 5-3 for more detail. In addition, the Department of Conservation has recently carried out further monitoring of radio-tagged moreporks through 1080 poison drops. The results are as yet unpublished, but the Department can be contacted for further information on this monitoring.

ii. Harrier hawk, Kaka, Tomtit, Kingfisher

Please refer to Attachment 4-1 for five-minute bird count results for Harrier, Kaka, Tomtit and Kingfisher covering the period from 2014-15 to 2017-18.

Briefly, an analysis of the five minute bird count data (Fisher's exact tests, $P<0.05$) before (2014-15 counts) and after the 1080 poison drops (2015-16 counts), showed that there was no significant difference between the numbers of harrier ($P=0.6844$), kaka ($P=0.0994$), tomtit ($P=0.0784$) and kingfisher ($P=1.0000$).

If we compare the numbers of these species between the pre-drop 2014-15 counts and the most recent 2017-18 counts, the numbers of kaka ($P<0.0001$), kingfisher ($P=0.0214$) and tomtit ($P=0.0010$) have all increased significantly, while the numbers of harriers did not change significantly ($P=1.0000$) (Fisher's exact tests, $P<0.05$).

iii. Hochstetter's frog

The Hochstetter's frog monitoring undertaken in the Hunua Ranges does not monitor individual frogs. The monitoring method used determines presence or absence and changes in the population, particularly population structure over time, in a number of streams throughout the Ranges.

Auckland Council did not carry out monitoring of frogs prior to the operation. An independent organisation has undertaken frog monitoring in the Hunua Ranges for a number of years, including prior to the operation.

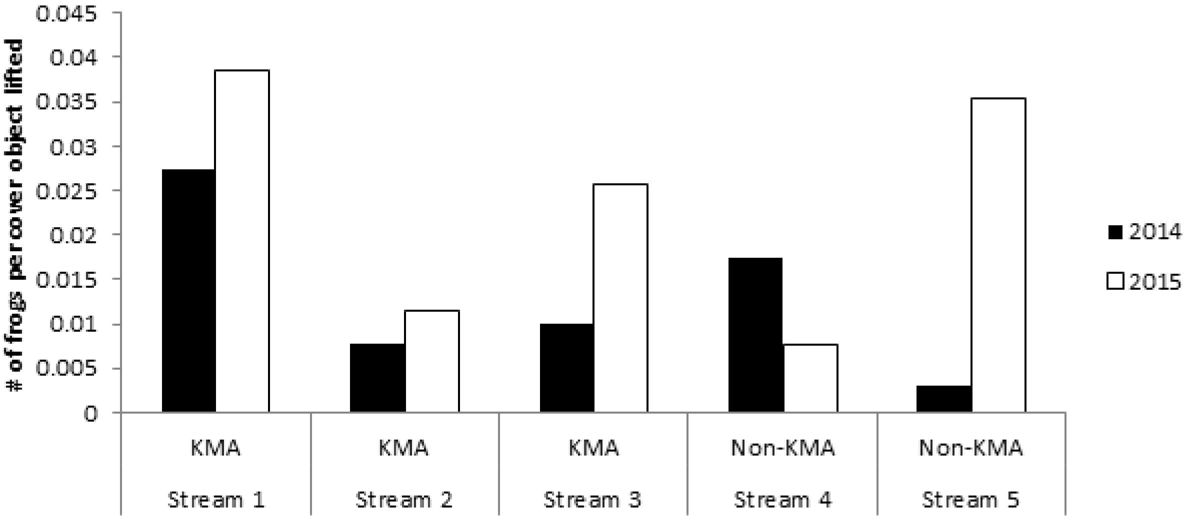
Catch per unit effort (i.e. the number of frogs found per cover object lifted) provides an indication of population size. Auckland Council undertook surveys in November 2015 and April 2016 following the aerial 1080 pest control operation.

In the sub-set of streams that Auckland Council monitored, the overall catch per unit effort was higher for most sites in November 2015 post-1080 drop than data from same sites in November 2014, with frogs found in all streams monitored (refer to Figure 1 below).

Inside the Kōkako Management Area (KMA) all age classes were present, including juveniles < 1 year old (<18mm body size). In the two streams monitored outside the KMA, both adult and sub-adult frogs were found, with the number of adults detected higher in November 2015 than the previous year.

In April 2016, frogs were also found in all streams monitored. Auckland Council has yet to do a full comparison of the most recent (April) data with pre-operational monitoring data.

Figure One: Comparison of number of frogs per cover object lifted in November 2014 and November 2015.



Attachment 6 contains further information on the Hochstetter's frog monitoring programme.

iv. North Island robin

No robins were counted in surveys immediately before or after the 1080 poison drops. In May 2001, 30 robins were released in the Kōkako Management Area.

Robins were closely monitored during the first few years after release, but within 5 years of the release there were no surviving breeding pairs in the release area, and the team carrying out annual monitoring and protection of kōkako found no breeding pairs of robins.

Robins were not recorded in any forest bird counts in the Hunua Ranges after November 2005.

v. Kōkako

Kōkako do feature in the five-minute bird counts (refer to Attachment 4-1) but the numbers are quite small (ranging from 1 per 150 counts in 2014-15 to 10 per 150 counts in 2017-18).

There was no significant difference (Fisher's exact tests, $P<0.05$) between the numbers of kōkako ($P=0.1211$) before (2014-15 counts) and after the 1080 poison drops (2015-16 counts). However, the numbers of kōkako ($P=0.0107$) increased significantly between the pre-drop 2014-15 counts and the most recent 2017-18 counts.

We also conduct a population census to determine total kōkako numbers at 4-yearly intervals. In 2014, 55 pairs were found in the managed area, and 5 pairs outside the managed area. The next census will take place later this year.

Every year we monitor a sub-sample of up to 6 pairs to determine breeding success. Kōkako have been doing very well since the first 1080 drop in 2015. The fledging rate immediately prior to the 1080 drop was zero, and all monitored nests failed that season. The season before (2014) there were 2 chicks per pair fledged but productivity per nest was only 0.83, indicating failed nest attempts with pairs having to re-nest to be able to fledge any chicks.

After the 1080 drop (2015) productivity increased to over 2 chicks per pair with less failed nest attempts. In terms of what this equates to across the whole kōkako population in the Hunua Ranges, if we assume a minimum of 55 pairs (as at 2014 census) a productivity of 2 chicks per year would mean that an average of 110 chicks are fledging each year, significantly increasing the population.

Results from the sample of study pairs show that breeding success is now consistently higher annually across the population and is higher than past records of kōkako breeding success in the Hunua Kōkako Management Area (refer to Table 2 below).

Table 2: Summary of kōkako productivity from a sample of up to six pairs in the Hunua Kōkako Management Area, 2012-2018

Season	Productivity per pair	Productivity per nest	No. of pairs
2017/18	1.83	Unable to determine	6
2016/17	2.25	1.86	6
2015/16	2.17	0.94	6
2014/15	0	0	6
2013/14	2	0.83	5
2012/13	Minimum of 1.33 (different methodology)	n/a	6

vi. <u>Long tailed bat</u>

A long-tailed bat survey was undertaken pre-application of 1080 in 2015 and repeated again in 2016. The data collected in the surveys aimed to compare activity levels at the same locations pre and post-application in the Hunua Ranges Regional Park.

Long-tailed bat activity in 2016 was generally consistent with activity recorded in 2015 with no significant changes. This is likely due to the slow reproduction rate of this native mammal.

Please refer to Attachment 7-1 and 7-2 for copies of these bat surveys.

If you feel that we have not responded adequately to your request, you have the right to seek an investigation and review by the Ombudsman of this decision. Information about how to make a complaint is available at www.ombudsman.parliament.nz or freephone 0800 802 602.

If you have any further queries please contact me on (09) 301 0101 quoting LGOIMA No. 8140002938.

Yours sincerely

Joanne May Kearney
Privacy & LGOIMA Business Partner
Privacy & LGOIMA

8140002938

Attachment 1-A Possum RTC report pre 1080 Oct 2014

Qualmons Limited
PO Box 121
Turangi
Phone: 07 386 0373
Fax: 07 386 0374
Email: qualmons@esalez-nz.co.nz

Hunua Range
Possum Monitor
October-14

RTC COMBINED STRATA

Line No.	Possums	Trapnites	Poss/TN
1	0	26.5	0.00
2	0	28	0.00
3	0	28.5	0.00
4	2	28	7.14
5	2	28.5	7.02
6	3	28.5	10.53
7	1	29.5	3.39
8	2	29	6.90
9	2	29	6.90
10	0	29	0.00
11	0	30	0.00
12	0	30	0.00
13	0	30	0.00
14	15	28.5	52.63
15	3	29	10.34
16	4	29.5	13.56
17	0	30	0.00
18	0	29.5	0.00
19	3	28.5	10.53
20	0	28.5	0.00
21	2	28.5	7.02
22	1	29.5	3.39
23	2	28.5	7.02
24	0	30	0.00
25	0	28	0.00
26	2	30	6.67
27	2	28	7.14
28	4	28.5	14.04
29	3	28.5	10.53
30	0	29	0.00
31	6	28	21.43
32	1	30	3.33
33	1	29	3.45
34	0	29.5	0.00
35	2	29.5	6.78
36	11	29	37.93
37	3	29.5	10.17
38	3	28	10.71
39	3	30	10.00
40	3	28.5	10.53
41	1	29.5	3.39
42	0	30	0.00
43	0	30	0.00
44	0	30	0.00
45	3	28	10.71
46	1	29.5	3.39
47	1	30	3.33
48	4	28	14.29
49	1	27.5	3.64

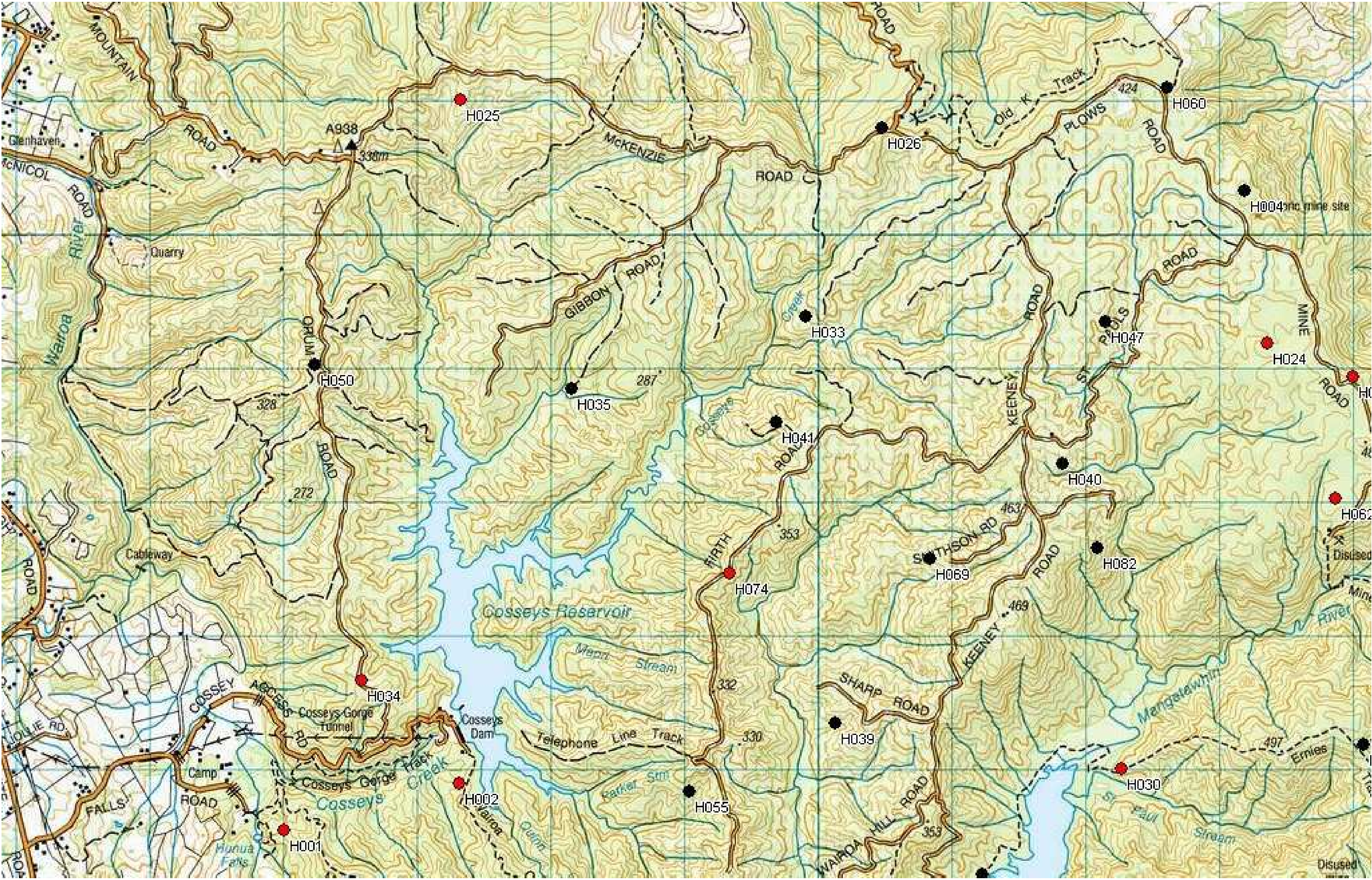
Column1	
Mean	9.350376174
Standard Error	0.988568688
Median	7.01754386
Mode	0
Standard Deviation	9.885686877
Sample Variance	97.72680503
Kurtosis	5.906229852
Skewness	2.149028908
Range	52.63157895
Minimum	0
Maximum	52.63157895
Sum	935.0376174
Count	100
Confidence Level(95.0%)	1.961534697

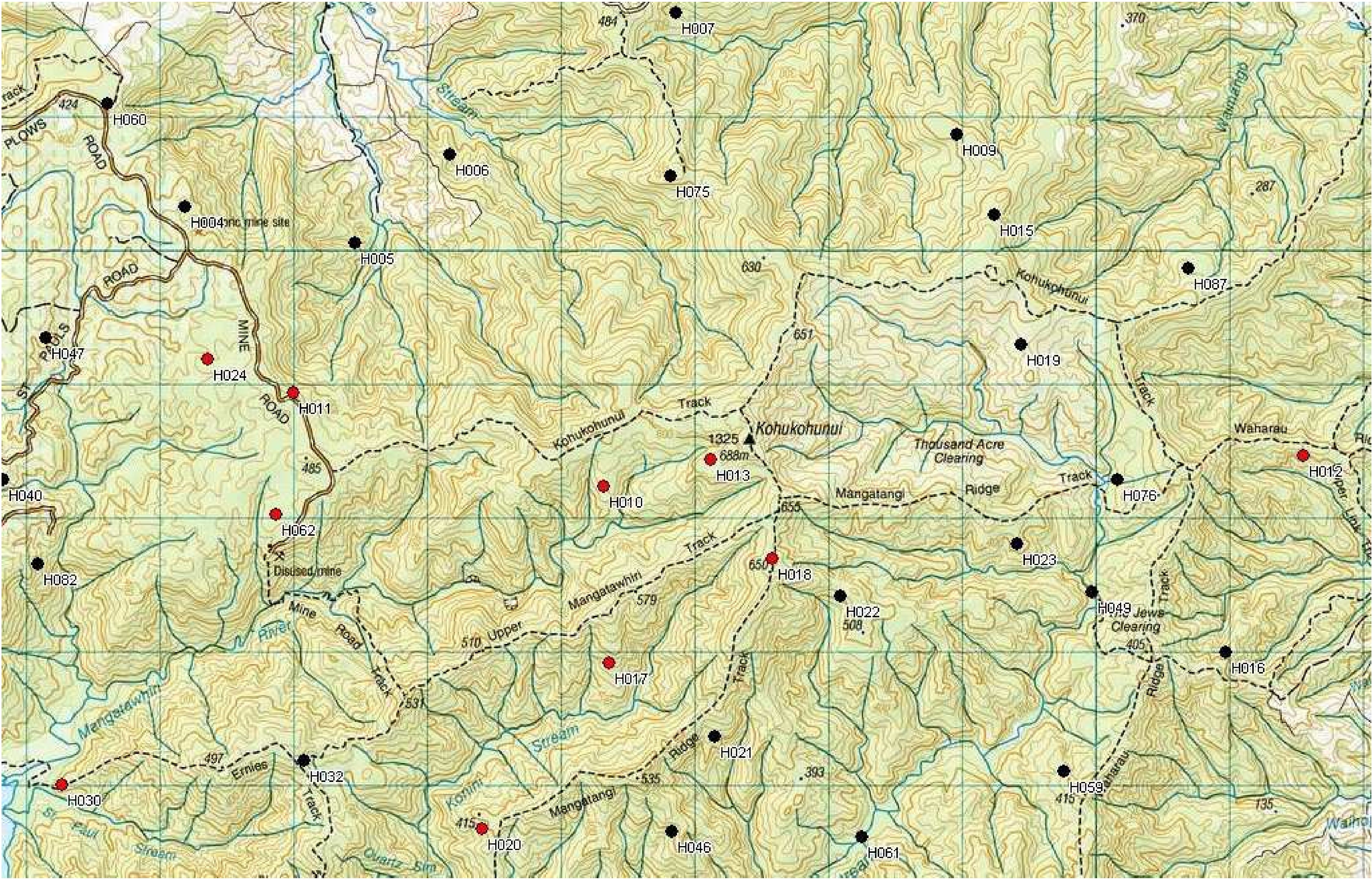
RTC = 9.35% (7.38% - 11.32%) +/- 1.97%

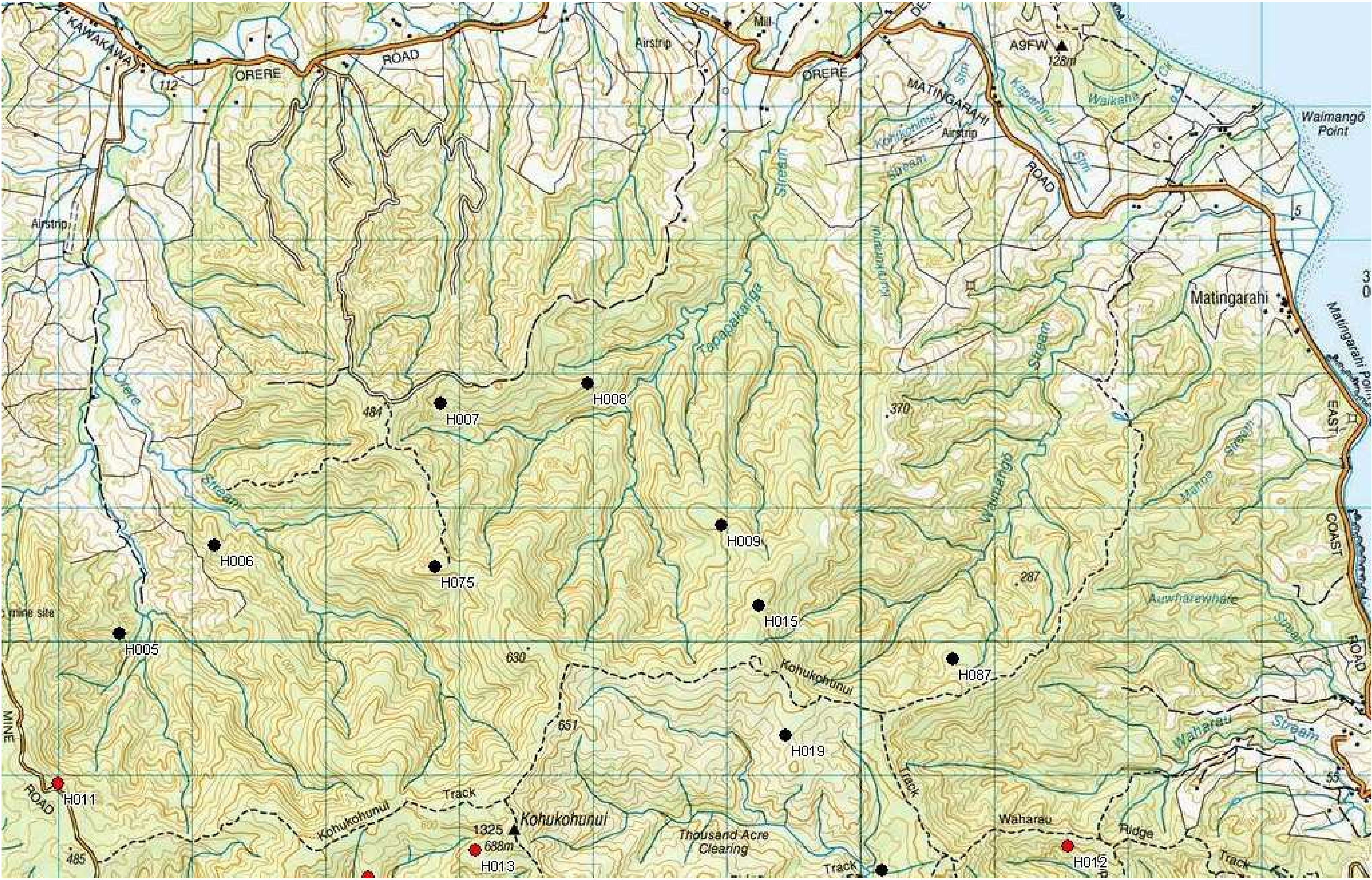
50	2	29	6.90	
51	4	28	14.29	
52	7	27	25.93	
53	2	28.5	7.02	
54	3	29.5	10.17	
55	3	29.5	10.17	
56	6	27	22.22	
57	2	28.5	7.02	
58	1	29.5	3.39	
59	2	29.5	6.78	
60	3	27.5	10.91	
61	4	27.5	14.55	
62	0	30	0.00	
63	1	26.5	3.77	
64	3	29	10.34	
65	4	28.5	14.04	
66	4	27.5	14.55	
67	2	29	6.90	
68	3	28.5	10.53	
69	8	29	27.59	
70	8	28.5	28.07	
71	5	29	17.24	
72	4	28.5	14.04	
73	2	29	6.90	
74	0	29.5	0.00	
75	1	30	3.33	
76	1	29.5	3.39	
77	5	28	17.86	
78	11	28.5	38.60	
79	6	30	20.00	
80	2	29	6.90	
81	1	29	3.45	
82	2	29	6.90	
83	3	29.5	10.17	
84	4	28.5	14.04	
85	7	28	25.00	
86	2	27.5	7.27	
87	6	29	20.69	
88	12	24.5	48.98	
89	2	28.5	7.02	
90	1	28.5	3.51	
91	3	28.5	10.53	
92	2	29	6.90	
93	1	28.5	3.51	
94	3	28	10.71	
95	2	28.5	7.02	
96	0	28.5	0.00	
97	3	28.5	10.53	
98	2	28	7.14	
99	2	28.5	7.02	
100	1	28.5	3.51	
	265	2875		
Mean			9.35	
StdDev			9.89	
StdErr			0.99	
95% CL			1.97	
Range		7.38	9.35	11.32

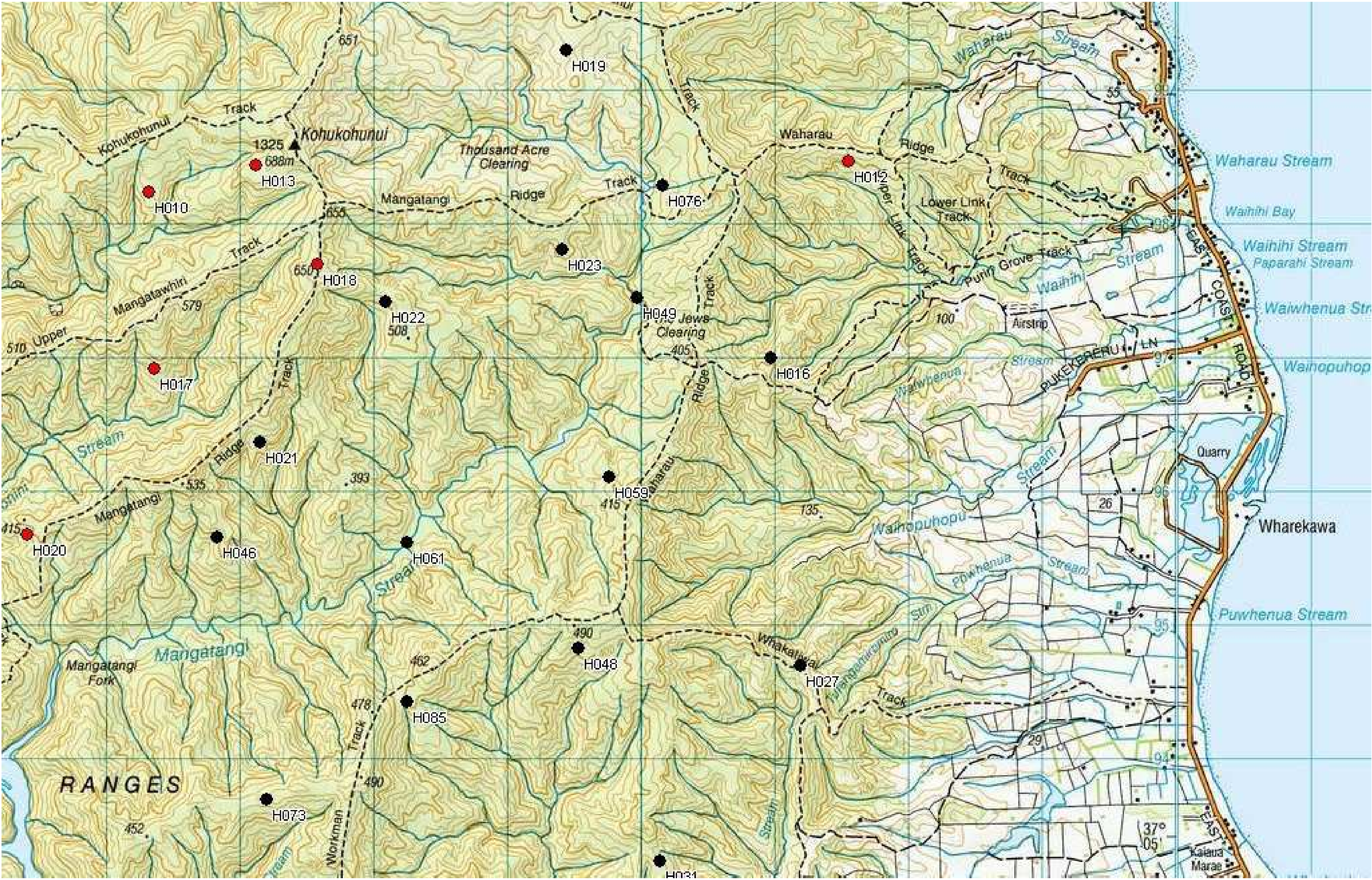
RTC = 9.35% (7.38% - 11.32%) +/- 1.97%

Attachment 1-B Possum RTC line locations pre 1080 work Oct 2014


MOUNTAIN ROAD
Glenhaven
McNICOL ROAD
Wairoa River
Quarry
A938
338m
H025
McKENZIE ROAD
H026
Old K Track
PLOWS ROAD
424
H060
H004
mine site
GIBBON ROAD
ORUM ROAD
H050
328
272
H035
287
Creek
H033
KEENEY ROAD
ST PAULS ROAD
H047
H024
MINE ROAD
Cosseys
H041
ROAD
H040
463
SMITHSON RD
H069
H082
H062
Disused
353
FIRTH
H074
469
Cableway
ROAD
Cosseys Reservoir
Mepin Stream
H034
332
SHARP ROAD
Mangatawhiri River
Mine
COSSEY ACCESS RD
Cosseys Gorge Tunnel
Cosseys Dam
H039
Telephone Line Track
330
497
Ernies
H030
JOLLIE RD
Camp
Cosseys Gorge Track
Cosseys Creek
H002
Parker Stm
H055
WAIROA HILL ROAD
353
St Paul Stream
FALLS ROAD
H001
Hunua Falls
Wairoa
Disused


484
H007
.370
Track
424
H060
PLOWS
ROAD
Stream
H009
Waimango
H006
H075
.287
H004
mine site
H015
H005
630
H087
Kohukohunui
ROAD
PAULS
651
MINE
H047
H019
H024
ROAD
H011
Kohukohunui
Track
Kohukohunui
1325
688m
Thousand Acre
Clearing
Waharau
485
H013
H012
H040
H010
Mangatangi
Ridge
Track
H076
H062
655
Track
Disused mine
650
H018
H023
H082
Mangatawhiri
Upper
579
H022
H049
Mine
Road
508
The Jews
Clearing
River
510
Track
405
H016
H017
Track
Ridge
Mangatawhiri
531
Stream
Ridge
H021
497
Ernies
H032
535
393
H059
H030
Track
Mangatangi
Kohini
415
Waharau
135
St Paul
Stream
415
H020
H046
H061
Quartz Stm
Waiho


KAWAKAWA
ORERE
ROAD
112
Mill
Airstrip
ORERE
A9FW
128m
MATINGARAHI
Kaparanui Stm
Waikeha Ck
Waimangō Point
Kohukohunui Stream
Airstrip
ROAD
Stream
Airstrip
5
Tapapakanga
Matingarahi
Matingarahi Point
Stream
Orere
484
H007
H008
370
EAST
Stream
Mahoe Stream
H009
Waimangō
COAST
H006
H075
287
mine site
H015
Auwharewhare
Stream
H005
630
Kohukohunui
H087
ROAD
MINE
651
H019
Waharau
Stream
55
ROAD
H011
Track
Kohukohunui
1325
Kohukohunui
Track
Waharau
Ridge
485
688m
H013
Thousand Acre Clearing
Track
H012
Track


H019
H010
H013
H012
H076
H023
H018
H022
H049
H016
H017
H021
H059
H020
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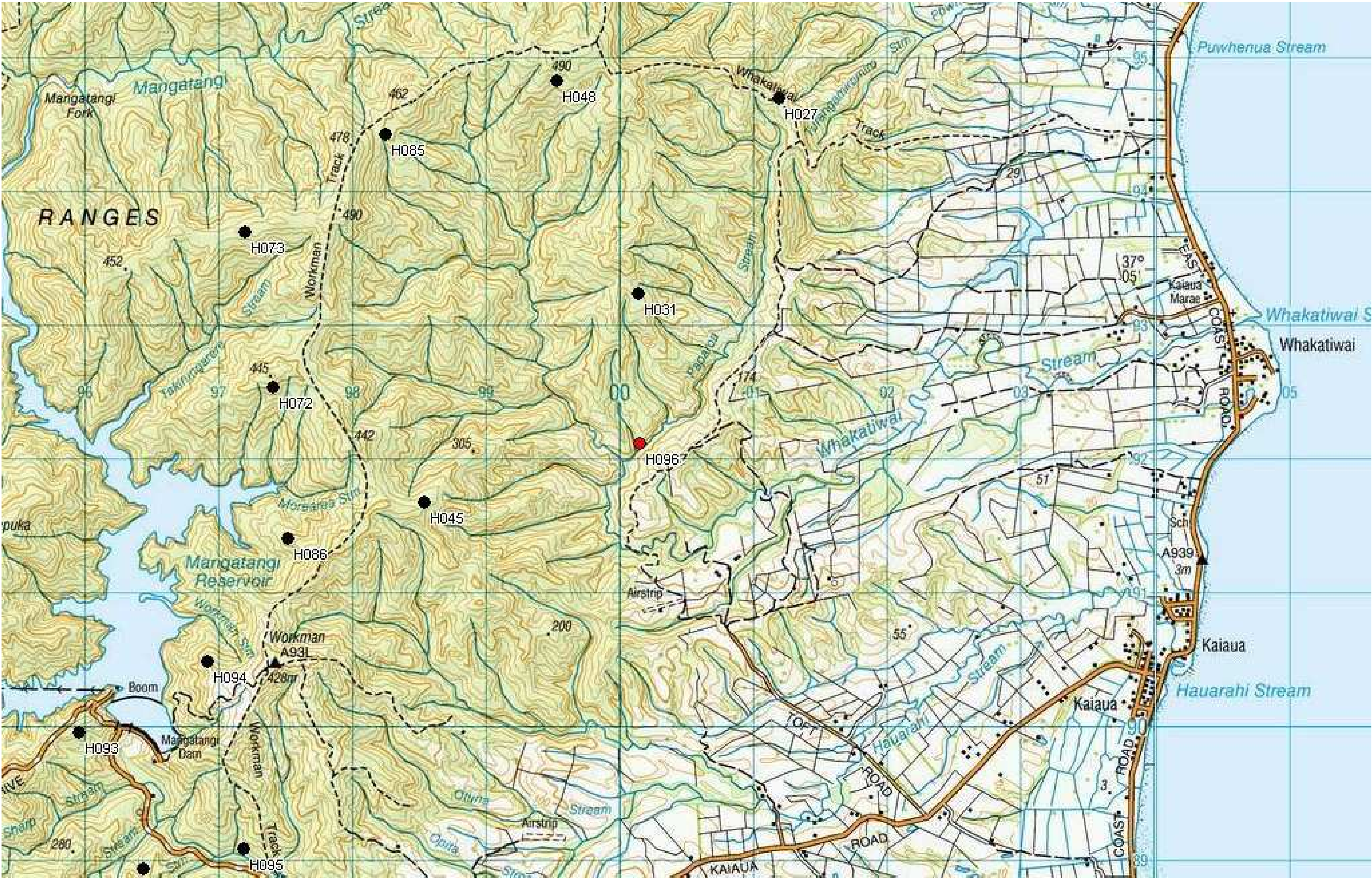
H061
H048
H027
H085
H073
H031
Kohukohunui
1325
688m
Kohukohunui
Track
Thousand Acre Clearing
Mangatangi Ridge Track
Waharau Ridge Track
Upper Link Track
Lower Link Track
Punu Grove Track
The Jews Clearing
Mangatawhiri
Upper
Ridge
Mangatangi
Mangatangi Fork
Mangatangi
Stream
Waharau Stream
Waihihi Bay
Waihihi Stream
Paparahi Stream
Waiwhenua Stream
Wainopuhopu
Waihopuhopu
Puwhenua Stream
Airstrip
PUKEKEREHU LN
EAST COAST ROAD
Quarry
Wharekawa
Whakatiwai
Track
Workman Track
RANGES
Kaiaua Marae
37° 05'
651
655
650
579
510
508
405
393
415
535
135
100
26
29
462
478
490
452
55
97
98
96
95
94


RANGES
Mangatangi
Mangatangi Fork
Mangatangi Reservoir
Mangatangi Dam
Boom
Workman Track
Workman
A93L
428m
Workman Stm
Takinngaroa Stream
Moreana Stm
Papakai Stream
Whakatiwai
Whakatiwai Stream
Whakatiwai
Kaiaua Marae
Kaiaua
Hauarahi Stream
Puwhenua Stream
Otura Stream
Opita Stream
Sharp Stream
Airstrip
Airstrip
TOFT ROAD
KAIAUA ROAD
EAST COAST ROAD
COAST ROAD
Sch
A939
3m
37°
05'
Track
H048
H027
H085
H073
H031
H072
H096
H045
H086
H094
H093
H095
490
462
478
490
452
445
442
305
200
174
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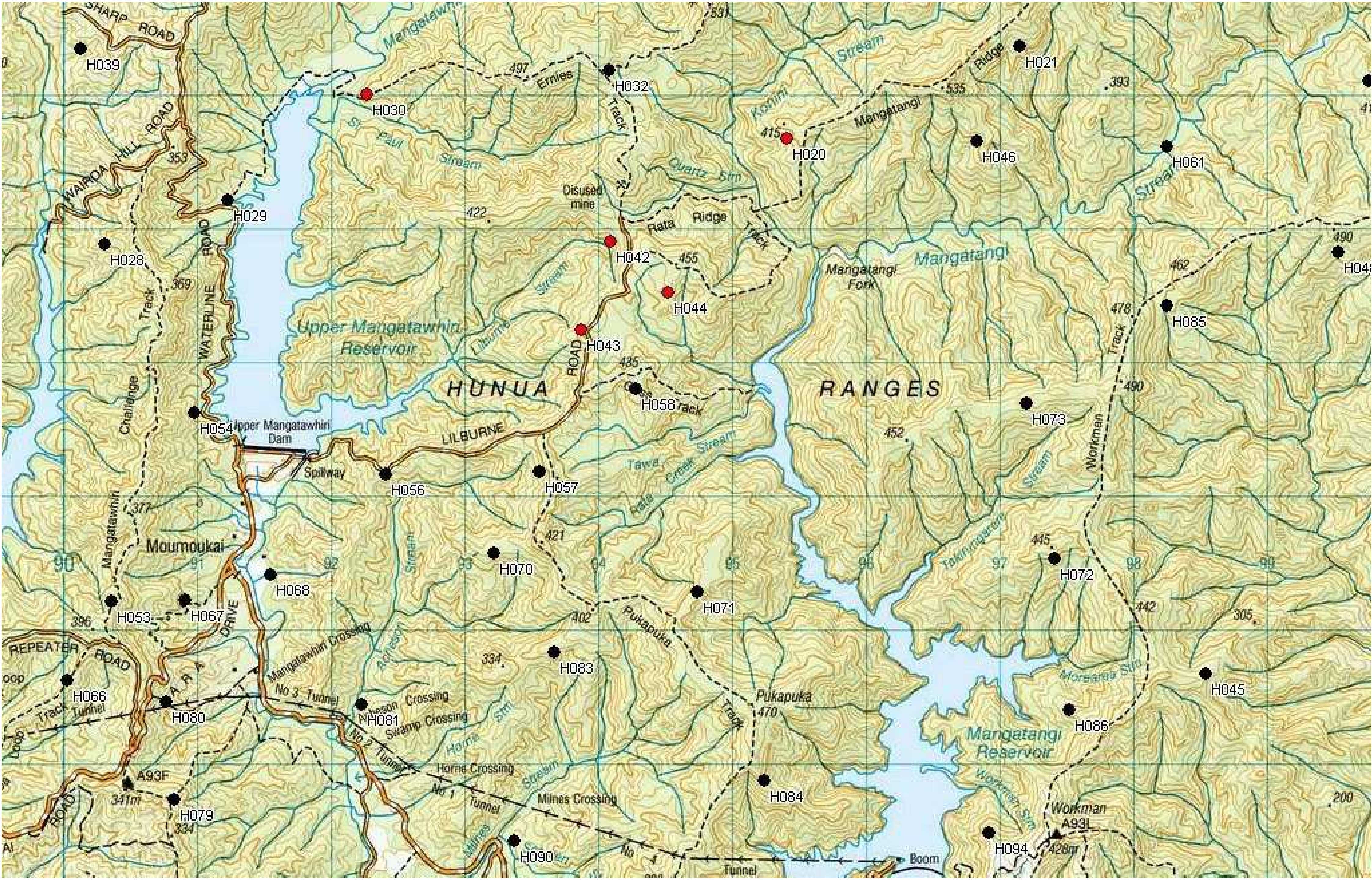
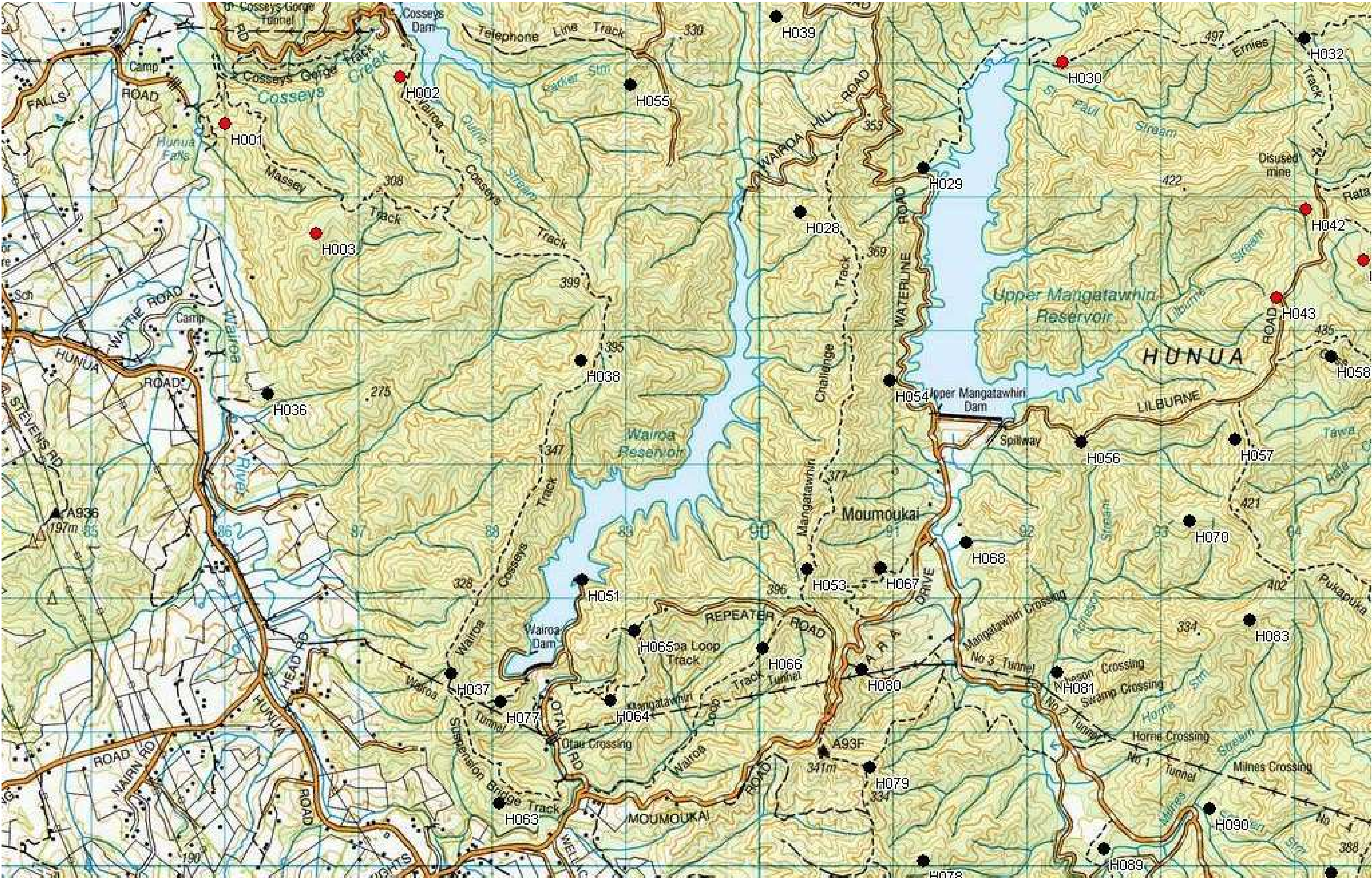
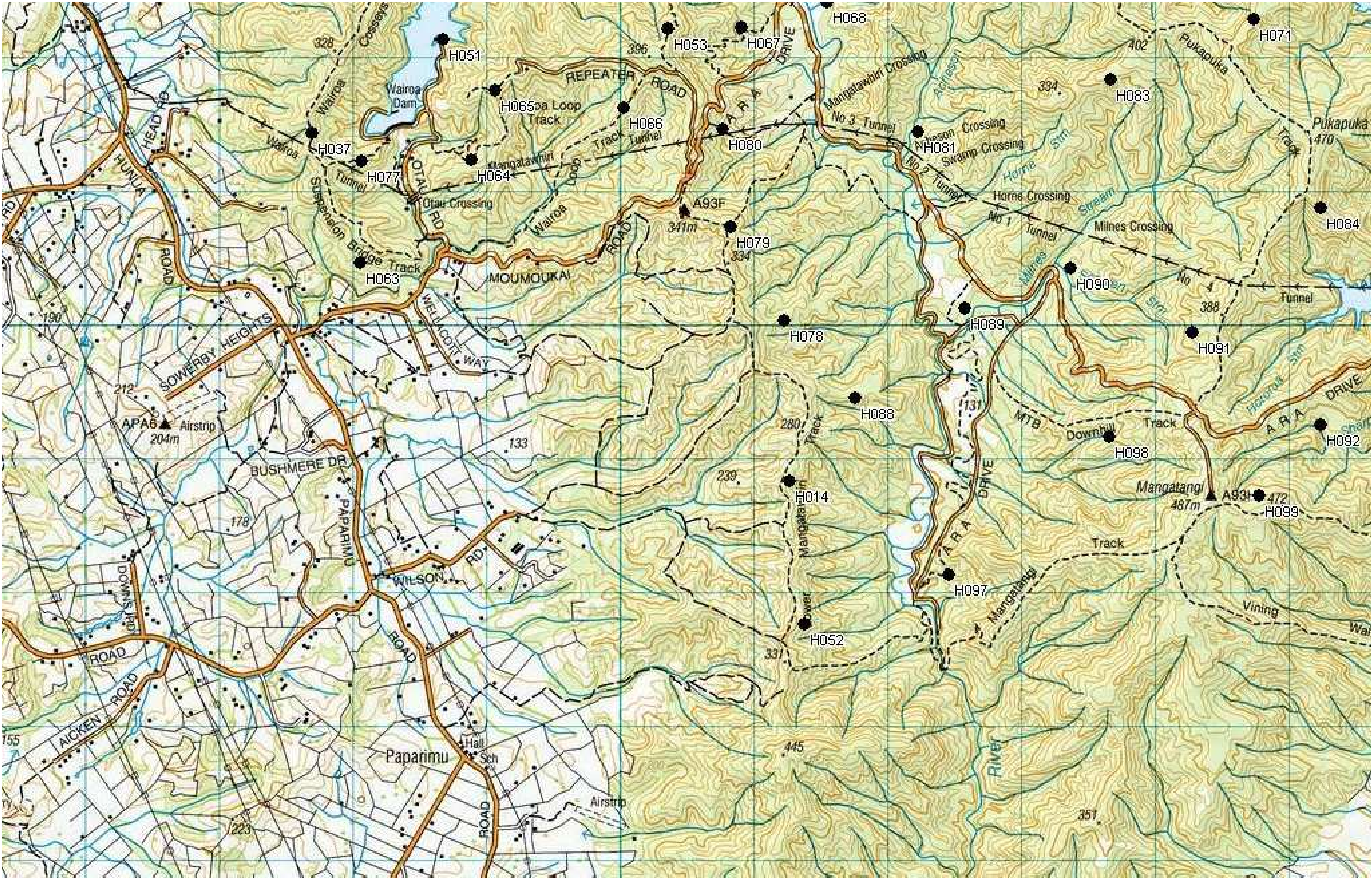
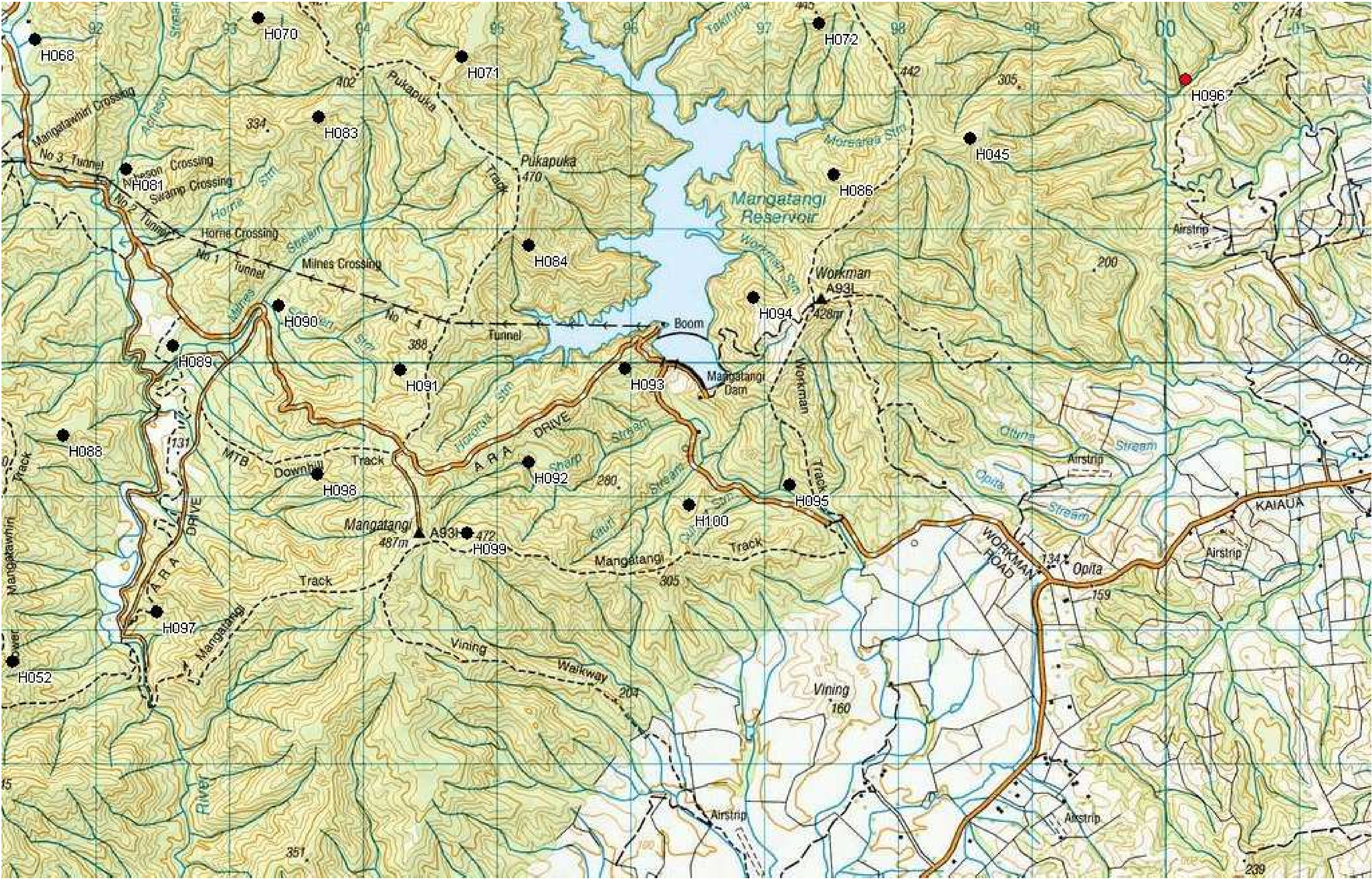
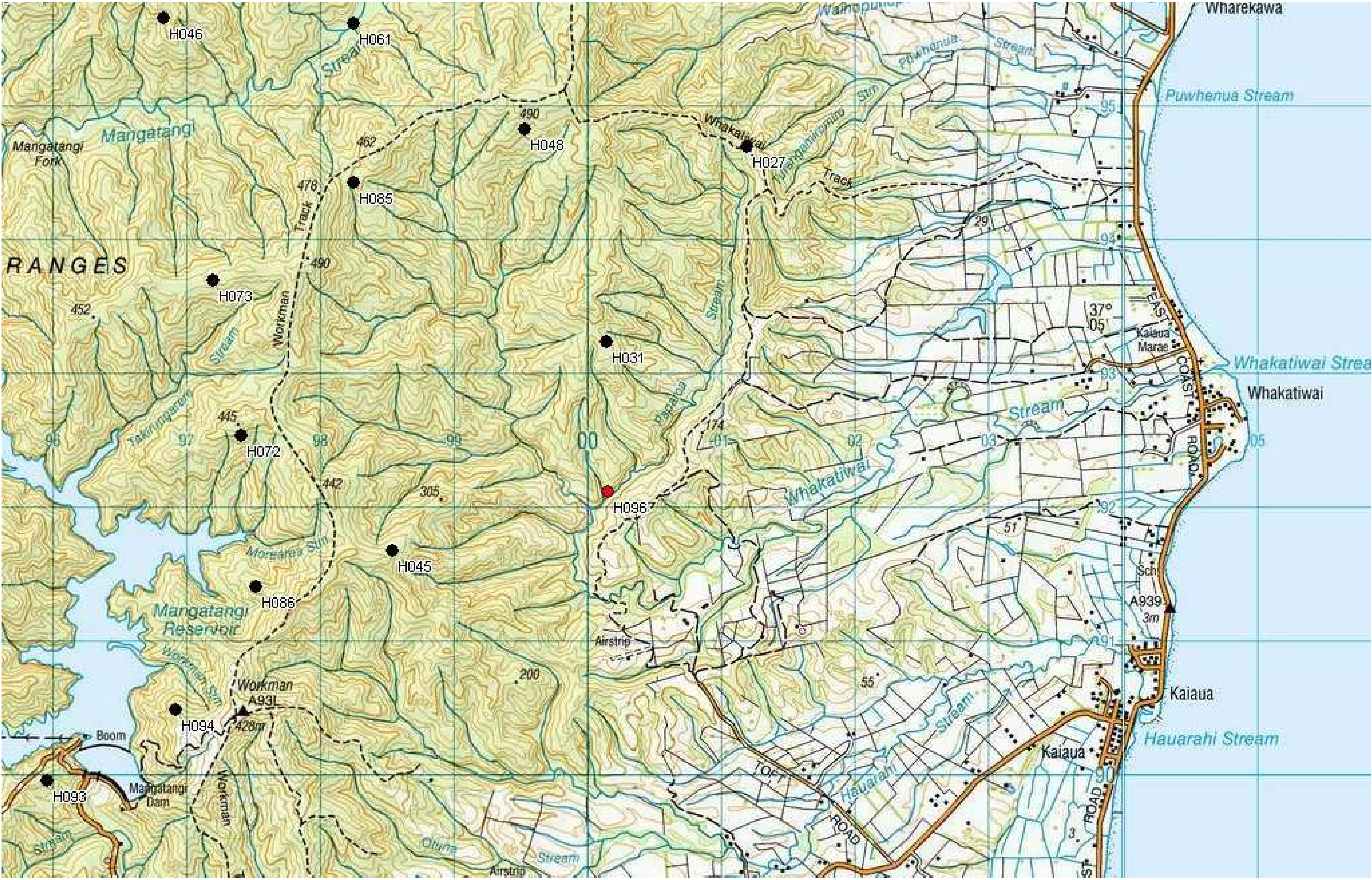

SHARP ROAD
H039
Mangatawhiri
497
Ernies
H032
Track
531
Stream
H021
Ridge
535
393
H030
St Paul
Stream
Konini
415
H020
Mangatangi
H046
H061
Stream
WAIROA HILL ROAD
353
H029
Quartz Stm
Disused mine
422
Rata
Ridge
Track
490
H028
H042
455
Mangatangi
Mangatangi Fork
H048
462
369
Challenge
Track
WATERLINE ROAD
Stream
H044
H085
Upper Mangatawhiri Reservoir
Lilburne
H043
ROAD
478
Track
435
HUNUA
H058
Cross Track
RANGES
490
H073
H054
Upper Mangatawhiri Dam
LILBURNE
452
Spillway
H056
H057
Tawa
Rata
Creek
Stream
Stream
Workman
377
421
Mangatawhiri
Moumoukai
445
90
91
92
93
94
95
96
97
98
99
Stream
H070
Tokiangareru
H072
H068
H071
H053
H067
DRIVE
402
Pukapuka
442
305
396
Mangatawhiri Crossing
Ashton
REPEATER ROAD
334
H083
Moreanas Stm
H045
Loop
H066
ARA
No 3 Tunnel
H080
Nicholson Crossing
H081
Swamp Crossing
Pukapuka
470
H086
Track
Loop
Tunnel
Track
Horne
Stm
No 2 Tunnel
Horne Crossing
Mangatangi Reservoir
A93F
341m
Stream
No 1 Tunnel
Milnes Crossing
H084
Workman Stm
200
ROAD
H079
334
Workman
A93L
428m
Milnes
H090
H094
No 4 Tunnel
Boom


Cosseys Gorge Tunnel
Cosseys Dam
Telephone Line Track
330
H039
H032
497
Ernies
H030
Track
Camp
Cosseys Gorge Track
Cosseys Creek
H002
Farker Str
H055
FALLS
ROAD
H001
Hunua Falls
Wairoa
Cosseys
Quinn Stream
Massey Track
308
WAIROA HILL ROAD
353
St Paul Stream
Disused mine
422
H029
Rata
H003
Track
Track
H028
WATERLINE ROAD
369
H042
Challenge Track
Upper Mangatawhiri Reservoir
399
Lilburne
Sch
WATTIE ROAD
Camp
Wairoa River
H043
485
ROAD
HUNUA
395
H038
HUNUA
ROAD
H058
H036
275
H054
Upper Mangatawhiri Dam
LILBURNE
STEVENS RD
Wairoa Reservoir
Spillway
H056
H057
347
Tawa
Track
Mangatawhiri
377
Rata
Moumoukai
421
A936
197m
85
86
87
88
89
90
91
92
93
94
Cosseys
H068
H070
Adams Stream
H051
H053
H067
DRIVE
402
Pukapuka
328
396
REPEATER ROAD
Mangatawhiri Crossing
334
H083
Wairoa Dam
H065
Wairoa Loop Track
H066
Tunnel
No 3 Tunnel
Anderson Crossing
H081
H080
Swamp Crossing
Wairoa
H037
HEAD RD
H077
Tunnel
Mangatawhiri
H064
Track
No 2 Tunnel
Horne Crossing
Horne Stream
OTAU RD
Otau Crossing
Wairoa Loop
A93F
341m
No 1 Tunnel
Mines Crossing
ROAD
NAIRN RD
HUNUA
ROAD
Suspension Bridge Track
ROAD
H079
334
H063
MOUMOUKAI
Mines Stream
H090
190
H089
388
H078
No 4



H051
H053
H067
H068
H071
H083
H065
H066
H080
H081
H037
H077
H064
H079
H063
H078
H089
H090
H091
H084
H088
H098
H092
H014
A93H
H099
H097
H052
A93F
341m
APA6
204m
Airstrip
Wairoa Dam
Cossey's
Wairoa
Wairoa Tunnel
Repeater Road
Wairoa Loop Track
Mangatawhiri Tunnel
Suspension Bridge Track
Otau Crossing
Otau Rd
Moumoukai
Ara Drive
Mangatawhiri Crossing
No 3 Tunnel
Adams Crossing
Swamp Crossing
No 2 Tunnel
Horne Crossing
Horne Stm
No 1 Tunnel
Milnes Crossing
Milnes Stm
No 4 Tunnel
Pukapuka Track
Pukapuka
470
402
394
388
396
328
334
Hunua Road
Head Rd
Sowerby Heights
Wellacott Way
Bushmere Dr
Paparimu Road
Wilson Rd
Downs Rd
Road
Aicken Road
Paparimu
Hall
Sch
Airstrip
190
212
133
178
155
223
280
239
331
445
351
131
Mangatawhiri River
Lower Mangatawhiri Track
MTB Downhill Track
Mangatangi
487m
472
Track
Mangatangi
Vining Walk
River
Ara Drive
Hoteo Stm


H068
H070
H071
H072
H096
H083
H081
H045
H086
H084
H090
H094
H089
H091
H093
H088
H092
H098
H095
H100
H099
H097
H052
Mangatawhiri Crossing
No 3 Tunnel
No 2 Tunnel
No 1 Tunnel
No 4 Tunnel
Swamp Crossing
Horne Crossing
Milnes Crossing
Horne Stm
Pukapuka
Pukapuka Track
Pukapuka 470
Mangatangi Reservoir
Moreanga Stm
Workman Stm
Workman A93L 428m
Workman Track
Boom
Mangatangi Dam
Hoiorua Stm
ARA DRIVE
Sharp Stream
Kauri Stream
MTB Downhill Track
Mangatangi A93H 487m
Mangatangi Track
Track
Vining Walkway
Vining 160
Opita Stream
Otuira Stream
Opita
WORKMAN ROAD
KAIAUA
Airstrip
Mangatawhiri River
Mangatangi
334
402
442
305
388
131
280
472
200
134
159
204
351
239
92
93
94
95
96
97
98
99
00


Wharekawa
H046
H061
Stream
Puwhenua Stream
Puwhenua Stream
95
Mangatangi
Mangatangi Fork
490
H048
462
Whakatiwai
H027
Track
478
H085
Track
29
94
RANGES
H073
490
452
Workman
Stream
Stream
37°
05'
Kaiaua Marae
EAST COAST ROAD
H031
Whakatiwai Stream
93
Whakatiwai
Papaiaia
Stream
445
H072
96
97
98
99
00
174
01
02
03
05
Whakatiwai
442
305
H096
92
51
Moreatea Stm
H045
H086
Sch
A939
3m
Mangatangi Reservoir
Airstrip
91
Workman Stm
200
55
Workman
A931
428m
H094
Kaiaua
Boom
Hauarahi Stream
Stream
Kaiaua
H093
Mangatangi Dam
Workman
TOFT ROAD
Hauarahi
ROAD
Stream
Ohira
Stream
Airstrip
3

Attachment 2-A Possum RTC report post 1080 Sept 2015 zone 1

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Hunua Zone 1
Possum Monitor
September-15

RTC COMBINED STRATA

Line No.	Possums	Trapnites	Poss/TN
Z1_01	0	30	0.00
Z1_02	0	30	0.00
Z1_03	0	30	0.00
Z1_04	0	30	0.00
Z1_05	0	30	0.00
Z1_06	0	30	0.00
Z1_07	0	30	0.00
Z1_08	1	30	3.33
Z1_09	0	30	0.00
Z1_10	0	30	0.00
Z1_11	0	30	0.00
Z1_12	0	30	0.00
Z1_13	0	30	0.00
Z1_14	0	30	0.00
Z1_15	0	30	0.00
Z1_16	0	30	0.00
Z1_17	0	30	0.00
Z1_18	0	30	0.00
Z1_19	0	30	0.00
Z1_20	0	30	0.00
Z1_21	0	30	0.00
Z1_22	0	30	0.00
Z1_23	0	30	0.00
Z1_24	0	30	0.00

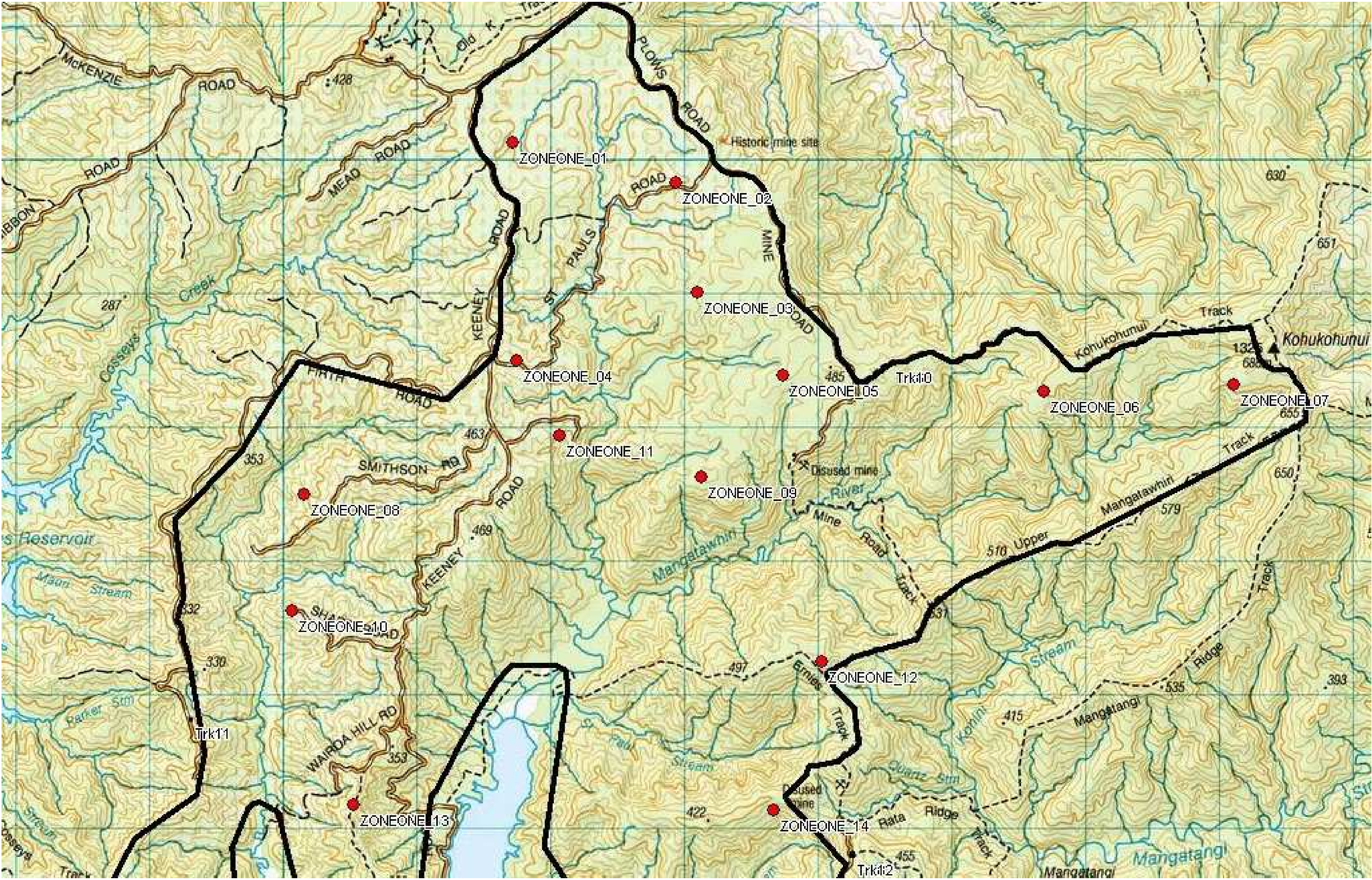
	Column1
Mean	0.25
Standard Error	0.140587899
Median	0
Mode	0
Standard Deviation	0.889155943
Sample Variance	0.790598291
Kurtosis	9.735880973
Skewness	3.35425542
Range	3.333333333
Minimum	0
Maximum	3.333333333
Sum	10
Count	40
Confidence Level(95.0%)	0.284365864

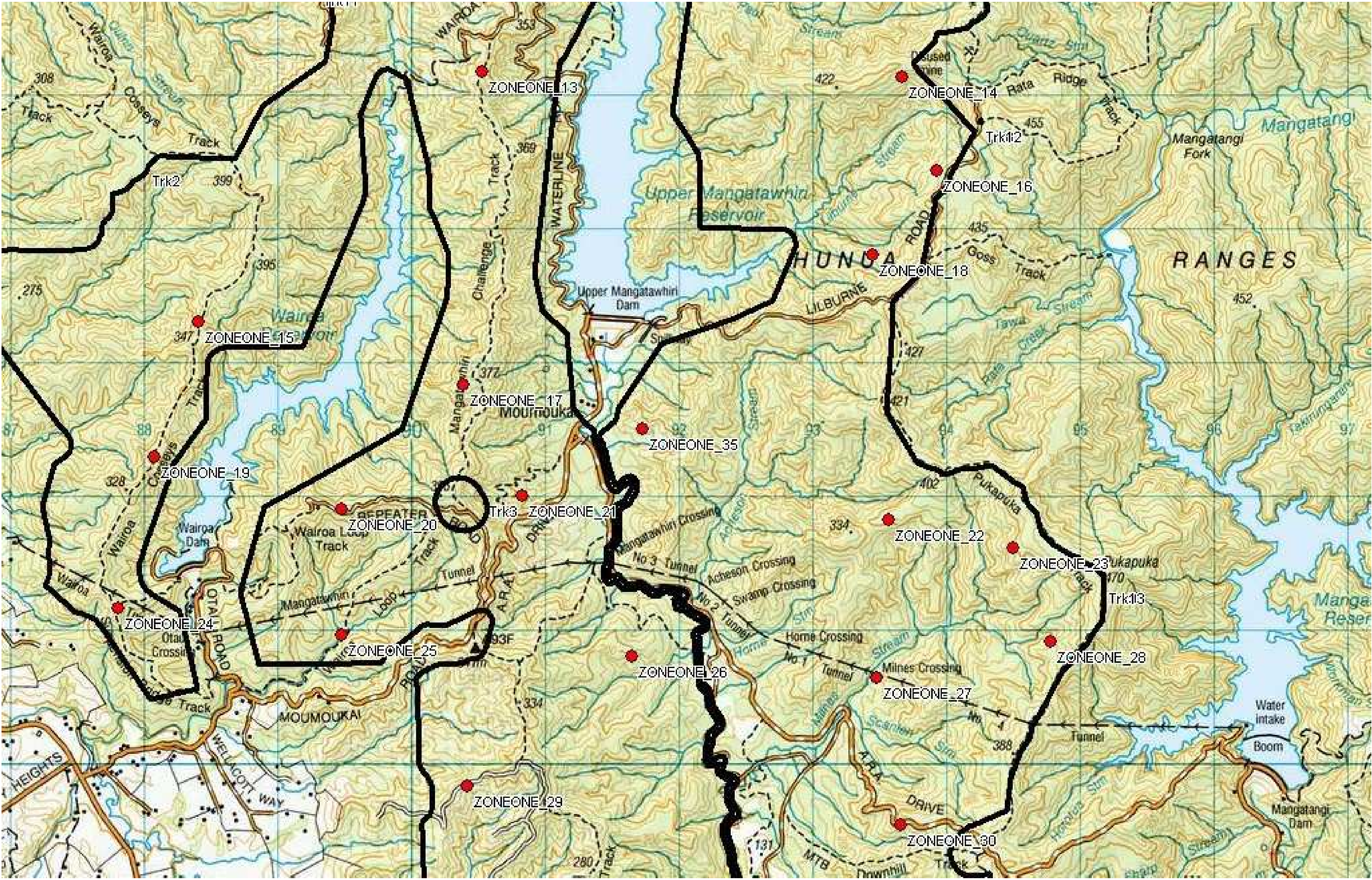
RTC = 0.25% (-0.04% - 0.54%) +/- 0.29%

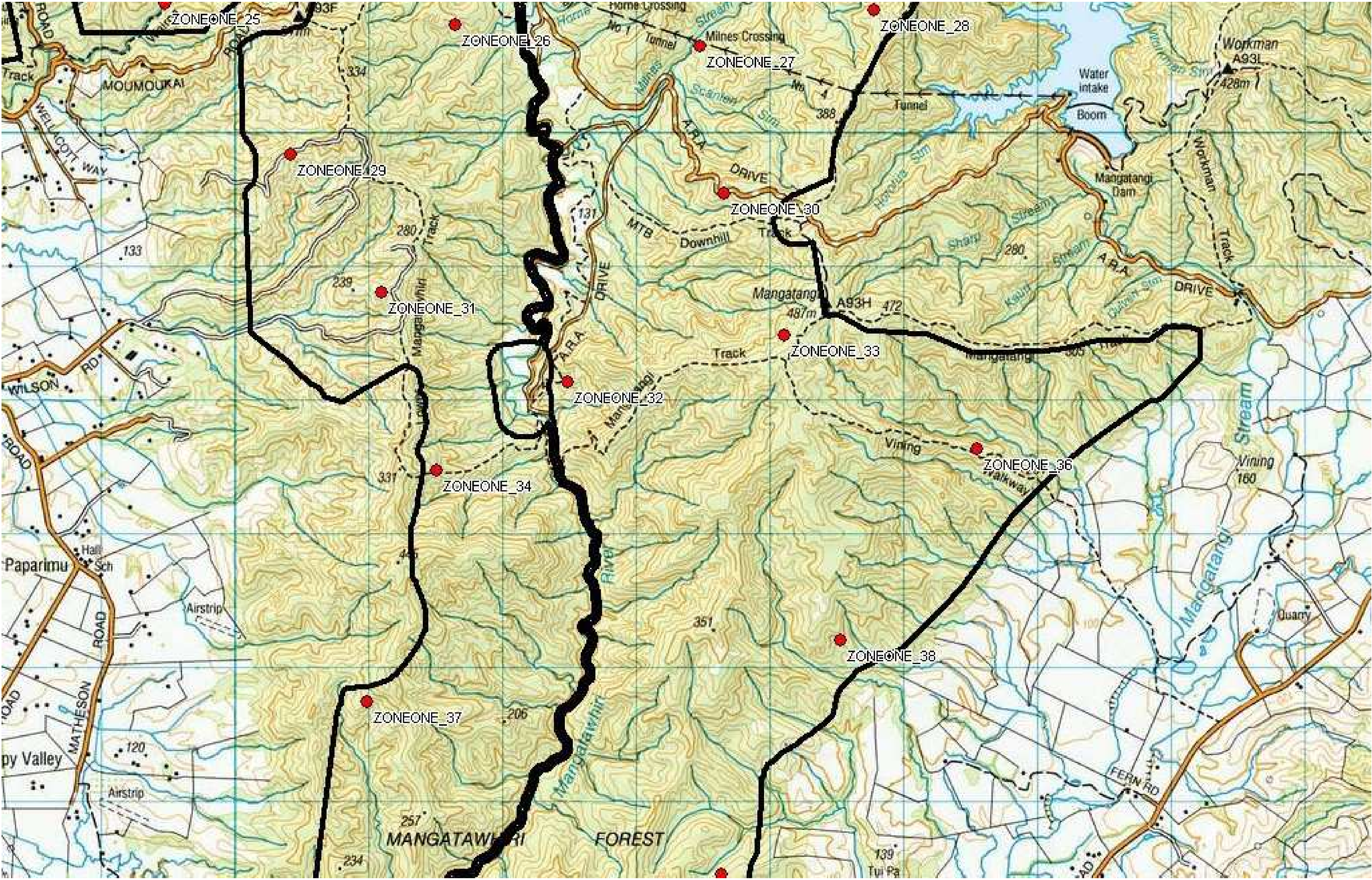
Z1_25	1	30	3.33	
Z1_26	0	30	0.00	
Z1_27	0	30	0.00	
Z1_28	0	30	0.00	
Z1_29	0	30	0.00	
Z1_30	0	30	0.00	
Z1_31	1	30	3.33	
Z1_32	0	30	0.00	
Z1_33	0	30	0.00	
Z1_34	0	30	0.00	
Z1_35	0	30	0.00	
Z1_36	0	30	0.00	
Z1_37	0	30	0.00	
Z1_38	0	30	0.00	
Z1_39	0	30	0.00	
Z1_40	0	30	0.00	
	3	1200		
Mean			0.25	
StdDev			0.89	
StdErr			0.14	
95% CL			0.29	
Range		-0.04	0.25	0.54

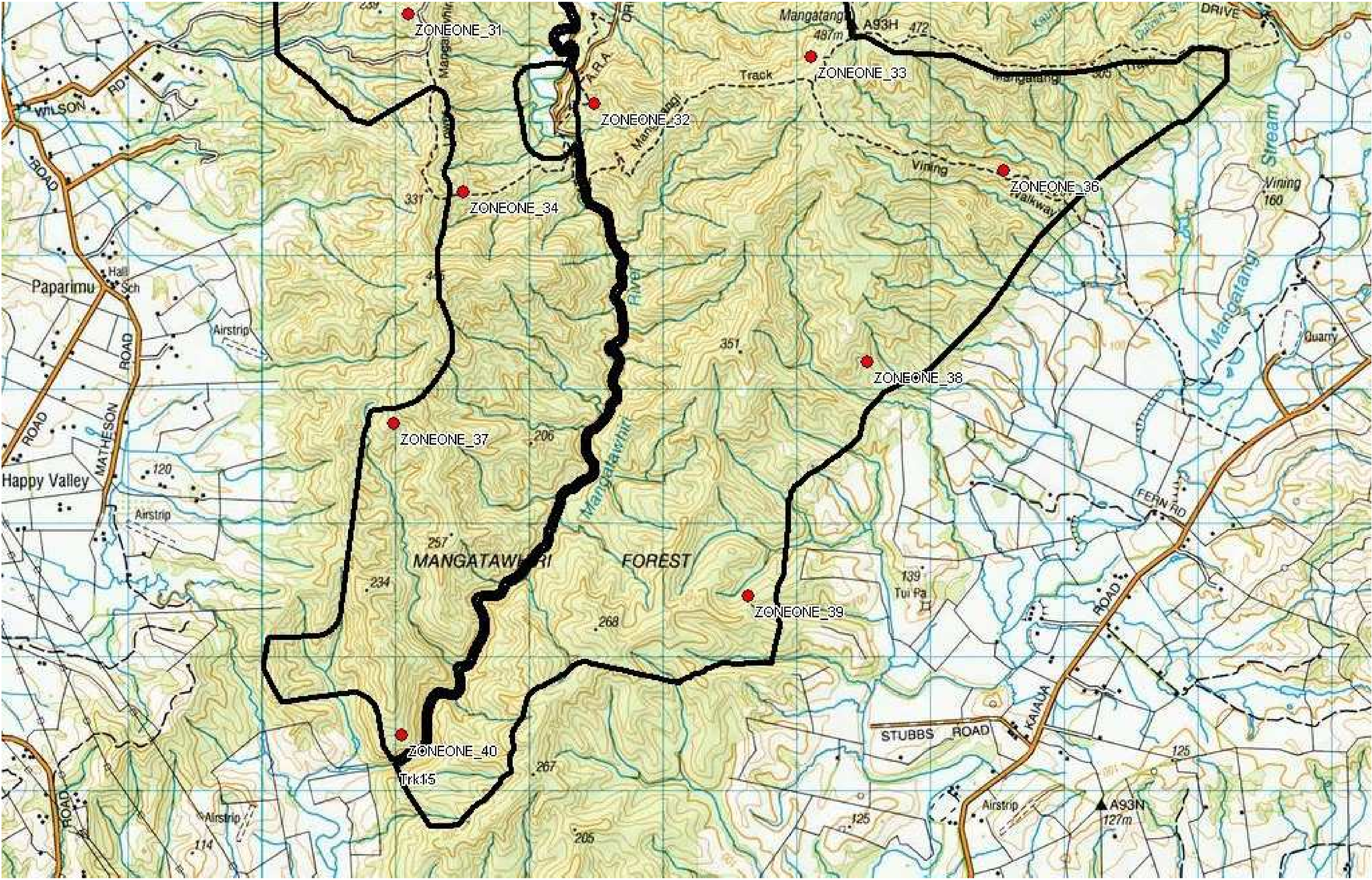
RTC = 0.25% (-0.04% - 0.54%) +/- 0.29%

Attachment 2-B Possum RTC line locations post 1080 Sept 2015 zone 1


McKENZIE
ROAD
428
Old K Track
ROAD
MEAD ROAD
RIBBON
PLOWS ROAD
Historic mine site
ZONEONE_01
ROAD
ZONEONE_02
630
KEENEY ROAD
ST PAULS
MINE ROAD
651
287
Creek
Cosseys
ZONEONE_03
Track
Kohukohunui
Kohukohunui
132
ZONEONE_04
485
ZONEONE_05
Trk10
ZONEONE_06
ZONEONE_07
655
FIRTH ROAD
463
ZONEONE_11
353
SMITHSON RD
Disused mine
ZONEONE_09
River
Track
650
ZONEONE_08
ROAD
Mine Road Track
Mangatawhiri
579
Reservoir
469
KEENEY
Mangatawhiri
510 Upper
Mangatawhiri
Track
Mason Stream
332
ZONEONE_10
531
Stream
330
497
ZONEONE_12
Ernies Track
Ridge
393
535
Parker Stm
Mangatangi
415
Kohini
Trk11
WAIROA HILL RD
353
St Paul Stream
Quartz Stm
Disused mine
ZONEONE_13
422
ZONEONE_14
Rata Ridge
Track
Stream
Cosseys
Track
455
Trk12
Mangatangi
Mangatangi


ZONEONE_13
ZONEONE_14
ZONEONE_15
ZONEONE_16
ZONEONE_17
ZONEONE_18
ZONEONE_19
ZONEONE_20
ZONEONE_21
ZONEONE_22
ZONEONE_23
ZONEONE_24
ZONEONE_25
ZONEONE_26
ZONEONE_27
ZONEONE_28
ZONEONE_29
ZONEONE_30
ZONEONE_35
Trk2
Trk3
Trk1l2
Trk1l3
Upper Mangatawhiri Reservoir
Upper Mangatawhiri Dam
Spillway
Wairoa Reservoir
Wairoa Dam
Cosseys Track
Wairoa Track
Challenge Track
WATERLINE
WAIROA ROAD
LILBURNE ROAD
Mangatawhiri
Moumoukai
MOUMOUKAI
HUNUA
RANGES
Mangatangi
Mangatangi Fork
Rata Ridge Track
Goss Track
Disused mine
Quartz Stm
Tawa Creek Stream
Pukapuka Track
Repeater Road
Wairoa Loop Track
Mangatawhiri Loop Track
Tunnel
No 3 Tunnel
No 2 Tunnel
No 1 Tunnel
No 4 Tunnel
Mangatawhiri Crossing
Acheson Crossing
Swamp Crossing
Home Crossing
Milnes Crossing
Otau Crossing
Home Stream
Scanlen Stm
A.R.A. DRIVE
MTB Downhill Track
OTAU ROAD
WELLACOTT WAY
HEIGHTS
Water intake
Boom
Mangatangi Dam
Mangatangi Reservoir
Takiwhanga Stream
93F
308
399
395
275
347
369
353
377
328
422
455
435
452
427
421
402
334
470
388
280
131
87
88
89
90
91
92
93
94
95
96
97


ZONEONE_25
A93F
ZONEONE_26
Horne Crossing
Milnes Crossing
ZONEONE_27
ZONEONE_28
Workman
A93L
428m
Water intake
Boom
Tunnel
No 1 Tunnel
No 4
Milnes Stream
Scanlen Stm
Horne Stream
ROAD
Track
MOUMOUKAI
WELLACOTT WAY
334
388
ZONEONE_29
A.R.A. DRIVE
ZONEONE_30
Mangatangi Dam
Workman Track
Sharp Stream
Kauri Stream
Quinn Stm
280
MTB Downhill Track
131
133
280
Track
239
ZONEONE_31
Mangatawhiri Track
Mangatangi
A93H
487m
472
DRIVE
ZONEONE_33
Track
Mangatangi
505
WILSON RD
ZONEONE_32
Mangatangi
ROAD
Vining
ZONEONE_36
Walkway
Vining
160
Stream
Mangatangi
331
ZONEONE_34
Paparimu
Hall
Sch
Airstrip
ROAD
351
ZONEONE_38
Quarry
River
ZONEONE_37
206
MATHESON
ROAD
120
py Valley
Airstrip
FERN RD
257
MANGATAWHIRI
FOREST
Mangatawhiri
234
139
Tui Pa
ROAD


ZONEONE_31
ZONEONE_32
ZONEONE_33
ZONEONE_34
ZONEONE_36
ZONEONE_37
ZONEONE_38
ZONEONE_39
ZONEONE_40
Trk15
MANGATAWHIRI FOREST
Mangatawhiri River
Mangatangi
487m
A93H
472
Track
Vining Walkway
Mangatangi Stream
Vining
160
Quarry
WILSON RD
ROAD
Paparimu
Hall
Sch
Airstrip
MATHESON ROAD
Happy Valley
120
331
446
351
206
257
234
268
267
205
114
139
Tui Pa
FERN RD
KAIAUA ROAD
STUBBS ROAD
125
A93N
127m
DRIVE

Attachment 2-C - Possum RTC report post 1080 Aug 2015 zone 2

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Hunua Range Zone 2
Possum Monitor
August-15

RTC COMBINED STRATA

Line No.	**Possums**	**Trapnites**	**Poss/TN**
ZONE2_01	0	30	0.00
ZONE2_02	0	30	0.00
ZONE2_03	2	30	6.67
ZONE2_04	0	30	0.00
ZONE2_05	1	30	3.33
ZONE2_06	1	30	3.33
ZONE2_07	1	30	3.33
ZONE2_08	0	30	0.00
ZONE2_09	0	30	0.00
ZONE2_10	0	30	0.00
ZONE2_11	0	30	0.00
ZONE2_12	0	30	0.00
ZONE2_13	1	30	3.33
ZONE2_14	1	29.5	3.39
ZONE2_15	0	30	0.00
ZONE2_16	0	30	0.00
ZONE2_17	0	30	0.00
ZONE2_18	0	30	0.00
ZONE2_19	0	30	0.00
ZONE2_20	0	30	0.00
ZONE2_21	0	30	0.00
ZONE2_22	0	30	0.00
ZONE2_23	0	30	0.00
ZONE2_24	0	30	0.00

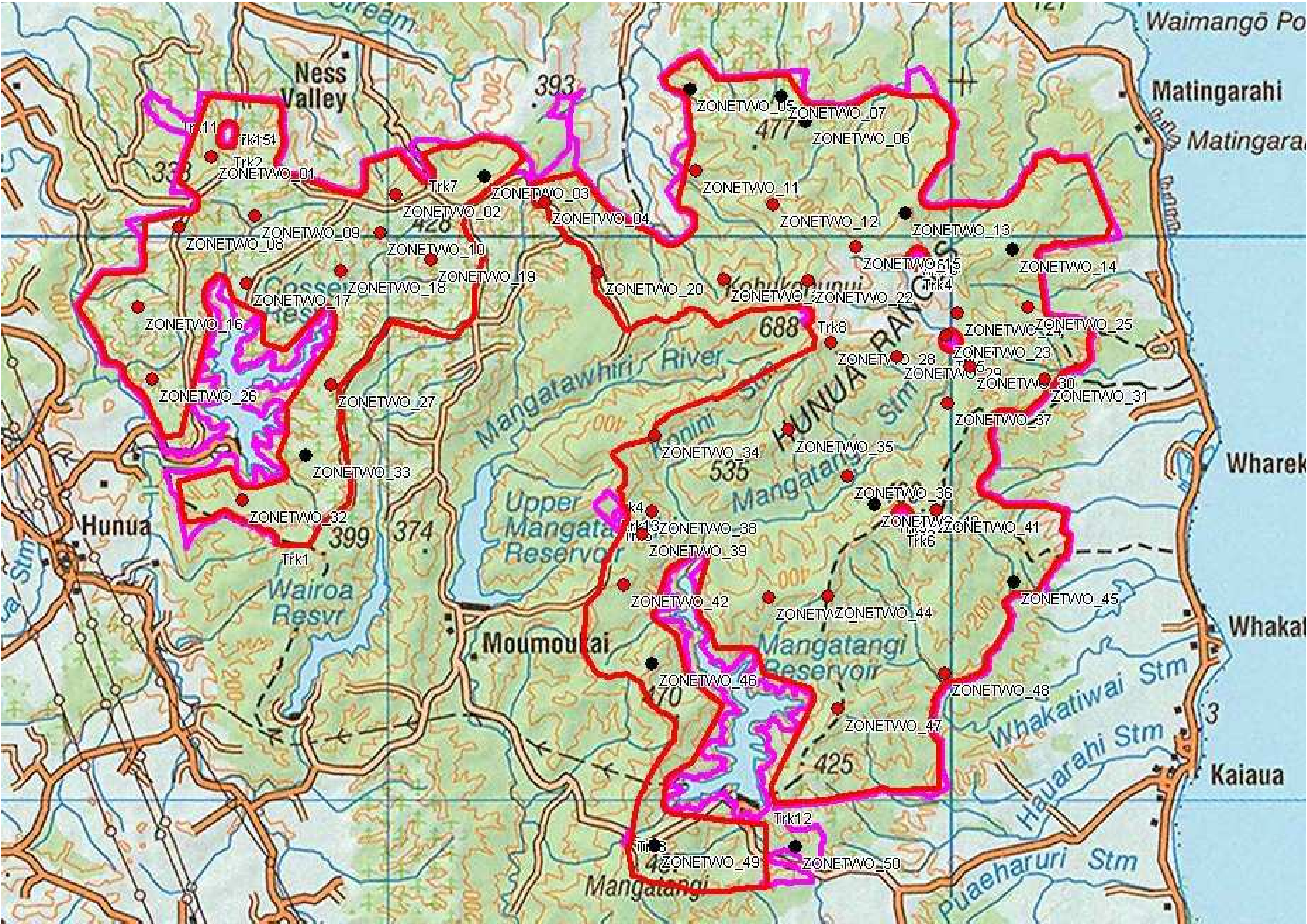
Column1	
Mean	1.001129944
Standard Error	0.273749561
Median	0
Mode	0
Standard Deviation	1.935701713
Sample Variance	3.746941121
Kurtosis	2.3907801
Skewness	1.824686441
Range	6.666666667
Minimum	0
Maximum	6.666666667
Sum	50.05649718
Count	50
Confidence Level(95.0%)	0.55012033

RTC = 1.00% (0.45% - 1.55%) +/- 0.55%

ZONE2_25	0	30	0.00	
ZONE2_26	0	30	0.00	
ZONE2_27	0	30	0.00	
ZONE2_28	0	30	0.00	
ZONE2_29	0	30	0.00	
ZONE2_30	0	30	0.00	
ZONE2_31	0	30	0.00	
ZONE2_32	0	30	0.00	
ZONE2_33	2	30	6.67	
ZONE2_34	0	30	0.00	
ZONE2_35	0	30	0.00	
ZONE2_36	0	30	0.00	
ZONE2_37	0	30	0.00	
ZONE2_38	0	30	0.00	
ZONE2_39	0	30	0.00	
ZONE2_40	1	30	3.33	
ZONE2_41	0	30	0.00	
ZONE2_42	0	30	0.00	
ZONE2_43	0	30	0.00	
ZONE2_44	0	30	0.00	
ZONE2_45	1	30	3.33	
ZONE2_46	1	30	3.33	
ZONE2_47	0	30	0.00	
ZONE2_48	0	30	0.00	
ZONE2_49	2	30	6.67	
ZONE2_50	1	30	3.33	
	15	1499.5		
Mean			1.00	
StdDev			1.94	
StdErr			0.27	
95% CL			0.55	
Range		0.45	1.00	1.55

RTC = 1.00% (0.45% - 1.55%) +/- 0.55%

Attachment 2-D Possum RTC line locations post 1080 Aug 2015 zone 2


Stream
Waimangō Po
Ness Valley
393
Matingarahi
Matingara
477
338
428
Trk11
Trk154
Trk2
Trk7
ZONETWO_01
ZONETWO_02
ZONETWO_03
ZONETWO_04
ZONETWO_05
ZONETWO_06
ZONETWO_07
ZONETWO_08
ZONETWO_09
ZONETWO_10
ZONETWO_11
ZONETWO_12
ZONETWO_13
ZONETWO_14
ZONETWO_15
ZONETWO_16
ZONETWO_17
ZONETWO_18
ZONETWO_19
ZONETWO_20
ZONETWO_22
ZONETWO_23
ZONETWO_24
ZONETWO_25
ZONETWO_26
ZONETWO_27
ZONETWO_28
ZONETWO_29
ZONETWO_30
ZONETWO_31
ZONETWO_32
ZONETWO_33
ZONETWO_34
ZONETWO_35
ZONETWO_36
ZONETWO_37
ZONETWO_38
ZONETWO_39
ZONETWO_41
ZONETWO_42
ZONETWO_44
ZONETWO_45
ZONETWO_46
ZONETWO_47
ZONETWO_48
ZONETWO_49
ZONETWO_50
Trk4
Trk5
Trk6
Trk8
Trk1
Trk3
Trk12
Cosseys Res
Kohukohunui
688
HUNUA RANGES
Mangatawhiri River
Stm
535
Mangatangi
Upper Mangatawhiri Reservoir
Hunua
399
374
Wairoa Resvr
Moumoutai
Mangatangi Reservoir
470
425
Wharek
Whakat
Whakatiwai Stm
Hauarahi Stm
Puaeharuri Stm
Kaiaua
3
Mangatangi

Attachment 3 - Possum RTC line locations April 2018

Printed from MapToaster Topo/NZ

MagNth is 21° East of Grid Nth. Crown Copyright Reserved

Map Series (NZTM) :1:50,000 [Topo50], Sheet: BB33 v2 2012. Scale 1:50000.

Attachment 4-1 - Hunua Ranges bird count data May 2018

Annual Hunua Five Minute Bird Count data
2014-15 season to 2017-18 season

Location	Year	Date	Time	Count #	Harrier	Kaka	Kingfisher	Tomtit	Kokako
Hunua	2014-15	23-Dec-14	751	1			1	1	1
Hunua	2014-15	23-Dec-14	801	2			1	1	
Hunua	2014-15	23-Dec-14	809	3		1	1	3	
Hunua	2014-15	23-Dec-14	818	4		1	1	1	
Hunua	2014-15	23-Dec-14	826	5				1	
Hunua	2014-15	23-Dec-14	836	6		2		1	
Hunua	2014-15	23-Dec-14	845	7				2	
Hunua	2014-15	23-Dec-14	853	8			1		
Hunua	2014-15	23-Dec-14	902	9					
Hunua	2014-15	23-Dec-14	910	10				1	
Hunua	2014-15	23-Dec-14	919	11			1	1	
Hunua	2014-15	23-Dec-14	927	12				3	
Hunua	2014-15	23-Dec-14	936	13				2	
Hunua	2014-15	23-Dec-14	944	14					
Hunua	2014-15	23-Dec-14	959	15			1	2	
Hunua	2014-15	12-Dec-14	810	1					
Hunua	2014-15	12-Dec-14	820	2		2			
Hunua	2014-15	12-Dec-14	830	3					
Hunua	2014-15	12-Dec-14	840	4					
Hunua	2014-15	12-Dec-14	848	5					
Hunua	2014-15	12-Dec-14	858	6			1		
Hunua	2014-15	12-Dec-14	907	7					
Hunua	2014-15	12-Dec-14	916	8					
Hunua	2014-15	12-Dec-14	925	9				1	
Hunua	2014-15	12-Dec-14	934	10				1	
Hunua	2014-15	12-Dec-14	944	11					
Hunua	2014-15	12-Dec-14	954	12				1	
Hunua	2014-15	12-Dec-14	1005	13				2	
Hunua	2014-15	12-Dec-14	1018	14				1	
Hunua	2014-15	12-Dec-14	1029	15				1	
Hunua	2014-15	3-Dec-14	745	1					
Hunua	2014-15	3-Dec-14	758	2					
Hunua	2014-15	3-Dec-14	809	3					
Hunua	2014-15	3-Dec-14	822	4					
Hunua	2014-15	3-Dec-14	833	5					
Hunua	2014-15	3-Dec-14	846	6					
Hunua	2014-15	3-Dec-14	859	7					
Hunua	2014-15	3-Dec-14	909	8					
Hunua	2014-15	3-Dec-14	920	9					
Hunua	2014-15	3-Dec-14	928	10					
Hunua	2014-15	3-Dec-14	942	11					
Hunua	2014-15	3-Dec-14	953	12					
Hunua	2014-15	3-Dec-14	1007	13					
Hunua	2014-15	3-Dec-14	1017	14					
Hunua	2014-15	3-Dec-14	1028	15					
Hunua	2014-15	3-Dec-14	751	1			1		
Hunua	2014-15	3-Dec-14	805	2			1		
Hunua	2014-15	3-Dec-14	816	3					

Annual Hunua Five Minute Bird Count data
2014-15 season to 2017-18 season

Location	Year	Date	Time	Count #	Harrier	Kaka	Kingfisher	Tomtit	Kokako
Hunua	2014-15	3-Dec-14	825	4					
Hunua	2014-15	3-Dec-14	834	5					
Hunua	2014-15	3-Dec-14	843	6					
Hunua	2014-15	3-Dec-14	852	7					
Hunua	2014-15	3-Dec-14	901	8			1		
Hunua	2014-15	3-Dec-14	910	9			2		
Hunua	2014-15	3-Dec-14	919	10					
Hunua	2014-15	3-Dec-14	928	11				1	
Hunua	2014-15	3-Dec-14	938	12			1	1	
Hunua	2014-15	3-Dec-14	947	13					
Hunua	2014-15	3-Dec-14	956	14					
Hunua	2014-15	3-Dec-14	1005	15	1			1	
Hunua	2014-15	3-Dec-14	754	1				2	
Hunua	2014-15	3-Dec-14	803	2					
Hunua	2014-15	3-Dec-14	812	3			1		
Hunua	2014-15	3-Dec-14	821	4			2		
Hunua	2014-15	3-Dec-14	830	5				1	
Hunua	2014-15	3-Dec-14	839	6					
Hunua	2014-15	3-Dec-14	848	7				1	
Hunua	2014-15	3-Dec-14	857	8				3	
Hunua	2014-15	3-Dec-14	909	9			2		
Hunua	2014-15	3-Dec-14	919	10					
Hunua	2014-15	3-Dec-14	932	11					
Hunua	2014-15	3-Dec-14	944	12			1		
Hunua	2014-15	3-Dec-14	955	13			1		
Hunua	2014-15	3-Dec-14	1006	14	1			2	
Hunua	2014-15	3-Dec-14	1016	15				1	
Hunua	2014-15	3-Dec-14	800	1					
Hunua	2014-15	3-Dec-14	815	2				1	
Hunua	2014-15	3-Dec-14	824	3				1	
Hunua	2014-15	3-Dec-14	832	4					
Hunua	2014-15	3-Dec-14	841	5					
Hunua	2014-15	3-Dec-14	849	6				1	
Hunua	2014-15	3-Dec-14	857	7					
Hunua	2014-15	3-Dec-14	905	8				1	
Hunua	2014-15	3-Dec-14	913	9					
Hunua	2014-15	3-Dec-14	921	10			1		
Hunua	2014-15	3-Dec-14	935	11			2	1	
Hunua	2014-15	3-Dec-14	943	12				2	
Hunua	2014-15	3-Dec-14	951	13				1	
Hunua	2014-15	3-Dec-14	959	14					
Hunua	2014-15	3-Dec-14	1007	15				1	
Hunua	2014-15	5-Jan-15	832	1				1	
Hunua	2014-15	5-Jan-15	842	2			1	1	
Hunua	2014-15	5-Jan-15	851	3					
Hunua	2014-15	5-Jan-15	859	4					
Hunua	2014-15	5-Jan-15	908	5				1	
Hunua	2014-15	5-Jan-15	917	6				1	

Annual Hunua Five Minute Bird Count data
2014-15 season to 2017-18 season

Location	Year	Date	Time	Count #	Harrier	Kaka	Kingfisher	Tomtit	Kokako
Hunua	2014-15	5-Jan-15	925	7				1	
Hunua	2014-15	5-Jan-15	937	8			1	1	
Hunua	2014-15	5-Jan-15	947	9					
Hunua	2014-15	5-Jan-15	956	10				1	
Hunua	2014-15	5-Jan-15	1005	11			1	1	
Hunua	2014-15	5-Jan-15	1014	12				1	
Hunua	2014-15	5-Jan-15	1022	13				2	
Hunua	2014-15	5-Jan-15	1030	14				1	
Hunua	2014-15	5-Jan-15	1038	15					
Hunua	2014-15	5-Jan-15	824	1				2	
Hunua	2014-15	5-Jan-15	836	2			1		
Hunua	2014-15	5-Jan-15	906	3			2	3	
Hunua	2014-15	5-Jan-15	915	4			1	1	
Hunua	2014-15	5-Jan-15	923	5			1	2	
Hunua	2014-15	5-Jan-15	935	6				2	
Hunua	2014-15	5-Jan-15	945	7			1	2	
Hunua	2014-15	5-Jan-15	953	8			1	2	
Hunua	2014-15	5-Jan-15	1000	9			1	1	
Hunua	2014-15	5-Jan-15	1008	10				2	
Hunua	2014-15	5-Jan-15	1056	11			2	1	
Hunua	2014-15	5-Jan-15	1105	12			2	2	
Hunua	2014-15	5-Jan-15	1113	13			4	1	
Hunua	2014-15	5-Jan-15	1121	14				2	
Hunua	2014-15	5-Jan-15	1128	15		1		2	
Hunua	2014-15	7-Jan-15	747	1				2	
Hunua	2014-15	7-Jan-15	754	2			1	3	
Hunua	2014-15	7-Jan-15	801	3				3	
Hunua	2014-15	7-Jan-15	807	4				1	
Hunua	2014-15	7-Jan-15	814	5			1	3	
Hunua	2014-15	7-Jan-15	820	6		1		2	
Hunua	2014-15	7-Jan-15	827	7				2	
Hunua	2014-15	7-Jan-15	835	8				2	
Hunua	2014-15	7-Jan-15	842	9			1	3	
Hunua	2014-15	7-Jan-15	849	10				2	
Hunua	2014-15	7-Jan-15	855	11				1	
Hunua	2014-15	7-Jan-15	902	12				2	
Hunua	2014-15	7-Jan-15	909	13		3		2	
Hunua	2014-15	7-Jan-15	916	14				2	
Hunua	2014-15	7-Jan-15	924	15			1	2	
Hunua	2014-15	7-Jan-15	944	1		1		2	
Hunua	2014-15	7-Jan-15	951	2			2		
Hunua	2014-15	7-Jan-15	1000	3				1	
Hunua	2014-15	7-Jan-15	1010	4			1	2	
Hunua	2014-15	7-Jan-15	1018	5				2	
Hunua	2014-15	7-Jan-15	1027	6		1		1	
Hunua	2014-15	7-Jan-15	1038	7				2	
Hunua	2014-15	7-Jan-15	1045	8				1	
Hunua	2014-15	7-Jan-15	1053	9		1		2	

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Location	Year	Date	Time	Count #	Harrier	Kaka	Kingfisher	Tomtit	Kokako
Hunua	2014-15	7-Jan-15	1101	10		1		1	
Hunua	2014-15	7-Jan-15	1110	11				3	
Hunua	2014-15	7-Jan-15	1119	12				2	
Hunua	2014-15	7-Jan-15	1128	13				2	
Hunua	2014-15	7-Jan-15	1137	14				2	
Hunua	2014-15	7-Jan-15	1146	15				1	
Hunua	2015-16	14-Jan-16	835	1			1	1	
Hunua	2015-16	14-Jan-16	848	2		1		1	
Hunua	2015-16	14-Jan-16	857	3		3			
Hunua	2015-16	14-Jan-16	905	4		3		2	
Hunua	2015-16	14-Jan-16	913	5		2		2	
Hunua	2015-16	14-Jan-16	922	6			1	1	
Hunua	2015-16	14-Jan-16	931	7				1	
Hunua	2015-16	14-Jan-16	943	8		1		2	
Hunua	2015-16	14-Jan-16	952	9			1	1	
Hunua	2015-16	14-Jan-16	1001	10		2		2	
Hunua	2015-16	14-Jan-16	1011	11			2		
Hunua	2015-16	14-Jan-16	1019	12				2	
Hunua	2015-16	14-Jan-16	1028	13				1	
Hunua	2015-16	14-Jan-16	1048	14		1		2	
Hunua	2015-16	14-Jan-16	1059	15				2	
Hunua	2015-16	14-Jan-16	838	1				2	
Hunua	2015-16	14-Jan-16	847	2				2	
Hunua	2015-16	14-Jan-16	856	3					
Hunua	2015-16	14-Jan-16	904	4		1		1	
Hunua	2015-16	14-Jan-16	912	5		1		1	
Hunua	2015-16	14-Jan-16	920	6				1	
Hunua	2015-16	14-Jan-16	929	7					
Hunua	2015-16	14-Jan-16	937	8				2	
Hunua	2015-16	14-Jan-16	945	9				1	
Hunua	2015-16	14-Jan-16	953	10				2	
Hunua	2015-16	14-Jan-16	1002	11				2	
Hunua	2015-16	14-Jan-16	1011	12				1	
Hunua	2015-16	14-Jan-16	1021	13				1	
Hunua	2015-16	14-Jan-16	1032	14				2	
Hunua	2015-16	14-Jan-16	1041	15					
Hunua	2015-16	2-Dec-15	800	1			1	2	
Hunua	2015-16	2-Dec-15	809	2			1		
Hunua	2015-16	2-Dec-15	818	3					
Hunua	2015-16	2-Dec-15	827	4	1			2	
Hunua	2015-16	2-Dec-15	836	5			1		
Hunua	2015-16	2-Dec-15	845	6					
Hunua	2015-16	2-Dec-15	854	7	1			1	
Hunua	2015-16	2-Dec-15	903	8				1	
Hunua	2015-16	2-Dec-15	912	9			2	2	
Hunua	2015-16	2-Dec-15	921	10					

Annual Hunua Five Minute Bird Count data
2014-15 season to 2017-18 season

Location	Year	Date	Time	Count #	Harrier	Kaka	Kingfisher	Tomtit	Kokako
Hunua	2015-16	2-Dec-15	930	11			2		
Hunua	2015-16	2-Dec-15	940	12					
Hunua	2015-16	2-Dec-15	950	13			2		
Hunua	2015-16	2-Dec-15	1000	14				1	
Hunua	2015-16	2-Dec-15	1009	15			1	4	
Hunua	2015-16	2-Dec-15	826	1			1		
Hunua	2015-16	2-Dec-15	838	2					
Hunua	2015-16	2-Dec-15	849	3			1		
Hunua	2015-16	2-Dec-15	900	4				1	
Hunua	2015-16	2-Dec-15	911	5				1	
Hunua	2015-16	2-Dec-15	923	6					
Hunua	2015-16	2-Dec-15	933	7				2	
Hunua	2015-16	2-Dec-15	945	8				2	
Hunua	2015-16	2-Dec-15	956	9					
Hunua	2015-16	2-Dec-15	1006	10					
Hunua	2015-16	2-Dec-15	1019	11			1	1	
Hunua	2015-16	2-Dec-15	1029	12				4	
Hunua	2015-16	2-Dec-15	1040	13					
Hunua	2015-16	2-Dec-15	1050	14					
Hunua	2015-16	2-Dec-15	1100	15				2	
Hunua	2015-16	2-Dec-15	821	1					
Hunua	2015-16	2-Dec-15	831	2		2			
Hunua	2015-16	2-Dec-15	840	3					
Hunua	2015-16	2-Dec-15	849	4				1	
Hunua	2015-16	2-Dec-15	900	5					
Hunua	2015-16	2-Dec-15	910	6				1	
Hunua	2015-16	2-Dec-15	919	7					
Hunua	2015-16	2-Dec-15	929	8					
Hunua	2015-16	2-Dec-15	940	9		2		1	
Hunua	2015-16	2-Dec-15	955	10		1			
Hunua	2015-16	2-Dec-15	1005	11					
Hunua	2015-16	2-Dec-15	1017	12				1	
Hunua	2015-16	2-Dec-15	1027	13					
Hunua	2015-16	2-Dec-15	1036	14		1			
Hunua	2015-16	2-Dec-15	1045	15					
Hunua	2015-16	2-Dec-15	829	1					
Hunua	2015-16	2-Dec-15	837	2					
Hunua	2015-16	2-Dec-15	848	3				1	
Hunua	2015-16	2-Dec-15	856	4				1	
Hunua	2015-16	2-Dec-15	906	5				2	
Hunua	2015-16	2-Dec-15	915	6			2	1	
Hunua	2015-16	2-Dec-15	928	7					
Hunua	2015-16	2-Dec-15	937	8					
Hunua	2015-16	2-Dec-15	945	9				1	
Hunua	2015-16	2-Dec-15	953	10			1		
Hunua	2015-16	2-Dec-15	1002	11					
Hunua	2015-16	2-Dec-15	1009	12			1		
Hunua	2015-16	2-Dec-15	1019	13			2		

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Location	Year	Date	Time	Count #	Harrier	Kaka	Kingfisher	Tomtit	Kokako
Hunua	2015-16	2-Dec-15	1027	14			2		
Hunua	2015-16	2-Dec-15	1035	15			2		
Hunua	2015-16	14-Dec-15	809	1				3	
Hunua	2015-16	14-Dec-15	819	2			1		
Hunua	2015-16	14-Dec-15	827	3				2	
Hunua	2015-16	14-Dec-15	836	4				1	
Hunua	2015-16	14-Dec-15	845	5			1	1	
Hunua	2015-16	14-Dec-15	854	6			1		
Hunua	2015-16	14-Dec-15	903	7			3	2	
Hunua	2015-16	14-Dec-15	914	8			1	2	
Hunua	2015-16	14-Dec-15	925	9			1		
Hunua	2015-16	14-Dec-15	933	10			1		
Hunua	2015-16	14-Dec-15	942	11				2	
Hunua	2015-16	14-Dec-15	951	12				1	
Hunua	2015-16	14-Dec-15	1005	13				1	
Hunua	2015-16	14-Dec-15	1013	14			2	1	
Hunua	2015-16	14-Dec-15	1022	15			2	1	
Hunua	2015-16	14-Dec-15	817	1				4	
Hunua	2015-16	14-Dec-15	827	2				1	
Hunua	2015-16	14-Dec-15	836	3			1	2	
Hunua	2015-16	14-Dec-15	844	4					
Hunua	2015-16	14-Dec-15	855	5				2	
Hunua	2015-16	14-Dec-15	904	6				2	
Hunua	2015-16	14-Dec-15	912	7			1	1	
Hunua	2015-16	14-Dec-15	920	8			1		
Hunua	2015-16	14-Dec-15	929	9			2		
Hunua	2015-16	14-Dec-15	946	10		2	1	1	
Hunua	2015-16	14-Dec-15	1022	11				3	
Hunua	2015-16	14-Dec-15	1032	12				4	
Hunua	2015-16	14-Dec-15	1040	13				1	
Hunua	2015-16	14-Dec-15	1048	14				2	
Hunua	2015-16	14-Dec-15	1056	15				3	
Hunua	2015-16	6-Jan-16	723	1				3	
Hunua	2015-16	6-Jan-16	733	2		1		2	
Hunua	2015-16	6-Jan-16	739	3				3	
Hunua	2015-16	6-Jan-16	748	4	1			3	2
Hunua	2015-16	6-Jan-16	756	5				1	
Hunua	2015-16	6-Jan-16	804	6				3	
Hunua	2015-16	6-Jan-16	812	7				2	
Hunua	2015-16	6-Jan-16	820	8					
Hunua	2015-16	6-Jan-16	827	9			1	3	
Hunua	2015-16	6-Jan-16	835	10	1			2	
Hunua	2015-16	6-Jan-16	842	11				2	1
Hunua	2015-16	6-Jan-16	850	12				3	
Hunua	2015-16	6-Jan-16	858	13		1		3	
Hunua	2015-16	6-Jan-16	905	14				2	
Hunua	2015-16	6-Jan-16	912	15				2	
Hunua	2015-16	11-Jan-16	752	1		1		1	2

Annual Hunua Five Minute Bird Count data
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Location	Year	Date	Time	Count #	Harrier	Kaka	Kingfisher	Tomtit	Kokako
Hunua	2015-16	11-Jan-16	759	2					
Hunua	2015-16	11-Jan-16	808	3		1		2	
Hunua	2015-16	11-Jan-16	817	4			1	4	
Hunua	2015-16	11-Jan-16	826	5				2	
Hunua	2015-16	11-Jan-16	834	6				1	
Hunua	2015-16	11-Jan-16	842	7			1	3	1
Hunua	2015-16	11-Jan-16	850	8				3	
Hunua	2015-16	11-Jan-16	859	9				3	
Hunua	2015-16	11-Jan-16	907	10				3	
Hunua	2015-16	11-Jan-16	915	11				3	
Hunua	2015-16	11-Jan-16	922	12				3	
Hunua	2015-16	11-Jan-16	930	13				4	
Hunua	2015-16	11-Jan-16	941	14				3	
Hunua	2015-16	11-Jan-16	952	15				2	
Hunua	2016-17	6-Dec-16	805	1		1		3	
Hunua	2016-17	6-Dec-16	815	2		1		1	
Hunua	2016-17	6-Dec-16	824	3		2		2	
Hunua	2016-17	6-Dec-16	832	4		1	1	1	
Hunua	2016-17	6-Dec-16	840	5		1			
Hunua	2016-17	6-Dec-16	850	6			2	2	
Hunua	2016-17	6-Dec-16	901	7		2		2	
Hunua	2016-17	6-Dec-16	909	8		2		1	
Hunua	2016-17	6-Dec-16	918	9				2	
Hunua	2016-17	6-Dec-16	927	10		1	1	1	
Hunua	2016-17	6-Dec-16	943	11			2	1	
Hunua	2016-17	6-Dec-16	951	12		2	1	1	
Hunua	2016-17	6-Dec-16	959	13		3	1	1	
Hunua	2016-17	6-Dec-16	1008	14			1	2	
Hunua	2016-17	6-Dec-16	1019	15				2	
Hunua	2016-17	20-Dec-16	830	1				1	
Hunua	2016-17	20-Dec-16	843	2				1	
Hunua	2016-17	20-Dec-16	852	3					
Hunua	2016-17	20-Dec-16	904	4					
Hunua	2016-17	20-Dec-16	915	5				1	
Hunua	2016-17	20-Dec-16	925	6					
Hunua	2016-17	20-Dec-16	935	7			2		
Hunua	2016-17	20-Dec-16	946	8			1		
Hunua	2016-17	20-Dec-16	956	9				1	
Hunua	2016-17	20-Dec-16	1005	10				1	
Hunua	2016-17	20-Dec-16	1016	11		1		1	
Hunua	2016-17	20-Dec-16	1026	12				1	
Hunua	2016-17	20-Dec-16	1036	13				3	
Hunua	2016-17	20-Dec-16	1046	14				1	
Hunua	2016-17	20-Dec-16	1100	15					
Hunua	2016-17	17-Jan-17	740	1			1	1	
Hunua	2016-17	17-Jan-17	753	2					

Annual Hunua Five Minute Bird Count data
2014-15 season to 2017-18 season

Location	Year	Date	Time	Count #	Harrier	Kaka	Kingfisher	Tomtit	Kokako
Hunua	2016-17	17-Jan-17	802	3					
Hunua	2016-17	17-Jan-17	813	4					
Hunua	2016-17	17-Jan-17	823	5			1	1	
Hunua	2016-17	17-Jan-17	833	6			1	1	
Hunua	2016-17	17-Jan-17	843	7				1	
Hunua	2016-17	17-Jan-17	853	8					
Hunua	2016-17	17-Jan-17	904	9					
Hunua	2016-17	17-Jan-17	914	10					
Hunua	2016-17	17-Jan-17	924	11					
Hunua	2016-17	17-Jan-17	942	12				2	
Hunua	2016-17	17-Jan-17	952	13			1		
Hunua	2016-17	17-Jan-17	1003	14			1	1	
Hunua	2016-17	17-Jan-17	1015	15				1	
Hunua	2016-17	2-Dec-16	825	1		2			
Hunua	2016-17	2-Dec-16	835	2					
Hunua	2016-17	2-Dec-16	845	3				1	
Hunua	2016-17	2-Dec-16	856	4		1			
Hunua	2016-17	2-Dec-16	904	5					
Hunua	2016-17	2-Dec-16	913	6				1	
Hunua	2016-17	2-Dec-16	923	7					
Hunua	2016-17	2-Dec-16	932	8					
Hunua	2016-17	2-Dec-16	941	9					
Hunua	2016-17	2-Dec-16	949	10				1	
Hunua	2016-17	2-Dec-16	957	11					
Hunua	2016-17	2-Dec-16	1006	12			1		
Hunua	2016-17	2-Dec-16	1014	13					
Hunua	2016-17	2-Dec-16	1021	14				2	
Hunua	2016-17	2-Dec-16	1029	15					
Hunua	2016-17	2-Dec-16	846	1				1	
Hunua	2016-17	2-Dec-16	900	2				3	
Hunua	2016-17	2-Dec-16	910	3				2	
Hunua	2016-17	2-Dec-16	920	4					
Hunua	2016-17	2-Dec-16	930	5					
Hunua	2016-17	2-Dec-16	940	6					
Hunua	2016-17	2-Dec-16	950	7				3	
Hunua	2016-17	2-Dec-16	1004	8			1	1	
Hunua	2016-17	2-Dec-16	1017	9				3	
Hunua	2016-17	2-Dec-16	1028	10			1	2	
Hunua	2016-17	2-Dec-16	1043	11				2	
Hunua	2016-17	2-Dec-16	1056	12					
Hunua	2016-17	2-Dec-16	1107	13			1	3	
Hunua	2016-17	2-Dec-16	1117	14				3	
Hunua	2016-17	2-Dec-16	1129	15			1	3	
Hunua	2016-17	2-Dec-16	855	1				1	
Hunua	2016-17	2-Dec-16	905	2					
Hunua	2016-17	2-Dec-16	915	3			3		
Hunua	2016-17	2-Dec-16	926	4				1	
Hunua	2016-17	2-Dec-16	936	5					

Annual Hunua Five Minute Bird Count data
2014-15 season to 2017-18 season

Location	Year	Date	Time	Count #	Harrier	Kaka	Kingfisher	Tomtit	Kokako
Hunua	2016-17	2-Dec-16	946	6			2		
Hunua	2016-17	2-Dec-16	956	7			1		
Hunua	2016-17	2-Dec-16	1006	8				1	
Hunua	2016-17	2-Dec-16	1019	9			2		
Hunua	2016-17	2-Dec-16	1028	10					
Hunua	2016-17	2-Dec-16	1039	11					
Hunua	2016-17	2-Dec-16	1049	12				1	
Hunua	2016-17	2-Dec-16	1059	13				1	
Hunua	2016-17	2-Dec-16	1104	14					
Hunua	2016-17	2-Dec-16	1124	15			2	1	
Hunua	2016-17	6-Jan-17	829	1			1	1	
Hunua	2016-17	6-Jan-17	839	2		2	2	1	
Hunua	2016-17	6-Jan-17	848	3		2		1	
Hunua	2016-17	6-Jan-17	859	4			1	1	
Hunua	2016-17	6-Jan-17	909	5			1	1	
Hunua	2016-17	6-Jan-17	918	6				1	
Hunua	2016-17	6-Jan-17	930	7					
Hunua	2016-17	6-Jan-17	941	8					
Hunua	2016-17	6-Jan-17	951	9				1	
Hunua	2016-17	6-Jan-17	1003	10					
Hunua	2016-17	6-Jan-17	1014	11				1	
Hunua	2016-17	6-Jan-17	1024	12					
Hunua	2016-17	6-Jan-17	1035	13			1		
Hunua	2016-17	6-Jan-17	1045	14					
Hunua	2016-17	6-Jan-17	1055	15				1	
Hunua	2016-17	6-Jan-17	819	1				2	
Hunua	2016-17	6-Jan-17	828	2			1		
Hunua	2016-17	6-Jan-17	839	3				2	
Hunua	2016-17	6-Jan-17	848	4				3	
Hunua	2016-17	6-Jan-17	857	5			2	2	
Hunua	2016-17	6-Jan-17	907	6			1	3	
Hunua	2016-17	6-Jan-17	915	7			1	2	
Hunua	2016-17	6-Jan-17	924	8			1	2	
Hunua	2016-17	6-Jan-17	933	9			1	1	
Hunua	2016-17	6-Jan-17	944	10					
Hunua	2016-17	6-Jan-17	1028	11				1	
Hunua	2016-17	6-Jan-17	1038	12				1	
Hunua	2016-17	6-Jan-17	1047	13					
Hunua	2016-17	6-Jan-17	1056	14				2	
Hunua	2016-17	6-Jan-17	1104	15			1	2	
Hunua	2016-17	16-Dec-16	706	1		1	1	1	
Hunua	2016-17	16-Dec-16	716	2		1		1	
Hunua	2016-17	16-Dec-16	725	3				1	
Hunua	2016-17	16-Dec-16	734	4		2		1	
Hunua	2016-17	16-Dec-16	743	5				1	
Hunua	2016-17	16-Dec-16	755	6		2		3	
Hunua	2016-17	16-Dec-16	805	7				2	2
Hunua	2016-17	16-Dec-16	814	8			1		

Annual Hunua Five Minute Bird Count data
2014-15 season to 2017-18 season

Location	Year	Date	Time	Count #	Harrier	Kaka	Kingfisher	Tomtit	Kokako
Hunua	2016-17	16-Dec-16	823	9				3	
Hunua	2016-17	16-Dec-16	833	10			1	2	
Hunua	2016-17	16-Dec-16	844	11				2	
Hunua	2016-17	16-Dec-16	853	12		1		1	
Hunua	2016-17	16-Dec-16	907	13		1		1	
Hunua	2016-17	16-Dec-16	919	14		1		2	
Hunua	2016-17	16-Dec-16	937	15				2	
Hunua	2016-17	3-Dec-16	733	1				1	
Hunua	2016-17	3-Dec-16	747	2					
Hunua	2016-17	3-Dec-16	753	3		3	2	2	
Hunua	2016-17	3-Dec-16	809	4				2	
Hunua	2016-17	3-Dec-16	821	5				1	
Hunua	2016-17	3-Dec-16	834	6		1	1	1	
Hunua	2016-17	3-Dec-16	849	7		1		2	
Hunua	2016-17	3-Dec-16	901	8				3	
Hunua	2016-17	3-Dec-16	912	9				1	
Hunua	2016-17	3-Dec-16	923	10		1		3	
Hunua	2016-17	3-Dec-16	939	11				3	
Hunua	2016-17	3-Dec-16	955	12				3	
Hunua	2016-17	3-Dec-16	1006	13		1		2	
Hunua	2016-17	3-Dec-16	1017	14		1	1	3	
Hunua	2016-17	3-Dec-16	1028	15		5		3	
Hunua	2017-18	27-Nov-17	740	1		1		2	1
Hunua	2017-18	27-Nov-17	749	2		2		2	
Hunua	2017-18	27-Nov-17	757	3		2	3	1	
Hunua	2017-18	27-Nov-17	805	4		4	3	1	1
Hunua	2017-18	27-Nov-17	814	5			1	2	2
Hunua	2017-18	27-Nov-17	823	6		1		1	
Hunua	2017-18	27-Nov-17	834	7			1	1	
Hunua	2017-18	27-Nov-17	843	8				2	
Hunua	2017-18	27-Nov-17	851	9			1	1	
Hunua	2017-18	27-Nov-17	900	10		1	1	2	
Hunua	2017-18	27-Nov-17	909	11				2	
Hunua	2017-18	27-Nov-17	917	12				2	1
Hunua	2017-18	27-Nov-17	926	13				2	
Hunua	2017-18	27-Nov-17	934	14			1	1	
Hunua	2017-18	27-Nov-17	950	15			1	2	
Hunua	2017-18	15-Dec-17	834	1				3	
Hunua	2017-18	15-Dec-17	844	2			1		
Hunua	2017-18	15-Dec-17	853	3				1	
Hunua	2017-18	15-Dec-17	902	4		1	1	3	
Hunua	2017-18	15-Dec-17	911	5		1	2	2	
Hunua	2017-18	15-Dec-17	920	6		1	1	1	
Hunua	2017-18	15-Dec-17	930	7		3	1	1	
Hunua	2017-18	15-Dec-17	939	8		1	2	2	
Hunua	2017-18	15-Dec-17	950	9		2		3	

Annual Hunua Five Minute Bird Count data
2014-15 season to 2017-18 season

Location	Year	Date	Time	Count #	Harrier	Kaka	Kingfisher	Tomtit	Kokako
Hunua	2017-18	15-Dec-17	1000	10		2		1	
Hunua	2017-18	15-Dec-17	1010	11		2		2	
Hunua	2017-18	15-Dec-17	1020	12		3		1	
Hunua	2017-18	15-Dec-17	1031	13			1		
Hunua	2017-18	15-Dec-17	1041	14				1	
Hunua	2017-18	15-Dec-17	1053	15				1	
Hunua	2017-18	12-Dec-17	804	1				2	
Hunua	2017-18	12-Dec-17	812	2				2	
Hunua	2017-18	12-Dec-17	824	3				2	
Hunua	2017-18	12-Dec-17	838	4		1		2	
Hunua	2017-18	12-Dec-17	847	5			2	2	
Hunua	2017-18	12-Dec-17	858	6				2	
Hunua	2017-18	12-Dec-17	909	7				1	
Hunua	2017-18	12-Dec-17	919	8		1	1	2	
Hunua	2017-18	12-Dec-17	931	9			1	2	
Hunua	2017-18	12-Dec-17	941	10			1	2	
Hunua	2017-18	12-Dec-17	1009	11			1	1	
Hunua	2017-18	12-Dec-17	1025	12				1	
Hunua	2017-18	12-Dec-17	1039	13				3	
Hunua	2017-18	12-Dec-17	1052	14			1	2	
Hunua	2017-18	12-Dec-17	1102	15				2	
Hunua	2017-18	13-Dec-17	706	1			1	2	
Hunua	2017-18	13-Dec-17	718	2				1	
Hunua	2017-18	13-Dec-17	726	3				1	
Hunua	2017-18	13-Dec-17	735	4			1	1	
Hunua	2017-18	13-Dec-17	744	5				1	
Hunua	2017-18	13-Dec-17	753	6		1	1	1	
Hunua	2017-18	13-Dec-17	803	7				1	
Hunua	2017-18	13-Dec-17	811	8			2		
Hunua	2017-18	13-Dec-17	819	9				1	
Hunua	2017-18	13-Dec-17	827	10				1	
Hunua	2017-18	13-Dec-17	837	11			3	1	
Hunua	2017-18	13-Dec-17	845	12			2	2	
Hunua	2017-18	13-Dec-17	853	13			1	2	
Hunua	2017-18	13-Dec-17	906	14			1	1	
Hunua	2017-18	13-Dec-17	915	15				1	
Hunua	2017-18	12-Dec-17	731	1			1	3	
Hunua	2017-18	12-Dec-17	742	2					
Hunua	2017-18	12-Dec-17	750	3			1	2	
Hunua	2017-18	12-Dec-17	759	4				1	
Hunua	2017-18	12-Dec-17	808	5				1	
Hunua	2017-18	12-Dec-17	815	6			1	2	
Hunua	2017-18	12-Dec-17	823	7			1	1	
Hunua	2017-18	12-Dec-17	832	8			1	2	
Hunua	2017-18	12-Dec-17	843	9			1	1	
Hunua	2017-18	12-Dec-17	853	10					
Hunua	2017-18	12-Dec-17	902	11				2	
Hunua	2017-18	12-Dec-17	911	12					

Annual Hunua Five Minute Bird Count data
2014-15 season to 2017-18 season

Location	Year	Date	Time	Count #	Harrier	Kaka	Kingfisher	Tomtit	Kokako
Hunua	2017-18	12-Dec-17	919	13			1	1	
Hunua	2017-18	12-Dec-17	928	14					
Hunua	2017-18	12-Dec-17	937	15				1	
Hunua	2017-18	12-Dec-17	731	1					
Hunua	2017-18	12-Dec-17	739	2				2	
Hunua	2017-18	12-Dec-17	755	3					
Hunua	2017-18	12-Dec-17	805	4				1	
Hunua	2017-18	12-Dec-17	815	5				4	
Hunua	2017-18	12-Dec-17	826	6				3	
Hunua	2017-18	12-Dec-17	835	7				2	
Hunua	2017-18	12-Dec-17	845	8					
Hunua	2017-18	12-Dec-17	853	9				2	
Hunua	2017-18	12-Dec-17	903	10				1	
Hunua	2017-18	12-Dec-17	912	11				2	
Hunua	2017-18	12-Dec-17	920	12					
Hunua	2017-18	12-Dec-17	1056	13					
Hunua	2017-18	12-Dec-17	1103	14					
Hunua	2017-18	12-Dec-17	1112	15					
Hunua	2017-18	6-Dec-17	804	1				1	
Hunua	2017-18	6-Dec-17	813	2				1	
Hunua	2017-18	6-Dec-17	822	3			2		
Hunua	2017-18	6-Dec-17	831	4			1	2	
Hunua	2017-18	6-Dec-17	841	5			1	1	
Hunua	2017-18	6-Dec-17	850	6	1				
Hunua	2017-18	6-Dec-17	859	7					
Hunua	2017-18	6-Dec-17	911	8			1		
Hunua	2017-18	6-Dec-17	921	9			1	1	
Hunua	2017-18	6-Dec-17	930	10			1	1	
Hunua	2017-18	6-Dec-17	940	11			1	1	
Hunua	2017-18	6-Dec-17	949	12				2	
Hunua	2017-18	6-Dec-17	958	13				1	
Hunua	2017-18	6-Dec-17	1008	14			1		
Hunua	2017-18	6-Dec-17	1018	15				1	
Hunua	2017-18	6-Dec-17	756	1				3	
Hunua	2017-18	6-Dec-17	806	2				4	
Hunua	2017-18	6-Dec-17	815	3				3	
Hunua	2017-18	6-Dec-17	825	4				5	
Hunua	2017-18	6-Dec-17	834	5			1	3	
Hunua	2017-18	6-Dec-17	842	6				2	
Hunua	2017-18	6-Dec-17	850	7			1	5	
Hunua	2017-18	6-Dec-17	859	8		1	1	2	
Hunua	2017-18	6-Dec-17	907	9				3	
Hunua	2017-18	6-Dec-17	915	10					
Hunua	2017-18	6-Dec-17	1008	11				2	
Hunua	2017-18	6-Dec-17	1016	12				3	
Hunua	2017-18	6-Dec-17	1023	13				2	
Hunua	2017-18	6-Dec-17	1032	14				4	
Hunua	2017-18	6-Dec-17	1042	15					

Annual Hunua Five Minute Bird Count data
2014-15 season to 2017-18 season

Location	Year	Date	Time	Count #	Harrier	Kaka	Kingfisher	Tomtit	Kokako
Hunua	2017-18	7-Dec-17	726	1		4	2	3	
Hunua	2017-18	7-Dec-17	734	2				3	
Hunua	2017-18	7-Dec-17	741	3				3	
Hunua	2017-18	7-Dec-17	749	4			1	4	
Hunua	2017-18	7-Dec-17	756	5				4	
Hunua	2017-18	7-Dec-17	804	6			1	4	
Hunua	2017-18	7-Dec-17	811	7				1	
Hunua	2017-18	7-Dec-17	819	8		2	1	3	
Hunua	2017-18	7-Dec-17	826	9			1	6	
Hunua	2017-18	7-Dec-17	834	10	1	1		2	
Hunua	2017-18	7-Dec-17	842	11			2	1	
Hunua	2017-18	7-Dec-17	849	12				1	
Hunua	2017-18	7-Dec-17	856	13			1	1	
Hunua	2017-18	7-Dec-17	904	14		2		2	
Hunua	2017-18	7-Dec-17	912	15			2	3	
Hunua	2017-18	7-Dec-17	733	1		1	1	1	
Hunua	2017-18	7-Dec-17	742	2					2
Hunua	2017-18	7-Dec-17	752	3				1	1
Hunua	2017-18	7-Dec-17	801	4			1	1	1
Hunua	2017-18	7-Dec-17	812	5				2	1
Hunua	2017-18	7-Dec-17	821	6		2	1	1	
Hunua	2017-18	7-Dec-17	830	7		2	1	2	
Hunua	2017-18	7-Dec-17	847	8			2	1	
Hunua	2017-18	7-Dec-17	856	9		2	1	1	
Hunua	2017-18	7-Dec-17	908	10			1		
Hunua	2017-18	7-Dec-17	916	11		1	1	1	
Hunua	2017-18	7-Dec-17	940	12			1	3	
Hunua	2017-18	7-Dec-17	950	13			1	2	
Hunua	2017-18	7-Dec-17	1002	14		1	1	1	
Hunua	2017-18	7-Dec-17	1013	15			1		

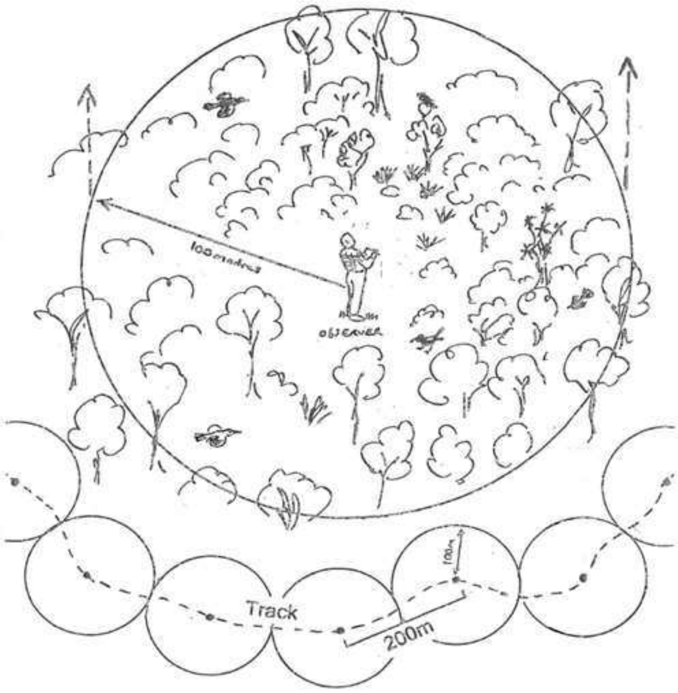
Attachment 4-2 - Notes on Five Minute Bird Counts Hunua Ranges May 2018

Notes on five minute bird counts carried out in the Hunua Ranges for pre- and post-1080 poison drop forest bird monitoring

Five minute bird counts, following the method outlined by Dawson & Bull (1975) (see also Handford 2000 and review in Hartley 2012) (Fig. 1.), are carried out annually during summer to monitor the long term effects on birdlife of pest mammal control by aerial 1080 poisoning in the Hunua Ranges.

Five minute bird counts have been widely used in New Zealand since the early 1970s (Hartley 2012) to monitor forest birds. The method provides an index of bird numbers rather than a census, and it allows one to sample bird numbers at a large number of sites over a relatively short period of time.

Fig. 1. Diagrammatic representation of five minute bird count method. Count stations were located 200m apart along tracks. All birds seen and heard including those flying over, out to a radius of 100m, were counted over a 5 minute period.



For the Hunua 1080 poison programme, five minute bird count stations were placed at 200m intervals along 10 existing tracks, with 15 count stations on each track, giving a total of 150 count stations sampled annually (see design in Appendix 1). The 10 tracks traverse a wide range of vegetation types and topographies across the Hunua Ranges. For logistical reasons the count lines were sited on tracks, because with very few goats and no deer, the Hunua forest is extremely dense, making off track counts at randomly-placed stations difficult and time-consuming. Since the count stations were not located randomly, for statistical purposes, the results apply to the sample provided by the count stations and not necessarily to the control area as a whole.

The first counts were carried out in 2014-15 before the first poison drop in July-August 2015. The counts have been repeated each year during the December-January period.

The Hunua five minute bird count data provides information on the effects on birdlife before and after the 1080 poison drops. An existing long-term five minute bird count programme in the Waitakere Ranges (15 counts on 9 tracks, giving 135 counts annually), which has been carried out annually since 1997, serves as a control.

Appendix 1. Design of the Hunua Five Minute Bird Count programme for pre- and post-1080 forest bird monitoring

15 x 5MBCs (150 counts total/year) on 10 tracks across the Hunua Ranges)

Location	Numbers of individual native and introduced bird species counted (Sp1 = species 1)																
Kohukohunui Track 15 counts	Sp1	Sp2	Sp3	etc													
Mangatangi Ridge Track 15 counts																	
Ernies Track 15 counts																	
Pukapuka North Track 15 counts																	
Pukapuka South Track 15 counts																	
Mangatangi Downhill Track 15 counts																	
Workman Track 15 counts																	
Whakatiwai Track 15 counts																	
Mine Road 15 counts																	
Hikers' Track 15 counts																	

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Attachment 5-1 - Robins and Moreporks Study - Powlesland et al 1999

Impacts of aerial 1080 possum control operations on North Island robins and moreporks at Pureora in 1997 and 1998

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Contents

Impacts of aerial 1080 possum control operations on North Island robins and moreporks at Pureora in 1997 and 1998

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ABSTRACT

This is the final report describing the results from the second and third years of a three-year programme to determine the costs and benefits of aerial 1080 possum control operations to North Island robins (*Petroica australis longipes*) and moreporks (*Ninox novaeseelandiae*) in Pureora Forest Park, North Island, New Zealand. During this study robins were individually colour-banded, and moreporks radio-tagged in both treatment and non-treatment study areas. A poison operation using carrot baits in August 1997 covered 8577 ha and incorporated the 300 ha Waimanoa study area. A poison operation using cereal baits in August 1998 covered just the 200 ha Long Ridge study area. After the 1997 operation, very few possums remained alive and rat foot-print tracking indices remained very low during the robin nesting season (September 1997–February 1998). Similarly, possum and rat population indices were much reduced after the 1998 operation, but rats and possums were found in a small portion of the study area, presumably because it did not receive baits.

Following both the 1997 and 1998 poison operations, there was no significant difference in the proportion of banded robins that disappeared from the non-treatment and treatment study areas. During the 1997/98 nesting season, the nesting success of robins was significantly better in the treatment area than in the non-treatment area. One year after the poison operation (spring 1998), the robin population in the treatment area had increased by 37% on the number present just prior to the poison operation, compared with 16.3% in the non-treatment area.

No radio-tagged moreporks were available in the treatment area during the 1997 poison operation, and all three radio-tagged in each of treatment and non-treatment areas were still alive two months after the poison operation in 1998.

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1. Introduction

Over the past 30 years there have been increasing attempts to reduce brushtail possum (*Trichosurus vulpecula*) populations in New Zealand because of the damage they do to indigenous forest ecosystems (Atkinson et al. 1995), and because they are a vector of bovine tuberculosis to cattle and deer (Livingstone 1994), particularly on farms bordering forests. One method of control involves the aerial distribution of carrot or cereal baits containing Compound 1080 (sodium monofluoroacetate), which achieves an average reduction in density of about 70% of populations near carrying capacity (Morgan et al. 1986) and can exceed 90% (Eason et al. 1994). Most operations are carried out in autumn and winter, but with a few in spring.

As well as possums, rodent populations, particularly those of the ship rat (*Rattus rattus* L.), are known to suffer high mortality (87–100%) during aerial 1080 possum poisoning operations (Innes et al., 1995). Since ship rats eat seeds, invertebrates, lizards, and birds and their eggs (Innes, 1990), including the eggs and young of North Island robins (Brown, 1997b), the major reduction in rat densities, albeit temporary, is a beneficial by-product of aerial possum control operations for forest ecosystem conservation.

Both native and endemic bird species have been found dead after aerial possum control operations (Spurr 1991, Spurr & Powlesland 1997). Various procedures have been implemented to reduce the number of birds killed, including screening out small fragments of bait, called ‘chaff’ that are created during production, that birds are more capable of swallowing, dyeing the baits green so that they are less attractive to birds, adding cinnamon which acts as a repellent to birds but not possums, and reducing application rates on the assumption that it will reduce bird-bait encounters and so reduce bird mortality (Harrison 1978a,b, Morgan et al. 1986, Spurr 1991).

The finding of dead poisoned birds gives no indication of the effect of possum control operations on bird populations. Poisoning of birds may be replacing other causes of mortality, such as winter starvation, or it may be additional to it. If it is additional to usual mortality then it may have considerable impact on the species’ population dynamics, and therefore on its long term survival. This would be particularly relevant in forests where bovine tuberculosis is endemic in the possum population since control operations are carried out at 3–5 year intervals to prevent the spread of the disease.

Birds can be marked using colour bands or transmitters so that they can be individually monitored (Powlesland et al. 1998). Using such methods, the objective of the project was to determine the costs and benefits of aerial possum control operations to the North Island robin (*Petroica australis longipes*) and morepork (*Ninox novaeseelandiae*) in Pureora Forest Park. These species were chosen for the study because they have been found dead after aerial 1080 possum control operations (Spurr & Powlesland 1997) and are territorial throughout the year. Robins can be trained to approach observers for a reward of food, thus enabling the monitoring of sufficient numbers of this relatively small species (29 g) for comparison of results from treatment and non-treatment study areas. By comparison, moreporks (185 g) can carry transmitters and so can be relocated by radio-telemetry at regular intervals for several months to determine mortality. The results from the 1996 poison operation were presented in Powlesland et al. (1998). This report describes the results from the 1997 and 1998 poison operations.

2. Methods

2.1 STUDY AREAS

2.1.1 Names of treatment and non-treatment study areas in each year

The treatment and non-treatment areas for each year of the study are indicated in Table 1.

TABLE 1. NAMES OF THE STUDY AREAS THAT WERE USED AS TREATMENT AND NON-TREATMENT AREAS IN EACH YEAR.

YEAR	TAHAE	WAIMANOA	LONG RIDGE
1996	Treatment	Non-treatment	
1997	Non-treatment	Treatment	
1998		Non-treatment	Treatment

2.1.2 Tahae

This forest block (Fig. 1), part of the Waipapa Ecological Area, is bordered by Fletcher's and Ranginui Roads (Leathwick 1987). The study area consists of about 100 ha, is relatively flat at 520–540 m a.s.l., and has not been logged. The forest cover consists of scattered podocarps, particularly rimu (*Dacrydium cupressinum*), kahikatea (*Dacrycarpus dacrydioides*) and matai (*Prumnopitys taxifolia*), emergent over a mainly tawa (*Beilschmiedia tawa*) canopy. Other fairly common canopy and understorey species include hinau (*Elaeocarpus dentatus*), kamahi (*Weinmannia racemosa*), mahoe (*Melicytus ramiflorus*), miro (*Prumnopitys ferruginea*), totara (*Podocarpus totara*), maire species (*Nestegis* spp.), wheki (*Dicksonia squarrosa*), soft tree fern (*Cyathea smithii*) and supplejack (*Ripogonum scandens*). While generally sparse under the dense canopy, ground species often present include filmy ferns (*Hymenophyllum* spp.), hen and chicken fern (*Asplenium bulbiferum*), bush rice grass (*Microlaena avenacea*), *Blechnum fluviatile*, hookgrass (*Uncinia* spp.) and *Leptopteris hymenophylloides* (Leathwick 1987). Prior to this study, possum and rat control in the study area was carried out until March 1994 using 1080 poison (0.15% w/w) in cereal baits (Wanganui RS 5 pellets) in stations at 150 m intervals along lines separated by 150 m. It is not known when this control programme began or the frequency with which the stations were refilled.

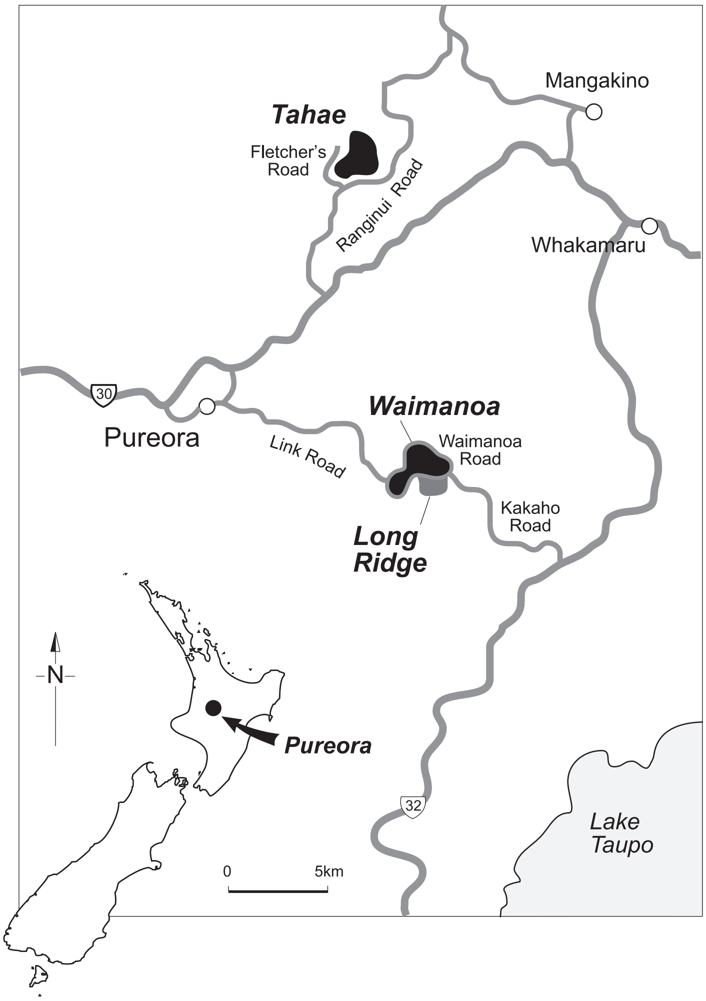

Figure 1. Locations of the three study areas at Pureora Forest Park.

2.1.3 Waimanoa

The Waimanoa study area is bordered by Waimanoa and Link Roads (Fig. 1). Although it comprises about 300 ha, some of it was not inhabited by robins and so only about 100 ha was regularly visited. It is rolling country, with altitude varying from 700 to 740 m a.s.l. Logging of mainly emergent podocarps occurred over some of the block during the 1970s, so the density of emergents is less in parts of the block than at Tahae. Toetoe (*Cortaderia fulvida*) and wineberry (*Aristotelia serrata*) are common on the former skid sites and logging tracks. There had been no possum control in the block in the previous ten years, but the forest to the north of Waimanoa Road was poisoned with 1080 carrot baits in winter 1993, and that to the south of Link-Kakaho Road with 1080 carrot baits in winter 1994 (J. Mason, pers. comm.).

2.1.4 Long Ridge

This study area, adjacent to Waimanoa (Fig. 1), is bordered by Long Ridge and Link Roads. It is 200 ha in area, but only about 100 ha was regularly visited to monitor robins and tomtits. It is rolling country, with altitude varying from 650 to 730 m a.s.l. The vegetation of this study area is much the same as that in Waimanoa, with logging in the 1970s having removed some emergent podocarps and created open areas now covered mainly by toetoe, wineberry, bush lawyer (*Rubus* spp.) and tree ferns, such as *Dicksonia squarrosa* and *Cyathea smithii.* 1080-carrot baits were distributed over the area in winter 1994.

2.2 CAPTURE AND MARKING OF BIRDS

Prior to capture attempts, most robins were fed mealworm (*Tenebrio molitor*) larvae in conjunction with tapping the lid against the mealworm container. This noise was made so that the robins associated the noise with being fed to encourage them to approach us for food, rather than us having to search for them. It is possible that robins trained to accept food rewards may be more likely to sample or eat novel food items. However, we consider this to be of low risk during our study because the offered food was alive and looked much the same as larvae of some native beetles in the forest, such as that of wireworms (*Conoderus exsul* or *Agryprus variabilis*), and quite different to a 1080 carrot or cereal bait, or a fragment of either.

Robins were captured using two methods—an electronically operated clap trap or a mist net. Those robins that would not feed at the clap trap were fed near a mist net and then startled into it or attracted into it using taped song. Once captured, each robin was fitted with an individual combination of a numbered metal leg band and colour bands obtained from the Banding Office, Department of Conservation.

Moreporks were caught in mist net rigs consisting of two 3 × 12 m nets (60 mm mesh size) erected one above the other using telescopic aluminium poles (Dilks et al. 1995). The top of the net was 7–8 m high. Owls were attracted to the rig by broadcasting various morepork calls or squeaky noises from an Aubudon bird caller through speakers, one on either side of the middle of the net about 20 m distant and 1–2 m above the ground. Most attempts to capture moreporks were made at dusk so that any owl could be seen when it arrived nearby, and caught in the net by switching the calls from one speaker to the other so that the bird flew into the net when flying from speaker to speaker. A numbered metal leg band was fitted to each morepork. A single stage transmitter (Sirtrack Ltd, Havelock North) was fitted using a back-pack harness design (Flux 1994, Karl & Clout 1987). The transmitters were 4–5 g in weight, signalled at 30 pulses per minute and had a transmission life of about nine months. The birds were then weighed and released.

2.3 MONITORING MARKED BIRDS

The survival of each banded robin was monitored by attracting and feeding it a few mealworms at least once a week from January 1997 to September 1998. To monitor nesting success we needed to locate nests. If the female was attracted she was followed back to the nest; if the male was attracted, often he would go to the vicinity of the nest with mealworms to feed his mate, and then we would follow her back to the nest. Once found, the nest location was marked nearby with track tape, and the nest visited about every third day to monitor the fate of its contents.

Each radio-tagged morepork was located during the day about once a week after it had been radio-tagged and until September 1998 to determine whether it was alive and its roost location.

2.4 RAT POPULATION INDICES

The proportion of baited tracking tunnels containing rat foot-prints was used to provide an index of rat abundance (King & Edgar 1977, Innes et al. 1995). We assumed that these indices directly reflected actual population densities (Innes et al. 1995, Brown et al. 1996a). One hundred tracking tunnels were placed at 50 m intervals along a circuit (Tahae) or three lines (Waimanoa and Long Ridge) through the study areas. Each tunnel was baited with peanut butter at both ends and left for one night. Data are expressed as percent 'available' tunnels with rat tracks; those tipped over, probably by possums, were deleted from analyses. Foot-print tracking indices in treatment and non-treatment study areas were taken on the same night to account for differences due to weather and the impact of other variables on rat activity.

2.5 POSSUM POPULATION INDICES

The capture rate of possums in leg-hold traps (Victor No. 1) was used to provide an index of possum abundance (Warburton 1996). Two trap lines were set up in both treatment and non-treatment areas, each line consisting of 20 traps spaced at 20 m intervals along a taped line. Lure, a mixture of 5 kg of white flour and 1 kg of icing sugar, was smeared on the tree just above each trap, and re-applied daily if necessary. The trap lines in both study areas were operated simultaneously for three dry nights. All trapped possums were killed and disposed of at least 10 m from the traps. Each post-operation trap line was 200 m from a pre-operation line.

3. Results

3.1 1997 POISON OPERATION

3.1.1 Poison drop

The August 1997 poison operation that included the Waimanoa study area encompassed 8577 ha, and was carried out by Environment Waikato. The Waimanoa study area was part of the second stage of the operation (5077 ha). Pre-feed carrot baits were spread during 5–7 August 1997 at a sowing rate of 5 kg/ha. The toxic baits (1080 carrot baits, the toxin at 0.08% w/w) were distributed at 10 kg/ha on 29–30 August from a hopper slung under a helicopter. Bait toxin analyses are available for 10 samples from the first stage of the operation when the toxin concentration was expected to be 0.15% w/w. The determinations at the Toxicology Laboratory, Landcare Research, Lincoln gave a mean toxicity level of 0.141% (range = 0.12–0.17, S.D. = ±0.0137). No bait samples were available from the second stage of the operation (0.08% w/w 1080), which included the Waimanoa study area, for toxin level analyses.

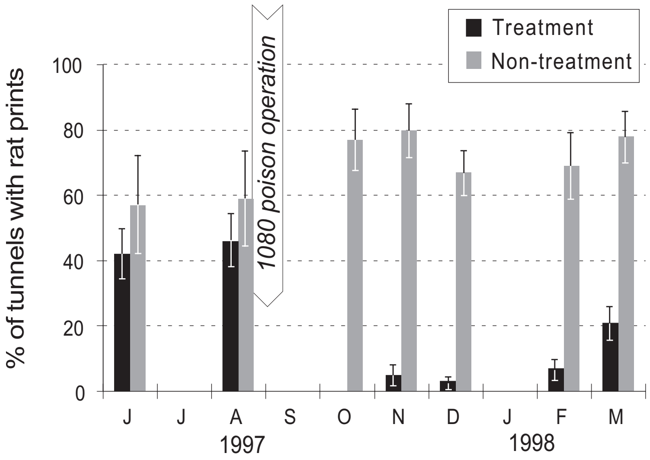

Figure 2. Tracking indices of rat abundance (percentage of tunnels with foot-prints) in treatment and non-treatment study areas before and after an aerial 1080 possum poisoning operation on 29–30 August 1997 at Pureora. Bars are standard errors from dividing the 100 tunnels into groups of 25.

Chaff content of samples of bait was checked by Department of Conservation staff. Chaff or fine fragments was considered to include any particle able to pass through a sieve of 5-mm square mesh. All 10 samples of bait checked contained less than 0.2% of chaff by weight of the processed carrots, and so were well within the guideline of 2.5%. There was 9.5 mm of rain during 2–3 September and a further 22 mm on 11–12 September. By 23 September over 100 mm of rain had fallen since the poison baits had been distributed.

3.1.2 Impact on rats and possums

Rat tracking indices for the treatment area (Waimanoa) were 44% during June-August 1997, and 58% for the non-treatment area (Tahae) during the same period (Fig. 2). Following the poison operation no rats were detected in the treatment area during September and October 1997, and the indices rose to 7% by February 1998, late in the robin nesting season. By comparison, rat tracking indices for the non-treatment area during October 1997 to February 1998 remained high (67–80%; Fig. 2).

Possum indices prior to the poison operation were determined during July 1997, in both the treatment and non-treatment study areas. The two trap lines in the treatment area resulted in 18.5 and 28.8 possums captured/100 trap-nights, with a mean of 23.7. By comparison, the two lines in the non-treatment area, which had been subjected to an aerial 1080 poison operation in September 1996, caught one possum; a mean of 0.8 possums captured/100 trap-nights.

The impact of the August 1997 poison operation on possums was determined by MAF Quality Management staff throughout the 8577 ha block over which baits were distributed. Fifteen lines were operated using Department of Conservation protocols (Warburton 1996), and two possums were caught, giving a mean of 0.22 captures/100 trap-nights (G. Cochrane, pers. comm.). No post-poison operation monitoring for possums was carried out in the non-treatment area.

3.2 1998 POISON OPERATION

3.2.1 Poison drop

The August 1998 poison operation encompassing just the Long Ridge study area (c. 200 ha), was contracted to Epro Ltd, Taupo. There was no pre-feeding with non-toxic baits; the toxic baits (1080 Wanganui No. 7 baits, toxin at 0.08% w/w) being distributed at 5 kg/ha on 4 August. Two samples of bait were submitted to the National Chemical Residue Laboratory (Ministry of Agriculture & Forestry, Wallaceville Animal Research Centre, Upper Hutt), with the analyses indicating the toxin level at 0.095 and 0.106%. JWK assisted with the loading of the baits into the hopper slung under the helicopter. He observed that the baits were in excellent condition, appearing to be freshly made, and the bags of baits contained little dust and few fragments.

The first two nights after the baits were spread were frosty, followed by a few showers during 7–9 August. On 10 August, 58 mm of rain fell, and by 16 August, 200 mm had fallen and baits on the ground were saturated and disintegrating.

3.2.2 Impact on rats and possums

The rat tracking index for the treatment area (Long Ridge) was 46% on 21 July 1998, and 45% for the non-treatment area (Waimanoa) on the same date. On 16 August, when the post-operation rat monitoring was carried out, the index for the treatment area was 9%, and 41% for the non-treatment area (% of 100 tunnels in each case). At Long Ridge, rat foot-prints were present in tracking tunnels about 500 m from the edge of the poison area, and in a few tunnels at the edge of the study area about 50 from Link Road.

Possum indices prior to the poison operation were determined during 16–19 July (traps closed because of rain for one night) in both treatment and non-treatment (beyond the boundaries of the Long Ridge study area) study areas. The trap lines in the treatment and non-treatment areas resulted in a mean of 9.7 and 13.2 possums captured/100 trap-nights respectively (Table 2). The possum indices after the poison operation were determined during 18–20 August. The trap lines in the treatment and non-treatment areas resulted in a mean of 2.5 and 8.6 possums/100 trap-nights.

TABLE 2. POSSUM MONITORING (POSSUMS PER 100 TRAP-NIGHTS) RESULTS FOR BEFORE AND AFTER THE AUGUST 1998 POISON OPERATION AT LONG RIDGE STUDY AREA, PUREORA FOREST PARK.

	NON-TREATMENT AREA			TREATMENT AREA		
	Line 1	Line 2	Mean	Line 1	Line 2	Mean
Pre-operation	13.9	12.4	13.2	8.8	10.7	9.7
Post-operation	3.5	13.7	8.6	0.0	5.0	2.5

3.3 ROBINS

3.3.1 Impact of the 1997 poison operation

In the non-treatment area (Tahae), of the 42 colour-banded robins that would approach us for mealworms, just one (2.4%) disappeared during the fortnight following the poison operation. By comparison, in the treatment area (Waimanoa), three (9.7%) of 31 birds disappeared. There was no significant difference in the proportion of robins that disappeared from the two study areas ($c^2 = 0.695$ with Yates correction, d.f. = 1, $P = 0.404$). The proportion of males that disappeared in the treatment area (10.0%, 2 of 20) was not significantly different to that of females (9.1%, 1 of 11) ($c^2 = 0.306$ with Yates correction, d.f. = 1, $P = 0.580$). No dead robins were found incidentally while we worked in either of the study areas.

3.3.2 Impact of the 1998 poison operation

In the non-treatment area (Waimanoa), of the 42 colour-banded robins that would approach us for mealworms, two (4.8%) disappeared during the fortnight following the poison operation. None of 17 robins in the treatment area (Long Ridge) disappeared during the same period.

3.3.3 Nesting success in 1997/98

We believe we located most robin nests during the 1997/98 season. In the non-treatment area, 67 robin nests were found or known of. Twenty (29.9%) of nesting attempts were successful. At least 34 fledglings were reared by the 23 pairs (1.5 fledglings/pair) present at the start of the season. Five males and two females disappeared during the nesting season, 14.9% of the 47 birds present at the start of the season. In contrast, in the treatment area, 30 nests were found or known of, of which 20 (66.7%) were successful. The difference in nesting success between the two study areas is significant ($c^2 = 10.1$ with Yates correction, d.f. = 1, $P < 0.01$). The proportion of robins that disappeared from the two study areas during the nesting season did not differ statistically ($c^2 = 0.032$ with Yates correction, d.f. = 1, $P = 0.859$).

3.3.4 Status of populations in September 1998

In the non-treatment area prior to the August 1997 poison operation there were 49 robins present as determined by territory mapping, 22 (44.9%) being females. In September 1998, there were 57 robins present in the same area, a 16.3% increase, and the proportion of females (45.6%) had not changed significantly ($c^2 = 0.015$ with Yates correction, d.f. = 1, $P = 0.903$).

By comparison, in the treatment area the population increased from 35 before the poison operation to 48 a year later, a 37% increase. In addition, the proportion of females in the population of the treatment study area increased from 34.3% to 41.7%, the increase not being significant ($c^2 = 0.206$ with Yates correction, d.f. = 1, $P = 0.650$).

3.4 MOREPORKS

3.4.1 Impact of the poison operations

No radio-tagged moreporks were present in the treatment area during the 1997 poison operation. Three radio-tagged moreporks were present in each of the non-treatment and treatment study areas during the 1998 poison operation. All six birds were alive two months after the distribution of the poison baits.

3.4.2. Mortality prior to poison operations

Of the 28 moreporks captured and tagged in the areas associated with the aerial 1080 possum poisoning study, 17 (61%) were alive and had functioning transmitters by the time the poison operations were carried out. The transmitters on five birds failed within six months, even though they had an expected field-life of nine months, and the fate of the birds wearing them could not be ascertained. Another six tagged birds died before the poison operations, one probably because its transmitter harness became loose and impeded its foraging. The other five birds died in winter.

In winter 1996, of 15 birds with functioning transmitters in Pureora Forest Park, including five in the Waipapa bait-station study area, three (20%) died in winter (none in the bait-station block). In winter 1997, three (43%) of seven birds died, but none of six birds died in winter 1998. Although the mean capture weight of the six birds that died during the 1996 and 1997 winters (170.7 g, S.D. = ±10.0) was less than that of the other 21 birds that survived these winters (185.9 g, S.D. = ±19.6), the difference was not significant (*t*-test = 1.81, d.f. = 25, P = 0.0817).

4. Discussion

4.1 POSSUM AND RAT MORTALITY DURING POISON OPERATIONS

There is no point in carrying out an aerial 1080 possum control operation designed to result in little or no robin mortality if it does not kill most possums. Ideally, for ecosystem conservation in areas inhabited by robins, the operation should result in a residual possum trap-catch rate of less than 3 possums per 100 trap-nights (see Saunders 1999) and insignificant robin mortality. Although minimal monitoring was carried out after the 1996 poison operation (Powlesland et al. 1998), the monitoring that was done indicated that both the 1996 and 1997 operation operations killed most possums. By comparison, three possums were caught along one of the trap lines operated in the treatment area following the 1998 operation, and none along the other. Based on observations made while monitoring robins through the study area, we suspect that these possums survived the poison operation because they occupied a small area that did not receive baits, rather than because there were too many possums for the density of baits or that the baits were unpalatable. Alternatively, the trapped possums could have migrated into the small poison area from contiguous habitat after the poison operation.

Indices of rat populations using foot-print tracking tunnels indicated that the aerial carrot 1080 possum poisoning operations at Pureora in 1996 (Powlesland et al. 1998) and 1997 (Fig. 2) reduced rat populations markedly. However, the 1998 poison operation resulted in the rat tracking index in the treatment area declined to only 9%. As for possums, rat foot-prints were present in tracking tunnels in an area over which baits apparently were not spread, and in a few tunnels at the edges of the study area because baits had to be a least 50 m from roads. Aerial 1080 cereal bait operations can be expected to reduce ship rat populations to an index of less that 5% (Innes et al. 1995).

The poison operations during this study at Pureora were planned to be carried out in July–August, just before the robins started nesting. The expectation was that ship rat populations would not recover to former levels before and during the following nesting season (September–February), thus allowing the birds to nest more successfully than if the poison operation was carried out in autumn (March–May), as is more usual (when suitable weather conditions for poison operations are more frequent). During both nesting seasons, rat tracking indices remained below 10%, much lower than pre-poison levels (94% in June 1996 (Powlesland et al. 1998) and 44% in August 1997 (Fig. 2)). While frequent rain in July–August can delay aerial poison operations, the use of toxic baits without pre-feeding with non-toxic baits reduces delays. The difference in nesting success of some forest bird species at 5% or less rat tracking index with that of 10–20% can be quite marked. For example, robins nesting in the Waipapa bait station area, Pureora, had 70.6% nesting success (n = 34) during the 1996/97 season when rat tracking indices averaged 6.5%, but only 47.6% success (n = 42) the following season when rat tracking indices averaged 12.5% (H.J. Speed, pers. comm.).

4.2 ROBIN MORTALITY DURING THE POISON OPERATIONS

Robins are known to eat both carrot and cereal-based baits, and have been found dead after aerial 1080 possum control operations, especially in the 1970s when unscreened carrot baits were distributed (Brown 1997a, Harrison 1978a, b, Spurr 1991, Spurr & Powlesland 1997). Therefore, it was not unexpected that some robins during this study would disappear immediately after toxic baits had been distributed. However, the magnitude of the mortality (43–55% loss of robins) after the first carrot operation in September 1996 was unexpected (Powlesland et al. 1998). The high level of mortality was considered to have been caused by much toxin-coated chaff being distributed with the baits (Lorigan 1996). The hazard to birds of spreading chaff with baits was determined during poison operations in the 1970s; removal of chaff reduced bird deaths by about 50% (Harrison 1978b).

The two differences in the baits used in the 1996 and 1997 carrot bait operations was the reduced sowing rate (15 kg/ha and 10 kg/ha respectively) and the lower incidence of chaff in the second operation. The result of 9.7% of monitored robins disappearing from the treatment area during the 1997 operation, compared with 54.5% in 1996 (Powlesland et al. 1998), suggests that reducing the sowing rate of toxic bait and the amount of chaff resulted in reduced robin mortality.

The further reduction in sowing rate to 5 kg/ha and a change from carrot to cereal bait for the 1998 experiment resulted in robin mortality being reduced to nil. This result was unexpected because dead robins had been found previously after aerial 1080 possum control operations using cereal baits. For example, an operation carried out at Waitotara, Wanganui Conservancy, in March 1998 using Wanganui No. 7 1080 baits (4 kg/ha, toxin at 0.15% w/w) resulted in 10 (26.3%) of 38 colour-banded robins that would readily approach for mealworms disappearing within three weeks (N. Marsh, pers. comm.). The level of mortality of colour-banded robins exposed to cereal baits containing brodifacoum was of a similar magnitude. At Maruia, South Island robins (*Petroica australis australis*) were monitored following the broadcasting of Talon 20P by hand in October 1996. At the non-treatment site, 14% of 21 robins disappeared, and at the treatment site 48% of 23 robins disappeared, the difference being significant (Fisher exact test, P = 0.0245) (Brown 1997).

Given that the 1998 Pureora aerial 1080 possum control operation was the first to result in no robin mortality and it encompassed a relatively small area, further monitoring of colour-banded robins is warranted when large scale possum control operations are being carried out using 1080 cereal baits. Even so, the results of the three operations at Pureora suggest that as long as bait production and quality protocols of the Department of Conservation are strictly adhered to, robin mortality is unlikely to differ significantly from that in non-treatment areas. Negligible or nil robin mortality may be the norm in future aerial 1080 possum poisoning operations as research leads to improvements in bait quality, reduced bait density and lower toxin levels while still achieving sufficient control of possum populations.

4.3 ROBIN NESTING SUCCESS

In the 1995/96 season, prior to any poison operation, nesting success was 22.2% of 18 nests found in the Tahae and Waimanoa study areas combined (Powlesland et al. 1998). Similarly, in 1996/97 in the non-treatment study area, nesting success was just 11% of 35 nests. Predators were responsible for most failed robin nesting attempts; at least 84.6% of 26 failed attempts in 1996–97 where the reason for the failure was determined (Powlesland et al. 1998). Two other studies have shown similar robin nesting success where introduced mammalian predators were not controlled. At Kaharoa, central North Island, 16% of 43 nesting attempts in the 1993/94 season were successful (Brown 1997a), and at Kowhai Bush, Kaikoura, 32% of 521 nesting attempts during 1971–77 were successful (Flack 1979).

In contrast, nesting success in the two Pureora study areas immediately after the poison operations was much greater. In 1996/97 at Tahae, nesting success was 72% (n = 18)(Powlesland et al. 1998), and in 1997/98 at Waimanoa it was 67% (n = 30). This improved nesting success can be attributed to the poison operations killing almost all possums and rats, both of which are predators of robin eggs and nestlings (Brown et al. 1996b, Brown 1997b, Brown et al. 1998).

The moderate nesting success (30%) of robins in the Tahae study area during the second season (1997/98) after the 1996 poison operation suggests that the beneficial effect of aerial 1080 possum control operations on robin nesting can continue into the second nesting season. This result may have occurred because the study area was part of a large block (37 525 ha) over which poison baits were spread. Away from the margins of the block, the gradual increase in predator numbers was probably the result of reproduction of the few survivors, rather than immigration from outside the treatment area. In July 1997, the possum index was 0.8 possums/100 trap-nights, indicating that the possum population had recovered little in the previous 10 months. In August 1997, just before the robins started nesting, the rat index was 58%, compared with 85–95% during May–June 1996 (Powlesland et al. 1998). Thus, while the rat population index had increased from its low of 5% immediately after the poison operation, it had not recovered to its former level one year later when the robins started nesting in the second season after the poison operation.

4.4 STATUS OF ROBIN POPULATIONS A YEAR AFTER THE 1997 POISON OPERATION

The high nesting success in the treatment areas during 1996/97 (3.7 fledglings/pair) (Powlesland et al. 1998) and 1997/98 (3.8 fledglings/pair) resulted in there being greater numbers of robins in both study areas one year after each 1080 operation than before. By August 1997 in the Tahae study area, the population had increased from 28 to 36, a 28% increase (Powlesland et al. 1998). Similarly, by September 1998 in the Waimanoa study area, the number of robins had increased from 35 to 48, a 37% increase.

This improvement was not just in robin density but also in the sex ratio. Before the possum control operations, both robin populations had about one female to two males, but one year later the ratio was 0.7–0.8:1 (Powlesland et al. 1998). It is not known how long this improved population status, in relation to both density and sex ratio, will continue. However, the nesting success of robins in the Tahae study area during the second breeding season following the poison operation in 1996 (1.5 fledglings/pair) and a subsequent further increase in density to September 1998 (16%), with a sex ratio of 0.8:1, suggests that if a decline does eventuate, it will not be evident until at least the third spring after the poison operation. With a more even sex ratio, the effective population size is still larger than before the operation.

4.5 MOREPORK MORTALITY

Too few radio-tagged moreporks were available during each of the three aerial possum control operations to state with any confidence what impact the operations had on the populations.

Overall, 18% of 28 radio-tagged moreporks died in winter before the poison operations. The deaths occurred in the first two winters when frosty weather was frequent, but none died during the very mild winter of 1998 when few frosts occurred. Almost the entire diet of Pureora moreporks, as determined from indigestible prey remains in regurgitated pellets, was of large nocturnal invertebrates, particularly adult beetles of the families Scarabaeidae and

Cerambycidae, stick insects (Phasmida), tree wetas (*Hemidiena* spp.) and spiders (Araneae) (Haw 1998). Frosty weather may dramatically reduce prey availability to moreporks presumably by reducing or preventing the movements of nocturnal invertebrates. We were unable to age the captured moreporks (adult or juvenile) and so it has not been possible to relate subsequent mortality to age and therefore possible foraging experience.

It is difficult to determine whether the carrying of transmitters by the five birds that died in winter was a factor in their deaths. The mean weight of the transmitters and harnesses was about 5 g, 2.2 to 3.2% of the heaviest and lightest morepork weights respectively. Therefore, even for the lightest bird, the transmitter and harness were less than the 4–6% guideline given for flighted birds greater than 50 g (Kenward 1987). The fact that moreporks died during the first two winters when frosts regularly occurred, but not during the very mild winter of 1998 when very few frosts were evident, suggests that prey availability may have been a contributing factor.

4.6 CONCLUSIONS

In areas at Pureora where no mammal predator control had been carried out, the robin sex ratio was 1.5–2.0:1.0 (male:female) and their nesting success was low (10–20% of nesting attempts fledged chicks). Thus, the long-term viability of such populations depends on no further mortality events impacting on the adults unless they coincide with increased nesting success and recruitment. Such a scenario is possible after an aerial 1080 possum control operation, whether carrot or cereal baits are used, from the results of our studies at Pureora. Even though a poisoning operation may lead to the death of some robins, if it is carried out just before the start of the robin nesting season (July–August), both the rat and possum populations are substantially reduced (rats to less than 5% tracking index, possums to less than 2 captures/100 trap nights), and a large area is involved (so that reinvasion of mammalian predators from neighbouring habitat is slow), the remaining robins can be expected to nest more successfully than they are able to when these predators are present at moderate densities. In this case, it enables the robin population to increase to above pre-poison levels within one year, and for the sex ratio to improve to about 1:0.9 (male:female). However, because of the low level of replication during this study (each species monitored in just one treatment and non-treatment study area each year) it has limited power in predicting impacts of future aerial 1080 operations on robins.

Too few radio-tagged moreporks were monitored during this study to determine the impact of aerial 1080 possum poisoning operations on the species. A team of researchers could successfully carry out such a study in future if their objective is just to capture and monitor this species, and they are experienced in setting up and operating canopy-height mist-net rigs (Dilks et al. 1995), rather than nets set up on telescopic poles.

5. Acknowledgements

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Attachment 5-2 - Moreporks diet - Haw et al 2001

Diet of moreporks (*Ninox novaeseelandiae*) in Pureora Forest determined from prey remains in regurgitated pellets

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Abstract: The diet of radio-tagged moreporks (*Ninox novaeseelandiae*) was studied at Pureora Forest from May to December 1997. An examination of 187 pellets yielded 1226 prey items. Approximately 99% of the diet was invertebrates; the commonest items being beetles (48.6%), stick insects (25.6%) and weta (11.8%). Vertebrate prey included silvereye (*Zosterops lateralis*) and rodents in small numbers. The diet varied significantly from month to month.

Keywords: morepork; monthly diet; pellet analysis; secondary poisoning.

Introduction

The morepork (*Ninox novaeseelandiae*[1]) or ruru, is widely distributed in New Zealand (Falla *et al*., 1986, Heather and Robertson, 1996), in forests and forest remnants, including those in farmland and urban areas (Moon, 1988). Moreporks are sedentary and territorial (Heather and Robertson, 1996). Some individuals use the same daytime roosts for several consecutive days, while others frequently choose new ones. Regurgitated pellets containing indigestible prey remains can be easily collected from beneath roosts and assigned to a particular individual.

The diet of the morepork consists mostly of insects (Haw and Clout, 1999), but they also take geckos (Ramsay and Watt, 1971), birds (Hogg and Skegg, 1961), mice (*Mus musculus*), and kiore (*Rattus exulans*) (Atkinson and Campbell, 1966). Of the insects eaten, moths, weta, and beetles appear to be the most common prey items (Cunningham, 1948; Lindsay and Ordish, 1964; Daniel, 1972; Imboden, 1975; Saint Girons *et al*., 1986; Clark, 1992; Haw and Clout, 1999).

These studies suggest that the morepork is primarily insectivorous but that it occasionally supplements its diet with vertebrate prey. Several authors report that moreporks feed on house mice and kiore when they are abundant (Atkinson and Campbell, 1966; Saint Girons *et al*., 1986). Because they feed on rodents, moreporks have been considered to be at risk of secondary poisoning in pest control or eradication programmes targeted at rodents. Ogilvie *et al*. (1997) found residues of brodifacoum in the liver tissue of a dead morepork after a poison operation on Lady Alice Island. Moreporks have also been found dead after 1080 poison operations using carrot or cereal-based baits to control possum (*Trichosurus vulpecula*) populations (Spurr and Powlesland, 1997). Presumably the birds died from secondary poisoning because they are not known to eat baits.

Because of concern about the possible effects of poisoning of moreporks and a lack of information on dietary changes throughout the year on the New Zealand mainland, the monthly diet of the morepork in Pureora Forest was investigated. Here we describe the diet of the species as a result of examining the prey remains in regurgitated pellets.

Methods

Study Area

Radio-tagged moreporks were present in two blocks of Pureora Forest: Tahae and Waimanoa (Fig. 1). Powlesland *et al*. (1999) describe the reserve in detail. The birds had been radio-tagged to monitor their mortality during 1080-carrot bait operations carried out by Environment Waikato to reduce possum densities and so reduce the incidence of bovine tuberculosis in cattle on neighbouring farms (Powlesland *et al*., 1998).

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[1] Bird nomenclature follows Heather and Robertson (1996); mammal nomenclature follows King (1990); plant nomenclature follows Salmon (1997)

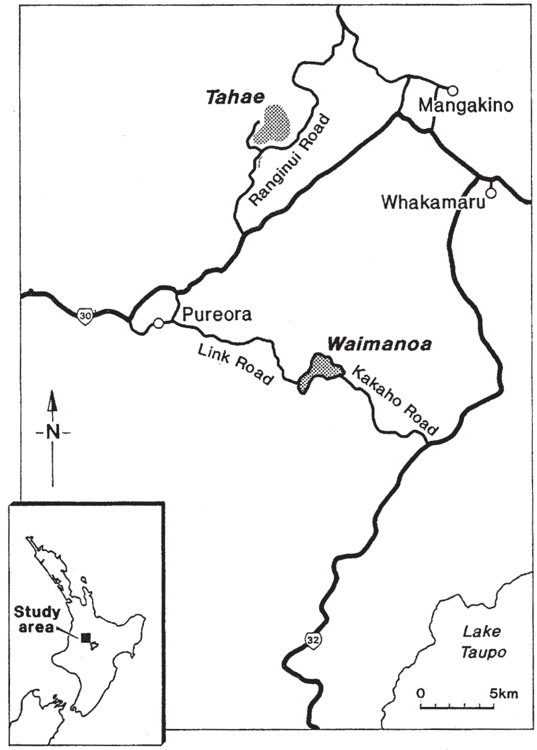

Figure 1. Location of study sites at Pureora Forest.

Radio-tags allowed ready location of birds at their roosts and therefore enabled a search for regurgitated pellets and partly eaten prey beneath the roosts.

The Tahae forest block is part of the Waipapa Ecological Area (38° 25¢ S, 175° 35¢ E), which covers an area of approximately 4000 ha, and is 45 km north-west of Taupo and 7 km north of Pureora village. It is situated on an extensive, flat plateau which forms a broad, low saddle between the Rangitoto Range to the north and the Hauhungaroa Range to the South. The topography over much of the reserve is gentle, with only shallowly incised streams. Forest covers about 70% of the Waipapa Ecological Area. It is largely unmodified, lowland rimu (*Dacrydium cupressinum*), miro (*Prumnopitys ferruginea*), totara (*Podocarpus totara*), kahikatea (*Dacrycarpus dacrydioides*) and tawa (*Beilschmiedia tawa*) forest with a mixed understorey (Leathwick, 1987). The reserve contains valuable habitats for many species, in particular for threatened birds such as the kokako (*Callaeas cinerea*), kaka (*Nestor meridionalis*), and New Zealand falcon (*Falco novaeseelandiae*). The long-tailed bat (*Chalinolobus tuberculatus*) and lesser short-tailed bat (*Mystacina tuberculata*) are also present, along with various introduced mammals. Possum control in the study area was carried out until March 1994 using 1080 (0.15% w/w) cereal baits in bait stations. Possum control by Environment Waikato was last carried out in the block in September 1996 by the aerial broadcasting of 1080 (0.08% w/w) -carrot baits.

The Waimanoa block is located to the south of Tahae (Fig. 1) and comprises about 3000 ha. The topography is of rolling country, with the altitude varying from 700 to 740 m a.s.l. During the 1970s, logging of mainly emergent podocarps occurred, therefore the density of emergents is less in parts of the block than at Tahae. On the former skid sites and logging tracks through the forest, wineberry (*Aristotelia serrata*) and toetoe (*Cortaderia fulvida*) are common. Possum control had not been carried out recently in this block; however the forest to the north of Waimanoa Road was aerially poisoned with 1080-carrot baits (1080 conc. unknown) in winter 1993, and that to the south of Link-Kakaho Road with 1080-carrot baits (0.08% w/w) in winter 1994.

Obtaining morepork pellets

The study was carried out between May 1997 and December 1997 at Tahae and Waimanoa. Radio-tagged birds were located at their roost sites, and the ground below each roost searched for pellets and partly eaten prey. When possible, roost sites were visited daily during monthly field trips. Collecting effort was the same for each month, but a lack of radio-tagged birds at Waimanoa after August 1997 meant pellets were collected from this site during only May to August. Each pellet was placed in an individual plastic bag, and the bag marked with location and date. Once back at the laboratory, each pellet was inspected under a dissecting microscope.

In addition to the pellets collected in 1997, a sample of 21 pellets was obtained from Pureora Forest between December 1995 and October 1996 by RGP, and J. Knegtmans and I. Marshall of the Department of Conservation (Pureora, N.Z.). These were not systematically collected.

Diet analysis

Prey items were identified by comparing the bones, feathers and fragments of insect exoskeleton present in the pellets with those of reference specimens. Vertebrates were identified at the Auckland Museum. Rodent remains were identified to species by dental and cranial features, whilst birds were identified by their skulls, bills, feet, pelvises and feathers. The number of individuals represented was determined by counts of skulls, jaws or pelvises for rodents, and skulls, mandibles

Table 1. Monthly number of regurgitated pellets found under the roosts of individual Morepork at Pureora Forest, May – December 1997.

	Monthly collection status[1]							
Bird	May	June	July	August	September	October	November	December
1	-	3	12	14	9	13	15	8
2	-	-	-	-	1	2	2	1
3	2	9	10	3	3	1	1	
4	1	+						
5	2							
6	-	-		4	13	7	6	2
7	-		2	#				
8	-	-	3	#				
9	-	4		+				
10	3	4	2	1	+			
11	1	+						
12	-	-	-	-	1	-	-	-
13				1		7	10	4
Total	9	20	29	23	27	30	34	15

[1] Symbols: - : bird unavailable; + : transmitter battery expired; # found dead

and long bones for birds, as demonstrated by investigations into the diets of tawny owls (*Strix aluco*) and other owl species (Short and Drew, 1962). Invertebrate material was identified to order, or further when possible. Invertebrates were counted when intact, and occasionally by compiling remains of partially digested individuals, as proposed by Calver and Wooller (1982). Data were analysed for individual pellets from both forest blocks together (Tahae and Waimanoa).

Statistical analysis

The importance of a particular prey item in the diet is expressed in terms of numerical occurrence and frequency of occurrence. For testing the significance of monthly variation in diet, ANOVA was used.

Table 2. Frequency and percentage of occurrence of prey items found in 187 morepork pellets collected in Pureora Forest from May 1997 to December 1997.

Prey item	Frequency	%
Vertebrates		
Rodentia		
Muridae		
Rattus rattus	1	0.1
Unidentified	3	0.2
Aves		
Passeriformes		
silvereye *Zosterops lateralis*	2	0.2
Unidentified	1	0.1
Invertebrates		
Lepidoptera	4	0.3
Coleoptera		
Scarabaeidae	391	31.9
Cerambycidae	174	14.2
Carabidae	11	0.9
Elateridae	1	0.1
Curculionidae	4	0.3
Brentidae	5	0.4
Unidentified	10	0.8
Orthoptera		
Stenopelmatidae	144	11.7
Rhaphidophoridae	1	0.1
Hemiptera		
Cicadidae	3	0.2
Cicadidae larvae	10	0.8
Phasmida	314	25.6
Hymenoptera	4	0.3
Araneae	119	9.7
Phalangida	3	0.2
Diplopoda	5	0.4
Chilopoda	16	1.3
Total	1226	99.8

Results

A total of 187 pellets were collected during the eight month study, from 13 moreporks (Table 1). In most months pellets were collected from five different individuals. Fewer pellets were collected in summer and autumn (December – May).

In all, 1226 prey items were recorded from six taxonomic classes; Insecta, Diplopoda, Chilopoda, Arachnida, Aves and Mammalia. Overall, beetles (Coleoptera) were the most frequently occurring prey item (Table 2), consisting of at least six family groups; Scarabaeidae, Cerambycidae, Carabidae, Elateridae, Curculionidae and Brentidae. Scarabaeidae and Cerambycidae were the most common Coleoptera eaten, comprising 94.8% of the total beetle items. Another

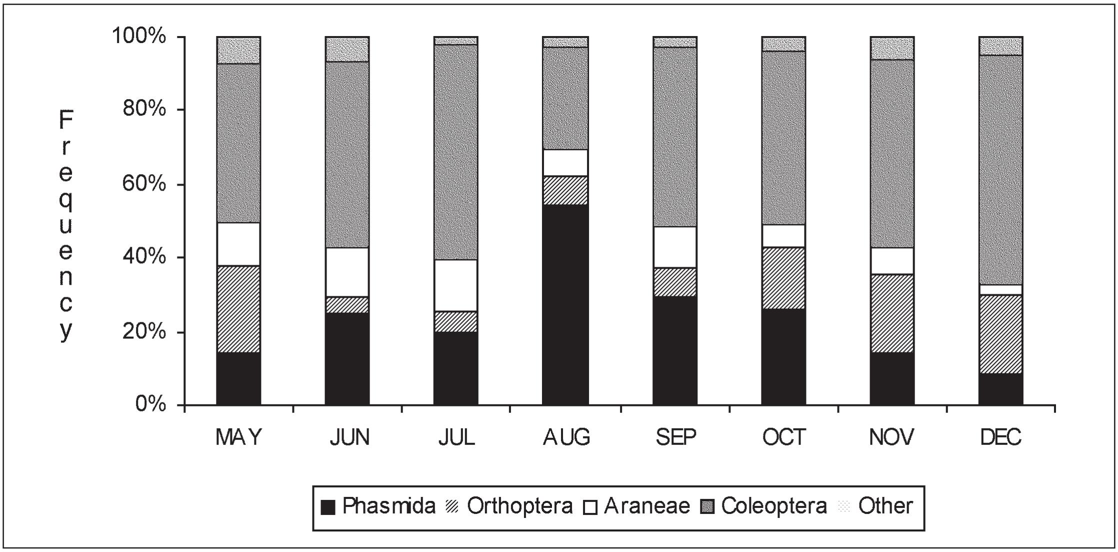

Figure 2. Percentages of five prey types each month in morepork pellets from Pureora Forest, from May 1997 to December 1997.

important component of the morepork's diet was stick insects (Phasmida), which accounted for 25.6% of the dietary items. Weta (Orthoptera) (11.8%) and spiders (Araneae) (9.7%) were also well represented. Other invertebrates recorded included cicadas (Hemiptera; suborder Homoptera), moths (Lepidoptera), bees (Hymenoptera), harvestmen (Phalangida), millipedes (class Diplopoda) and centipedes (class Chilopoda). The remains of just three birds were found in the pellets (0.3%). Of these, two were identified as silvereyes (*Zosterops lateralis*). Rodents also made up a very small portion of the diet (0.3%) numerically. Of four rodents found, just one could be identified to species from bones, and it was a young ship rat (*Rattus rattus*).

A fairly consistent monthly pattern of was exhibited from May to December 1997 (Fig. 2). Four main prey types (Coleoptera, Phasmida, Orthoptera, and Araneae) were consumed each month. The number of individuals taken varied significantly between months ($P = 0.031$) and there were also significant differences between months in the type of prey eaten ($P = 0.012$). The staple prey appeared to be beetles which was well represented each month and was the most commonly taken prey type each month except for August. A distinct change in diet involved the reduction in consumption of Scarabaeidae from October to December. Cerambycidae replaced Scarabaeidae as the most commonly eaten beetles throughout this period.

Stick insects were an important food source, particularly in winter; they were the most frequently occurring prey item in August (Fig. 2). Weta were present in the diet every month and were most frequent in November, December and May. Spiders were a constant food source and showed little monthly variation. Birds were present in autumn and spring samples only, whilst rodents were taken in winter, spring and summer but at extremely low frequencies.

A similar range of prey items was found in pellets collected from December 1995 to October 1996 (Table 3) compared to those present in May – December 1997. Again, beetles were the most frequently preyed upon item each month in 1995 – 96 (Fig. 3), as for the other sample period. Overall differences between the two collection periods include more Coleoptera and Hemiptera eaten and reduced Phasmida and Araneae from December 1995 to October 1996.

Discussion

The food items recorded at Pureora Forest are typical of those taken by moreporks in general (Cunningham, 1948; Lindsay and Ordish, 1964; Saint Girons *et al.*, 1986; Clark, 1992; Haw and Clout, 1999). However, differences in the preference for particular prey indicate feeding habits of the morepork are dependent on habitat (mainland forest, urban, island). In particular, the preponderance of beetles in the diet of forest–dwelling moreporks was evident at Pureora (Tables 2, 3) and at Lady Alice Island (e.g. Saint Girons *et al.*, 1986).

At Pureora, beetles were the most frequently consumed invertebrates during every season. Scarabaeid beetles are active, noisy and clumsy fliers

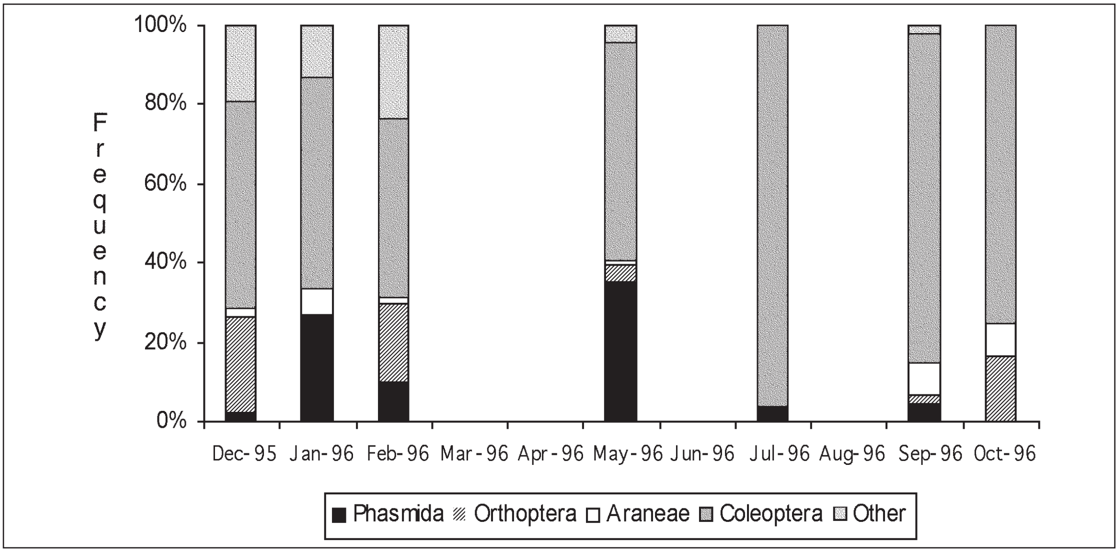

Figure 3. Percentages of five prey types each month in morepork pellets from Pureora Forest, December 1995 to October 1996.

(Gillott, 1995). It is interesting that Pureora moreporks consistently fed on this food item, but that these beetles were not evident in the diet of moreporks studied elsewhere. The shift from these to Cerambycidae in the morepork diet during October to December may reflect changes in the availability of prey. Scarabaeid beetles overwinter as active adults and are therefore more abundant from June to August (Gillott, 1995). In contrast, Cerambycid adults are most common in summer (Gillott, 1995). Other authors (Cunningham, 1948; Lindsay and Ordish, 1964) have suggested that the morepork's diet changes in response to the seasonal availability of its prey.

Predation of stick insects in large numbers by moreporks has not previously been recorded, but they were frequent prey in this study. According to Salmon (1991), most New Zealand stick insects hatch in early spring and reach maturity in autumn. Weta were the third largest group of invertebrates consumed by Pureora moreporks, the Orthoptera comprising 11.8% of the total diet. From their studies, Lindsay and Ordish (1964) also noted the importance of weta (which are available throughout the year) in the diet of moreporks. From the results of this study, weta emerge as an important food source in May 1997 and from October 1997 to December 1997.

Spiders were taken mostly in winter, particularly in June and July. Previous authors have reported the presence of spiders in morepork diets (Cunningham, 1948; Lindsay and Ordish, 1964; Clark, 1992), but not to the extent reported here (9.7% of the total prey items). Cicadids and their emerging pupae, Diplopods and Phalangids were minor prey items of moreporks in 1997. Chilopods and Hymenoptera, which were recorded in this study, have not previously been recorded as morepork prey.

Table 3. Frequency and percentage of occurrence of prey items found in 21 morepork pellets collected in Pureora Forest during December 1995 to October 1996.

Prey item	Frequency	%
Vertebrates		
Rodentia		
Muridae		
Mus musculus	1	0.4
Unidentified	1	0.4
Aves		
Passeriformes	1	0.4
Unidentified	4	1.5
Invertebrates		
Coleoptera		
Scarabaeidae	130	48.9
Cerambycidae	24	9.0
Carabidae	5	1.9
Brentidae	3	1.1
Unidentified	5	1.9
Orthoptera		
Stenopelmatidae	26	9.8
Hemiptera		
Cicadidae	11	4.1
Cicadidae larvae	8	3.0
Phasmida	38	14.3
Araneae	9	3.4
Total	266	100.1

In comparison with Cunningham's (1948) study conducted in urban Masterton and that of Clark's (1992), our study showed that forest-dwelling moreporks at Pureora consumed few moths. A possible explanation is that few pellets were collected at Pureora in summer. Also moths are attracted to street lights in the urban situation where perhaps they can be readily captured by moreporks while flying or settled near lights. When flying in the forest, moths may be more difficult for moreporks to capture on the wing.

Vertebrates comprised only 0.6% of total prey items at Pureora, including just four rodents in all of the 187 pellets examined. It must be noted that rat numbers at Tahae were low at the beginning of the sampling period in May 1997 due to a possum control operation in September 1996, but mice were abundant throughout the study. According to Powlesland *et al*., (1999), rodent populations were very high and remained so throughout the study as Waimanoa remained a non-treatment area for 1080 possum poison operations. However, Pureora moreporks largely ignored mice as a food source.

The relative insignificance of rodents in the diet of moreporks inhabiting mainland forest (Clark, 1992; Lindsay and Ordish, 1964; this study) is of particular interest in relation to the risk of secondary poisoning of moreporks during 1080 possum control operations. However, a note of caution is that no pellets were collected from January to April, when numbers of rodents, especially young ones, would have been expected to be more readily available (King, 1990). It seems that rodents are only an important prey of moreporks when they are very common (e.g., on some offshore islands), and that moreporks typically only take mice and small rats (kiore and juvenile ship rats), not adult ship rats. Overall, this study suggests that moreporks at Pureora Forest have a mainly insectivorous diet, which changes as the availability of prey species changes.

Conservation implications

Studies of morepork diet have not found them feeding on endangered native birds or reptiles. However, shore plover (*Thinornis novaeseelandiae*) released on Motuora Island, in Hauraki Gulf, in February 1997 were preyed upon by resident moreporks (S.A. Boyd, Department of Conservation, Auckland, N.Z., *pers. comm.*). This emphasises that all morepork populations cannot be considered similar in their feeding habits.

Aerial possum control operations are becoming increasingly common, and little is known about the effects that secondary poisoning has on predatory birds that prey on invertebrates or rodents. Included among the forest bird species that have been found dead and contained 1080 after aerial possum poisoning operations, (whether carrot or cereal baits were used) was the morepork (Spurr and Powlesland, 1997). At the population level, Spurr and Powlesland (1997) considered that there was a medium risk of moreporks going extinct as a result of the mortality brought about by poisoning during an aerial 1080 possum poisoning operation. However, too little information is available about the population dynamics and reproductive capacity of the morepork to be certain of the risks of extinction of morepork populations from 1080 operations. Limited observations indicated that moreporks were still common in areas where aerial 1080 operations had been carried out (Pierce and Montgomery, 1992; Walker, 1997; Powlesland *et al*., 1998).

This study suggests that moreporks are at minimal risk in mainland forests from secondary poisoning through consumption of poisoned rodents because moreporks eat few rodents. Our study indicates that the more likely source of secondary poisoning of moreporks in such habitats is by the eating of invertebrates that have fed on baits or on carcasses of animals poisoned by 1080 (Spurr, 1994). While little work has been carried out to determine the risk which morepork populations face when 1080 poison operations are carried out in mainland forests, the information available suggests that there is a minimal risk of population extinction (Spurr and Powlesland, 1997).

Brodifacoum, a second generation anticoagulant rodenticide, has been used successfully in rodent eradication operations on islands in New Zealand (Ogilvie *et al*., 1997). Eason and Spurr (1995) suggested that the morepork is at risk of secondary poisoning by eating rodents or invertebrates that have eaten brodifacoum baits. One study on Kapiti Island of moreporks exposed to two aerial applications of brodifacoum baits in September – October 1996 and monitored by calling rate, suggested that the rodent eradication programme had little impact on the morepork population (Empson and Miskelly, 1999).

Ogilvie *et al*. (1997) reported the presence of brodifacoum in the liver tissue of a morepork found dead after an aerial application of brodifacoum baits on Lady Alice Island. The authors noted that the bird may have consumed prey that had eaten brodifacoum, but the source was unknown. The presence of brodifacoum in the tissues of cave weta suggests that moreporks could accumulate brodifacoum in their liver through their invertebrate diet (Ogilvie *et al*., 1997; P. Craddock, University of Auckland, Auckland, N.Z., pers. comm.). However, no assessment of risks via this route has been attempted. Too little work has yet been carried out at mainland sites where brodifacoum baits have been placed in bait stations over several years to determine whether or not this toxin will accumulate in the livers of moreporks and affect reproduction or survival.

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Attachment 5-3 - Fate of Birds and Invertebrates - Pierce and Montgomery 1992

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THE FATE OF BIRDS AND SELECTED INVERTEBRATES DURING A 1080 OPERATION

by

R. J. Pierce and P. J. Montgomery

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THE FATE OF BIRDS AND SELECTEDINVERTEBRATES DURING A 1080 OPERATION

by R J Pierce and P J Montgomery

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ABSTRACT

An aerial 1080 poison operation for possums at Waipoua Forest in spring 1990 applied cereal pellets lured with cinnamon. Numbers of brown kiwi, moreporks, fernbirds, kokako and common diurnal birds were monitored before, during and after the operation, while small numbers of insects and kauri snails were tested for 1080 uptake. Of the birds only blackbird and tomtit showed possible declines after the poisoning. Although some kiwi had consumed non-toxic baits, no 1080 related deaths were detected following the poison operation. Low concentrations of 1080 were found in the insects, but none of the kauri snails had detectable levels of 1080.

INTRODUCTION

During aerial 1080 operations for possum control in the 1960's and 1970's there was sometimes high mortality of non-target species of birds. Trials to determine safer baits showed that screening out fragments and using a green dye with a cinnamon lure all helped to lower mortality for most common bird species (Harrison 1978, Spurr 1979, Warren 1984, Calder and Deuss 1985).

The impact of 1080 on many species of animal however, including several in the previously unpoisoned Northland forests, remained uncertain. Thus, when a 1080 programme was planned for Waipoua in 1990 there was a need for some preliminary experimental work as well as monitoring before and after the poison operation. The area studied in shown in Figure 1.

The concerns addressed at Waipoua included:-

1. Brown kiwi *(Apteryx australis) :* The omnivorous diet of kiwi could lead to birds consuming 1080 pellets.

2. Morepork or ruru *(Ninox novaeseelandiae) :* This species feeds largely on rodents (which feed on 1080 baits and obtain lethal doses) and invertebrates (some of which are attracted to baits). Moreporks could, therefore, obtain quantities of 1080 via their prey (Spurr 1991).

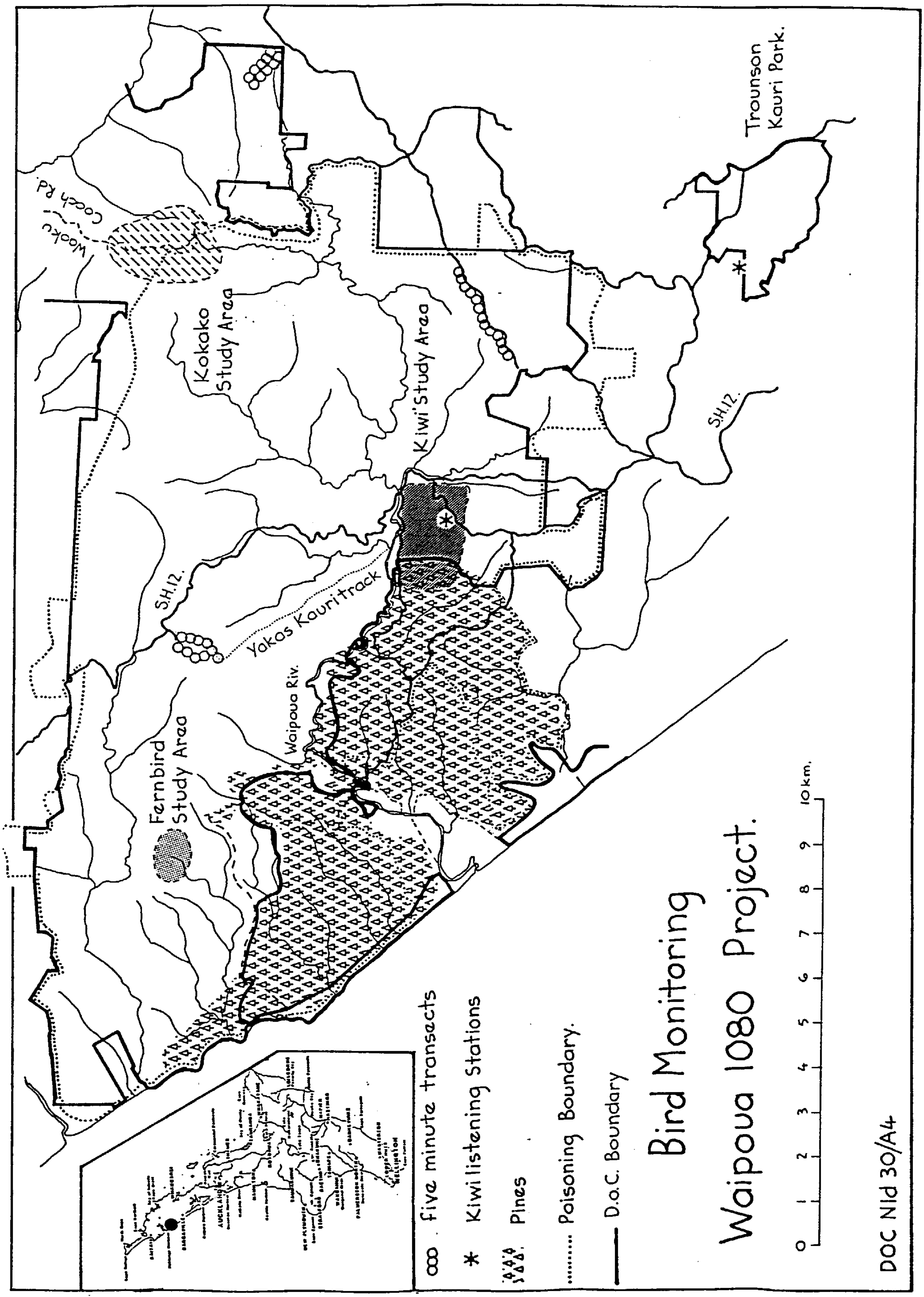

Figure 1. The study area.

3. Fernbird *(Bowdleria punctata) :* This insectivorous species could potentially suffer secondary poisoning.

4. Kokako *(Callaeas cinerea) :* This species was located in the eastern Waipoua forest (Mataraua plateau) by Wildlife Service staff in 1979 (P Anderson pers. comm.). In 1990 the population consisted of at least six pairs and five singles (P Montgomery in prep.). In six previous 1080 operations in the central North Island a total of 83 kokako have been monitored revealing low risk, but monitoring in kauri forest was a recommendation of these earlier studies (Innes in prep.).

5. Common forest birds : This was the first time an aerial 1080 operation had taken place in a Northland/kauri forest ecosystem. Kukupa *(Hemiphaga novaeseelandiae)* take some green fruit (the colour of the baits) while insectivorous birds could be susceptible to secondary poisoning.

6. Invertebrates : The fate of different invertebrates during 1080 operations has not been adequately researched. Limited work on kauri snails (carnivorous but a possible candidate for secondary poisoning) and insects (potential for direct or secondary poisoning) was carried out here.

Of these six groups, previous field testing of the effects of 1080 have been inadequate or non-existent for kiwi, morepork, fernbirds and kauri snails. Waipoua forest and other Northland forests are important habitats for all of these species and others such as NZ pigeon (Eadie et al. 1987). It was important, therefore, that adequate monitoring was in place in order to help assess undesirable impacts of this and future 1080 programmes in Northland.

METHODS

The Poison Operation

The 1080 pellets were cereal based (Wanganui No. 7) weighing an average of 8 grams with a toxicity of 0.08% w/w. They were dyed green and lured with cinnamon. Baits were scattered at an average density of 5kg/ha or 1 pellet/10m^2 by fixed wing aircraft and helicopter on 11 to 13 September 1990 (McKenzie in prep.).

Kiwi

During a trial of possum bait takes, rhodamine B dye was used in non-toxic, brown, cinnamon-lured Wanganui No. 7 baits in an area of 1km^2 near Waipoua lookout (McKenzie in prep.). For three weeks after this trial kiwi scats were collected from this trial area and examined under an ultraviolet lamp for presence of the dye.

Radio-transmitters (standard kiwi packages, R Colbourne pers. comm.) were placed on 7 kiwi which had been captured in nets or by using a trained "kiwi dog". Each transmitter was placed on the tibia and a numbered metal band covered in reflector tape was placed on the tarsus. The core home range areas were established and, for five birds (from three pairs) along the Waipoua Lookout Road, toxic baits were thrown into their core home ranges. For three birds this operation was repeated due to early rainfall (on the second night). Bait distribution simulated an actual 1080 drop with coverage at approximately 1 bait/10m2. Birds were relocated to establish if they had survived.

These same birds were monitored following the 1080 operation in September, being relocated at approximately ten day intervals until December when transmitters were removed. Two transmitters fell off soon after the 1080 operation and an additional incubating male was found, bringing the number of post-poison monitored birds to six.

A larger sample of kiwi was monitored by call counts. Listening stations were operated from Waipoua lookout and at Trounson (control) before and after the poison operation. Calls were counted during the first hour of darkness following recommendations of the Kiwi Call Scheme (R Colbourne pers. comm.). We recorded sex of bird, compass direction of call, approximate distance, weather and moonlight. Four people carried out these counts, each with similar abilities to detect kiwi. We avoided windy nights which produced low counts.

Moreporks (Ruru)

Ruru were monitored during the kiwi counts at Waipoua lookout and Trounson. During the first and last ten minutes of each kiwi count we recorded the minimum number of ruru individuals heard calling. This provided an index of conspicuousness which was compared between the poison and control areas before and after the poison operation. A total of 19 counts was made, nine in the pre-poison period and ten in the post-poison period. Four listeners were used.

Fernbirds

Searches for fernbirds were carried out in several shrubland areas in Waipoua. Where birds were located three pre-poison visits were made. At three sites fernbirds were seen on all three visits so were used in the monitoring programme and visited again after poisoning. In addition two birds were caught and metal-banded to assist in identification of individuals.

Kokako

We used a simplified version of techniques established for monitoring kokako through 1080 operations which basically entails territory mapping and three roll calls before and after the poison operation (Speed et al. 1988, Innes in prep.). Our monitoring method involved partial territory mapping and one roll call before and after the poison operation. This design assumes that kokako have the same levels of conspicuousness before and after the 1080 operation and that the same individuals occupy the same -territories.

Six pairs and five individuals had been located in about 1000ha of eastern Waipoua forest on the Mataraua plateau before the poisoning (Montgomery et al in prep.). We decided to monitor the six pairs only because with pairs twice as many birds can be monitored with virtually the same amount of effort as with singles. In addition the ranges/territories of the pairs were better known than those of the singles. Post-poison roll calls occurred in the period 18 October 1990 to 9 November 1990.

Five Minute Bird Counts

The design and methods of the five minute bird counts were similar to those of earlier operations (eg. Spurr 1979). The count data provided an index of conspicuousness which was compared between two "poisoned" and one "control" transect, both before and after the poison operation. The percent change in conspicuousness is based on the formula:

% change	-(1-O/E)*100
Where O	observed post-treated mean
and E	(pre-treated/pre non-treated)*post non-treated mean

The two poisoned transects were -

(i) a circuit transect at the north end of Yakas track, and
(ii) a transect along Marlborough Road.

The control transect was in adjoining Mataraua forest 2km east of Waipoua forest and 12km from the nearest poison transect.

All three transects were on a gently rolling westward sloping plateau with underlying late tertiary basalt which weathered to a soft reddish brown clay, generally strongly leached, up to 30m deep (Department of Lands and Survey 1980, 1982). The transects were located at 300-360m asl (Yakas), 410-440m (Marlborough Road) and 500-530m (control), with corresponding increases in estimated annual rainfall - 2100-2400mm (Yakas) and 2500-2800mm (Marlborough Road and control).

Vegetation varied somewhat with the Yakas track being dominated by the canopy species totara, miro, rimu, northern rata, rewarewa, hinau, towai, kauri and tawari, with kauri grass and ferns on the forest floor. The Marlborough Road and control sites were dominated by rimu, northern rata, taraire and towai with the forest floor often moss and fern covered. All three blocks had the same common species of bird.

Each transect had ten stations set at 200m intervals. At each station all birds seen or heard during a five minute period were counted. Other variables which may have influenced the count (Appendix 1) were also noted. The transects and the stations were visited in the same order each day which lessened the number of variables. It also meant that the most exposed transect could be attempted first and so the suitability of weather for the day was quickly found. All counts occurred in fine weather between 0930 and 1630h which avoided changes in bird conspicuousness in early morning and late afternoon.

The counts occurred on ten days from 1 to 16 June 1990 (in the pre-poison period) and on ten days from 18 October to 4 November 1990 after the poisoning. Some preliminary counts identified the best control site (selected on the basis of similar composition of bird species) and enabled familiarity with local bird vocalisations. The wide gap between before and after assessments was a result of the poison operation being delayed by bad weather for three months.

The data were analysed by E Spurr of FRI. Two methods of analysis were used on the data:

1. The first method was standard repeated measures Analysis of Variance and Randomisation (ANOVA), looking specifically for a significant interaction between the pre and post-operation readings over the treated and non-treated transects. That is, is the before and after change different depending upon whether the transect was treated with poison or not? This method assumes parity in all regards other than treatment between compared transects.

2. The second method used a non-parametric randomisation test to see if the mean difference between the daily treated and non-treated differences pre and post-operation is greater than the random fluctuations that occur in the differences.

   The daily differences between treated and non-treated areas were calculated from the means of the ten stations in each area.

Invertebrates

Invertebrates were kept in eight 1 m^2 enclosures of chicken netting and hessian contained within a larger possum-proofed enclosure near Waipoua lookout. The floors of the 1m^2 enclosures were covered in litter, logs and vegetation.

Two kauri snails were placed in each of four enclosures and a variety of invertebrates, including bush weta, cave weta, centipedes, millipedes, beetles and cockroaches in the other four. Four toxic baits were placed in two of the kauri snail enclosures (two baits in each enclosure) and the remaining kauri snail enclosures were kept as controls. This treatment was repeated exactly for the other invertebrates, ie. two enclosures with toxic baits, two controls. The experiment ran for 14 days in June before all invertebrates that could be found were collected and frozen, before being despatched to FRI Christchurch where they were tested for 1080 residues. No weta were recovered at the end of the experiment and were assumed to have escaped. All insects were blended together including 3 centipedes, 3 millipedes, 4 cockroaches, 2 beetles, 12 termites, 3 red ants and 1 unidentified insect (C T Eason, G R Wright pers. comm.).

Weta counts at night were carried out during the hour long kiwi listening counts at Waipoua lookout and the control site (Trounson).

TABLE 1: Mean number and ratios of kiwi calls heard in treated (T) and control (C) areas.

Note: "Ratios" refers to ratio of calls between treated and control areas.

	PRE-POISON COUNTS				POISON	POST-POISON	
	18 May-13 June		29 Aug-10 Sept		11 Sept to 13 Sept	17 Oct-3 Nov	
Area	T	C	T	C		T	C
Means	28.1	13.9	9.3	15.0		23.7	7.2
Ratios	2.02	1	0.62	1		3.29	1

TABLE 2: Mean number and ratios of moreporks heard calling in treated (T) and control (C) areas.

	PRE-POISON COUNTS				POISON	POST-POISON	
	18 May-13 June		29 Aug-10 Sept		11 Sept to 13 Sept	17 Oct-3 Nov	
Area	T	C	T	C		T	C
Means	8.8	5.3	6.7	9.0		13.2	2.2
Ratios	1.66	1	0.74	1		6	1

TABLE 3A: Five minute bird count means (and standard errors) for 10 stations counted 8 times (counts 2-9) at Yakas Track, Waipoua Forest (transect 1) and Mataraua Forest (Transect 3).

	Yakas Track				Mataraua Forest			
	Pre		Post		Pre		Post	
Fantail	1.050	(0.188)	0.625	(0.049)	1.150	(0.119)	0.425	(0.090)
Grey warbler	1.163	(0.083)	2.263	(0.123)	1.025	(0.100)	2.763	(0.200)
Kukupa	0.188	(0.065)	0.125	(0.042)	0.275	(0.045)	0.100	(0.036)
Silvereye	4.213	(0.235)	0.663	(0.243)	6.438	(0.448)	0.675	(0.128)
Tit	1.475	(0.120)	1.175	(0.118)	1.575	(0.129)	2.188	(0.188)
Tui	0.450	(0.060)	1.788	(0.196)	0.250	(0.089)	0.863	(0.084)
Blackbird	0.350	(0.072)	0.225	(0.076)	0.488	(0.160)	1.013	(0.206)
E. rosella	0.425	(0.095)	1.263	(0.259)	0.275	(0.069)	1.000	(0.136)
Myna	0.125	(0.053)	0.350	(0.081)	0.138	(0.051)	0.163	(0.042)

RESULTS AND DISCUSSION

Kiwi

Results

Of 17 scats collected following the Rhodamine B trial, one contained much dye, one contained a little dye and 15 no dye at all. The two scats containing dye were collected 15 and 19 days respectively after the trial by which time surviving baits were soft and saturated with water. All baits were soft and wet through within 12 days of sowing. Several instances were found where kiwi had probed for food along paths but did not peck at or eat any of the baits which lay in their path.

The five transmittered kiwi which had toxic baits experimentally provided all survived. Following the full poison operation on 11-13 September 1990 five out of six bird survived to the late December cessation of monitoring. The sixth bird died near the Waipoua lookout. It had broken vertebrae which was consistent with the individual having been hit by a solid object, eg. a vehicle. After transmitters were removed (or fell off) in December one of these birds and an unbanded bird were also found dead on the Waipoua Lookout Road, their injuries consistent with having been killed by vehicles.

During the poison period Waipoua kiwi were nesting. Three of the four pairs monitored by radiotelemetry were found nesting and all three had their first nests fail due to egg disappearing (1 nest); egg infertile and deserted (1 nest), and one egg broken/one gone (1 nest). One of these pairs re-nested.

Kiwi call counts from Waipoua forest and Trounson (control) are given in Table 1. Before the poison operation twice as many kiwi calls were recorded in the poison versus the control blocks. This was not unexpected due to the greater listening coverage possible at the Waipoua forest site. Call rates were, however, several times lower at Waipoua immediately prior to the poison operation despite good listening conditions. After the poison drop call counts in the poisoned area were again at a high level (Table 1).

Discussion

The rhodamine experiment revealed that kiwi will sometimes consume all or part of Wanganui No. 7 pellets lured with cinnamon. It is not known whether the baits were consumed intentionally or inadvertently during probing, although the quantity of dye in one scat suggests the former in that case.

That no 1080-related mortality of kiwi was detected suggests that bait consumption, if it took place at all, was delayed until the bait was wet and largely detoxified (21 days after the poison operation the mean concentration of 1080 in baits was about 20% of the original concentration), and/or the birds took baits in insignificant quantities. LD50s of the kiwi are another unknown factor which may have contributed to the resistance of the Waipoua birds.

The vehicle-induced deaths may be exceptional. While some "road-kills" have been found in the past, mauling by dogs is the most common cause of death of Northland kiwi reported to the Department of Conservation.

Moreporks

Results

In the treated area the numbers of birds detected doubled after the poison operation but declined in the control area (Table 2). Two birds were found using a roost site beneath nikau fronds near Waipoua lookout in May 1990. Both birds survived experimental poisoning of their roost area and they survived the main 1080 operation.

Discussion

The post-poison increase in morepork detected in the poisoned area may reflect seasonal differences in conspicuousness but the decrease in the control was a surprise. The decline at the control site may be attributable in part to a 'new' listener being employed there at this time. It is not known if moreporks scavenge on 1080-killed animals as do some diurnal raptors, eg. harriers (Pierce and Maloney 1989).

Although high morepork numbers were maintained after this operation it is not clear what effects the poisoning may have had on their feeding behaviour and productivity. Recent studies have shown 95-100% reductions of ship rats through use of 1080 (Warburton 1989, J Innes pers. comm). In Waipoua too, rodent numbers declined to low levels immediately after the operation (R Pierce unpub. data). As rodents contribute significantly to morepork diet it is probable that the 1080 operation greatly altered their diet and possibly also productivity. These impacts are likely to be of limited duration however, due to high recolonisation/recovery rates of rats at least (J Innes pers. comm.; unpub. data).

Fernbirds

Results

All 14 fernbirds (including the two banded birds) were relocated five weeks after the 1080 operation.

TABLE 3B: Five minute bird count means (and standard errors) for 10 stations counted 10 times (counts 1-10) at Marlborough Road, Waipoua forest (transect 2) and Mataraua forest (transect 3).

	Marlborough Rd				Mataraua Forest			
	Pre		Post		Pre		Post	
Fantail	1.300	(0.060)	0.740	(0.098)	1.230	(0.093)	0.510	(0.102)
Grey warbler	1.140	(0.124)	2.890	(0.207)	1.120	(0.105)	2.750	(0.171)
Kukupa	0.260	(0.083)	0.240	(0.037)	0.270	(0.054)	0.110	(0.038)
Silvereye	6.090	(0.449)	1.350	(0.189)	6.700	(0.399)	0.700	(0.092)
Tit	1.720	(0.088)	2.010	(0.170)	1.650	(0.110)	2.220	(0.174)
Tui	0.350	(0.031)	1.620	(0.106)	0.270	(0.086)	0.890	(0.084)
Blackbird	0.280	(0.059)	0.520	(0.093)	0.490	(0.157)	1.070	(0.190)
E. rosella	0.290	(0.074)	0.480	(0.087)	0.230	(0.060)	0.990	(0.126)
Myna	0.320	(0.098)	0.360	(0.097)	0.160	(0.048)	0.190	(0.055)

TABLE 4: Percent changes in five minute bird count means from pre to post-poison, Waipoua 1990.

Transect 1 (Yakas)

	Pre-Poison		Post-Poison		% Change
	Yakas	Control	Yakas	Control	
Blackbird	0.350	0.488	0.225	1.013	-69.03
Fantail	1.050	1.150	0.625	0.425	61.06
Grey warbler	1.163	1.025	2.263	2.763	-27.81
Myna	0.125	0.138	0.350	0.163	137.06
Kukupa	0.188	0.275	0.125	0.100	82.85
Rosella	0.425	0.275	1.263	1.000	-18.28
Silvereye	4.213	6.438	0.663	0.675	50.10
Tit	1.475	1.575	1.175	2.188	-42.66
Tui	0.450	0.250	1.788	0.863	15.10

Transect 2 (Marlborough Rd)

	Pre-Poison		Post-Poison		% Change
	Yakas	Control	Yakas	Control	
Blackbird	0.280	0.490	0.520	1.070	-14.95
Fantail	1.300	1.230	0.740	0.510	37.29
Grey warbler	1.140	1.200	2.890	2.750	10.62
Myna	0.320	0.160	0.360	0.190	-5.26
Kukupa	0.260	0.270	0.240	0.110	126.57
Rosella	0.290	0.230	0.480	0.990	-61.55
Silvereye	6.090	6.700	1.350	0.700	112.17
Tit	1.720	1.650	2.010	2.220	-13.14
Tui	0.350	0.270	1.620	0.890	40.42

Discussion

The survival of all monitored fernbirds during this operation suggests that risk of secondary poisoning was not high under these conditions.

Kokako

Results

The poison operation covered 5.5 of the six kokako territories occupied by pairs. Five of the six pairs were relocated, both members of the pair being seen in each case. A further three single birds were seen after the poisoning although singles were not specifically roll called. One pair was not relocated after the poisoning.

Discussion

Kokako largely or totally survived the 1080 operation. The one pair that was not found after the poisoning was the least well known of all the local pairs. It had been followed once only prior to their roll call in the week before the poison operation. This pair least fitted the two basic assumptions for kokako monitoring (same levels of conspicuousness and occupy the same territories before and after) and probably should not have been included in the assessment. We feel that the most likely explanations for not relocating this pair are (in decreasing order of likelihood): utilising a different part of their territory, may be breeding (and therefore cryptic), may have died from poisoning or other causes, may in fact be the same as one of the other pairs of kokako.

Common Forest Birds

Results

Silvereye

ANOVA indicated a significant decrease in silvereye conspicuousness with time (pre to post-poison) in all three transects (Tables 3 and 4). There was also, however, a significant time/area interaction with the decrease in each of the treatment transects being significantly less than that in the non-treatment area. The results of the randomisation test agree with those of ANOVA for transect 1 v 3, but for 2 v 3 there was no significant difference (Table 5).

Tui

ANOVA indicated a significant increase in tui conspicuousness with time (pre to post-poison) overall. There was, however, a significant time/area interaction with the increases in both transects 1 and 2 being significantly greater than in transect 3 (non-treated control). The results of the randomisation test agree with those of ANOVA.

TABLE 5: P-values for time x area interaction from (A) Analysis of Variance and (R) Randomisation test.

Control vs

	Transect 1		Transect 2		Transects 1 & 2	
	A	R	A	R	A	R
Rosella	-	0.59	-	0.01	-	0.20
Kukupa	-	0.12	0.18	0.14	0.15	0.09
Grey warbler	0.004	0.05	0.65	0.54	0.48	0.19
Fantail	0.10	0.04	0.28	0.28	0.17	0.10
Tomtit	0.001	0.002	0.26	0.35	0.02	0.02
Silvereye	0.001	0.002	0.03	0.13	0.04	0.001
Blackbird	0.001	0.001	0.03	0.12	0.004	0.004
Tui	0.005	0.001	0.001	0.01	0.001	0.001
Myna	-	0.12	-	0.94	0.46	0.36

- = unable to test

TABLE 6: Mean number of weta heard per count in treated (T) and control (C) areas.

	PRE-POISON COUNTS				POISON	POST-POISON	
	18 May-13 June		29 Aug-10 Sept		11 Sept to 13 Sept	17 Oct-3 Nov	
Area	T	C	T	C		T	C
Means	0.9	0.0	0.0	0.0		2.7	1.4

Blackbird

ANOVA indicated a significant increase in blackbird conspicuousness with time. There was a significant time/area interaction with conspicuousness increasing in the non-treated area, but not in either of the treated areas (Tables 3 and 4). The results of the randomisation test agree with those of ANOVA for transect 1 v 3, but not for transect 2 v 3 for which there was no significant difference.

Tomtit

For transect 1 v 3 ANOVA indicated no change in tit conspicuousness with time overall. There was a significant time/area interaction, however, with a conspicuous decrease in the treated area, but an increase in the non-treated area. The results of the randomisation test agree with those of ANOVA.

For transect 2 v 3 ANOVA inidicated an increase in tit conspicuousness with time, but there was no significant time/area interaction. The results of the randomisation test agree with those of ANOVA.

Fantail

ANOVA indicated a significant decrease in fantail conspicuousness with time overall. There was no significant time/area interaction. The results of the randomisation tests agree with those of ANOVA for transect 2, but for transect 1 the decrease was significantly smaller (Table 5).

Grey warbler

ANOVA indicated a significant increase in grey warbler conspicuousness with time overall. There was no significant time/area interaction.

Kukupa

ANOVA indicated no significant difference in kukupa conspicuousness with time. There was a suggestion of increased conspicuousness on transect 2 (Tables 4 and 5) but this was not significant.

Eastern rosella

These were detected in increased numbers with time overall (Tables 4 and 5). Randomisation tests indicated that numbers recorded in transect 2 were less than expected.

Myna

Myna were detected in increased numbers with time overall (Tables 4 and 5). There was a suggestion of increased numbers in transect 1 but this was not significant.

Discussion

The causes of decreased detection of blackbirds in both treated areas (and tomtits in transect 1) are unknown but could be attributable to poisoning. Instances were found of blackbirds taking non-toxic red-dyed baits prior to the operation and peck marks on toxic baits were consistent with those of blackbird.

The lower than expected post-treatment conspicuousness of blackbirds and tomtits in transect 1 could also reflect other factors, eg. food supply or altitudinal shifts, transect 1 being the lowest of the transects (140-230m lower than transect 3).

Similarly it was not known whether silvereyes or tui (which were recorded in greater numbers than expected in the treatment areas after the operation) responded positively because of the effects of the possum poisoning. These and other species, eg. rosella and myna, are very mobile in the forest seasonally (R Pierce pers. obs.) and could have simply followed changed food availability or other seasonal habitat choice.

Invertebrates

Results

All invertebrates left in the enclosures, with the exception of one beetle, were alive when finally sampled. None of the kauri snails had detectable levels of 1080. A low concentration of 1080 was found in the insects (0.05-0.75mg 1080/g tissue).

Weta data from listening stations were of very limited use. Seasonal changes in weta activity and possibly the poorer control habitat prevented useful comparisons of weta abundance between the treated and control areas. More weta were heard in the treated area after the 1080 drop, however, indicating that substantial numbers had survived (Table 6).

Kauri snails of varying ages were also frequently encountered at night before and after the poison operation, but no attempt was made to quantify any changes.

Two mice (*Mus musculus*) were found dead in the enclosures and both contained significant levels of 1080 in their bodies.

Discussion

The enclosure experiments and nocturnal counts, however crude, produced no evidence of 1080 uptake in kauri snails and a small uptake in insects. Hutcheson (1989) found that captive weta can obtain lethal and sublethal amounts of 1080 by consuming pellets. It is not known, however, what impacts there may be on wild invertebrates. In order to assess this, intensive field monitoring of terrestrial species in particular is needed before and after 1080 operations. These data would then need to be balanced against the damage caused by possums and the depredations of rats, the effects of which are reduced by 1080 programmes.

CONCLUSIONS AND RECOMMENDATIONS

Species monitored during the Waipoua operation included brown kiwi, morepork, NZ pigeon, eastern rosella, fantail, tomtit, grey warbler, fernbird, blackbird, silvereye, tui, myna, kokako and kauri snail. Of these, only blackbird and tomtit (one transect) were recorded with lower than expected numbers in the treated area after the poison operation and these declines could have been attributable to poisoning. Both blackbirds and tomtits are multiple-brooded so have greater potential for rapid recovery than some of the species which were unaffected, especially in a rodent-depleted environment. Rats (important nest predators) were heavily depleted for most of the 1990-91 breeding season so blackbirds and tomtits should have quickly recovered in numbers.

Recommendations for further work are:-

1. For future 1080 operations in Northland forests we believe there is no need to closely monitor the common forest birds, with the possible exception of tomtit. Instead, rarer species should be researched and more emphasis placed on invertebrates, lizards and the breakdown of 1080 in soil.

2. Find conditions under which kiwi will consume baits and what levels of 1080 ingestion kiwi can survive unaffected.

3. Trials for kiwi acceptance of non-toxic lured baits should be carried out before all large-scale 1080 operations and kiwi monitored during 1080 applications until results and recommendations from 1. indicate that this is unnecessary.

4. Morepork numbers and diet should be examined during 1080 operations in other forests, especially those with high mouse densities.

5. Monitor invertebrate populations during 1080 operations to assess any changes in species composition and biomass. This includes surface and subsurface macro and micro-organisms including those living beneath decomposing baits.

6. Carry out bait and lure acceptance experiments on any sensitive invertebrates identified in 5.

7. Examine impacts of 1080 on rodents and predators and particularly on survival and behavioural shifts of mustelids and cats.

ACKNOWLEDGEMENTS

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Many helpful comments on the text were provided by M Clout, C O'Donnell and E Spurr.

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Attachment 6 - Notes on Hochstetters frog counts Hunua Ranges May 2018

Notes on Hochstetter’s frog counts carried out in the Hunua Ranges pre- and post-1080 poison drop

Hochstetter’s frog monitoring part of a long term monitoring programme run by EcoQuest in the Hunua Ranges. Auckland Council used a small subset of the EcoQuest transects to conduct frog counts pre- and post-1080 drop in 2015/2016 to check on frog presence. This data represents a subset of the EcoQuest long term data and cannot by itself be used to extrapolate changes in population size. Auckland Council counts were only conducted immediately before and after the 1080 drop to establish frog presence/absence and must be interpreted in the context of the long term data held by EcoQuest. Frog counts can fluctuate widely due to weather dependent behaviour changes and difficulties with detecting cryptic species. Habitat quality in small streams can also change rapidly with flooding events, making existing transects undesirable for frogs.

Streams were surveyed following protocols established by EcoQuest, except that habitat quality was not always recorded due to time constraints:

Upon arrival at the downstream transect markers, the measuring tape was laid out in the middle of the stream, downstream to upstream, to the 20 meter mark. Stream width was measured with the meter sticks at 0, 10, and 20 meter points along the measuring tape. Each group took precautionary measures to avoid disturbing frog habitat by staying in the stream at all times.

Before starting the frog survey, we recorded the following data: date of survey, area (KMA vs non KMA), transect number, who is the searcher for the transect, water temperature, Whole Site Suitability, and Habitat Quality. Whole Site Suitability refers to a qualitative judgment of the amount of suitable habitat available along the transect as a whole (optimal, suitable, marginal, not suitable). Habitat Quality was then determined using a qualitative assessment of the degree of canopy cover and amount of riparian zone vegetation present (ranging from 1: minimal canopy cover and riparian vegetation, to 5: full canopy cover and heavy riparian vegetation). The recorder documented stream temperature by using a thermometer.

Next, the searcher conducted a transect suitability assessment starting downstream (0m). At each 1m interval, the searcher extended a 1m measuring stick perpendicular to the stream bank. The stream bank was assessed at either a horizontal distance of 1m or up to a height of 60cm if on a steep bank. This was conducted for both the left and right sides of the stream and a middle if the stream split into two channels. We also assessed the presence or absence of cover objects a frog may have been under, such as rocks, branches, and debris. Each side was then evaluated as Suitable (at least one suitable refuge the size of a golf ball, ca. 42.7mm), Not Suitable (no suitable objects), or Unsearchable (the habitat looked suitable, but could not be accessed because of large, immovable obstacles).

When searching for frogs, the recorder timed the search process and all suitable cover objects lifted along the stream banks were recorded with a tally counter. Only cover objects that could be returned to their original position were lifted. Larger cover objects were lifted directly upward, often with two hands, to prevent them from harming frogs that may have been hidden underneath. While surveying, the searcher indicated to the recorder all cover objects that were potentially suitable for frogs, but did not relay those that were moved in order to access other suitable cover objects.

Upon discovering a frog under a cover object the stopwatch was paused and the searcher conducted three measurements. The first was to take an immediate estimate of the frog’s size in case the frog jumped away before the searcher could measure it. This estimate was taken to the nearest 5mm increment. If the frog remained in its spot, the searcher then took an accurate measurement of the snout-urostyle length (SUL) in mm by holding a clear plastic ruler directly above the frog without touching it. The searcher then measured the frog’s distance along the transect (m) as well as its distance from the water’s edge (cm) and relayed all data to the recorder.

Attachment 7-1 - 14132 Hunua bat REPORT 2015

AUCKLAND COUNCIL

LONG-TAILED BAT SURVEYS
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CONTENTS

EXECUTIVE SUMMARY

A long-tailed bat (LTB) survey was undertaken within the Hunua Ranges at 11 fixed locations using Automatic Bat Monitoring (ABM) detectors. The locations were selected to provide a broad coverage of the Hunua Ranges and compliment the coverage achieved by a 2014 survey undertaken around the Kokako Management Area.

LTBs were recorded from nine ABMs throughout the Hunua Ranges. Most ABMs recorded a few single passes which occurred intermittently throughout the survey period.

The highest number of passes was recorded at Piggots Campground (average 82.5 passes per night) and Waterline Road (average 45.5 passes per night). Both of these ABMs recorded high numbers of passes periodically, suggesting that a colony or colonies of bats were passing at a time throughout the survey period.

Most ABMs recorded passes throughout the night, though some locations had stronger patterns of activity. Acheson and Milnes Streams recorded most passes between 2100 and 2300 over the survey period. Single passes at Piggots Campround were recorded throughout most nights, however multiple recordings of 10+ passes were typically recorded after midnight.

1 INTRODUCTION

The long-tailed bat (LTBs; *Chalinolobus tuberculatus*) is one of two bat species in New Zealand and is classified as 'Nationally Vulnerable' in the North Island (O'Donnell et al. 2012). This classification is given the qualifier "Data Poor" which indicates that there is low confidence in the rating due to poor data available on the species populations and distribution (Townsend et al. 2008). Within the Auckland Region, records from the Waitākere Ranges, Dome Valley and the Hunua Ranges represent the better known populations.

A recent survey that included parts of the Hunua Ranges (Bioresearches 2014) found that LTB activity was variable within and around an area of intense pest animal control (KMA, Kokako Management Area). Activity within the KMA ranged from 3 – 45 average passes per night and activity outside the KMA similarly recorded from 0 – 91 average passes per night. Further survey effort was recommended to provide baseline information for LTB activity in the Hunua Ranges. This information would be of particular value given the proposed application of sodium fluoroacetate (1080) to manage pests over some 17,000 ha of the Hunua Ranges Regional Park in July/August 2015.

1.1 Long-tailed bat habitat requirements

LTBs require large trees (including standing dead trees) with cavities (e.g. deep knot holes), epiphytes or loose bark for roosting, and typically use linear landscape features such as bush edges, gullies, watercourses and roadways to transit between roosting and feeding sites (Borkin and Parsons 2009; Griffiths 1996).

They tend to forage in open areas, including clearings (Borkin and Parsons 2009; Griffiths 1996), wetlands, open water and along rivers and roadways (Borkin and Parsons 2009; Griffiths 1996).

Long-tailed bats are highly mobile, regularly change roost sites (Griffiths 1996) and can fly at 60 km/hr over very large home ranges (up to 5629 ha; O'Donnell 2001). LTB activity is significantly reduced in winter, though usually does not cease completely.

1.2 Survey aims

The investigations presented in this report aimed to build on a previous survey to provide baseline information on LTB activity throughout the Hunua Ranges Regional Park.

2 METHODS

2.1 Automatic Bat Monitoring (ABM) detectors

Automatic Bat Monitoring (ABM) detectors were used to record ultrasonic echolocation calls emitted by bats. The ABM converts these calls to frequencies that are audible to humans (Parsons & Szewczak, 2009).

An ABM is comprised of two ultrasound sensors and microphones, a sound-activated recording device, a timer to turn the system on and off each day, and a rain-noise detector that turns the system off in the event of persistent rainfall. ABMs record and store data passively and remotely, and have the capacity to record both long-tailed (40 kHz) and lesser short-tailed (28 kHz) bat calls. The ABMs were set to begin recording 30 minutes before sunset and turn off 30 minutes after sunrise, during February and March 2015.

2.2 Survey Sites

Eleven (11) ABMs were set at fixed locations (Figure 1) alongside roadways, wetlands, watercourses and other forest edges.

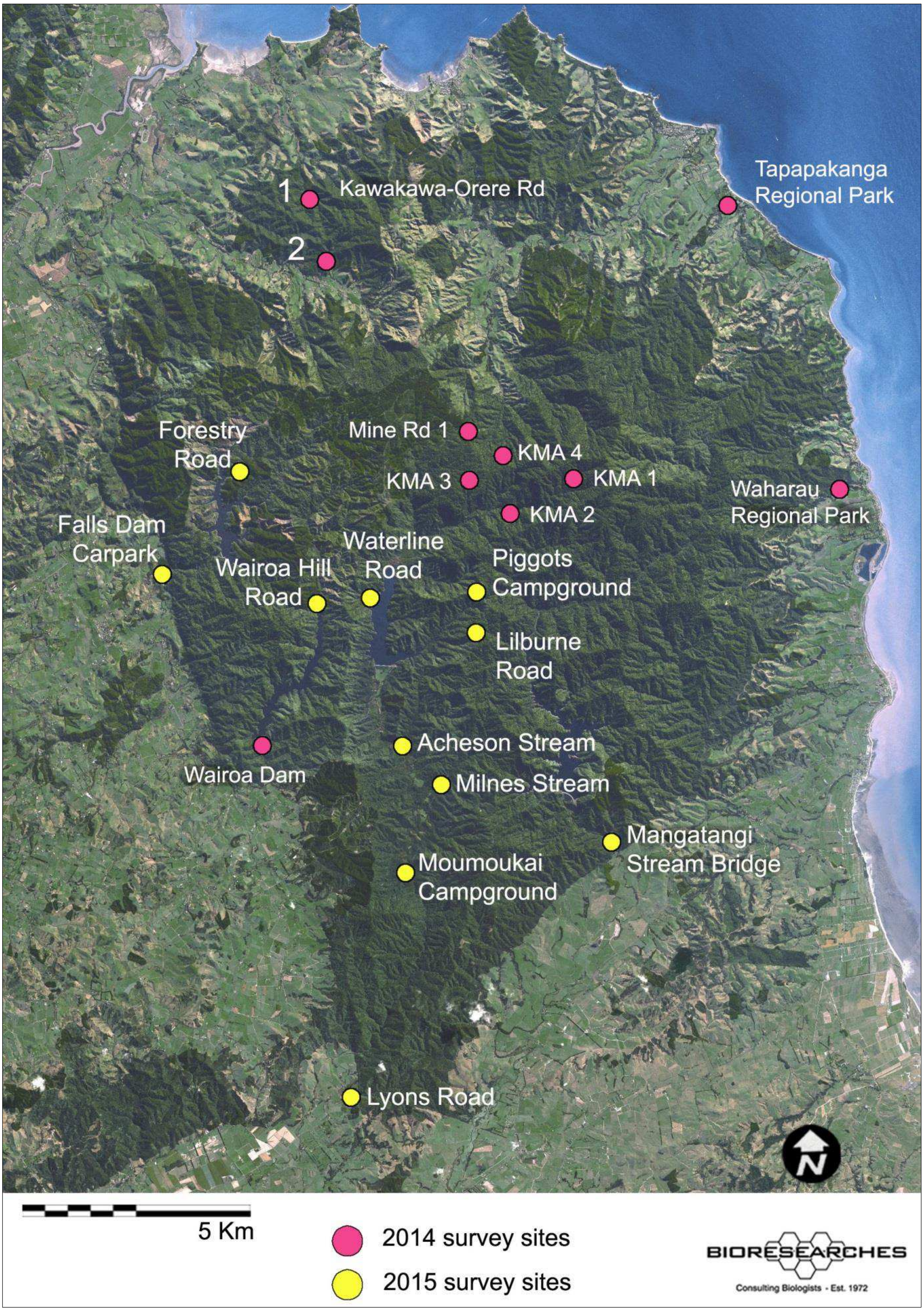

Figure 1. **Location of 11 ABMs set.** ***2014 data courtesy of Bioresearches (2014)***

2.3 Data analysis

ABM data were downloaded and the waveforms analysed using Bat Box 1.0 software (Department of Conservation, 2008). The total number of 'usable nights' (UNs) was determined using climate data (CliFlo, New Zealand's National Climate Database, NIWA) and recording analyses (e.g. when the recorder log indicated a noise switch- pause for a period of more than half the night). Nights were considered 'useable' if the temperature remained above 5°C and more than half the night was free of rain or insect noise.

Each echolocation pass was time (hour/minute/second) and date (year/month/day) stamped providing timing information for activity. This information was tabulated and provided as Appendix I.

Each bat pass was further distinguished as one of two echolocation categories:

1. 'bat pass' (i.e. short pulse(s) at low repetition rates, indicating a bat using its echolocation to navigate as it flies by the recorder [mean inter-pulse interval of c. 104 ms]);
2. 'feeding buzz' (i.e. series of pulses emitted rapidly over a short duration [mean inter-pulse durations of 4.5 ms], indicating the pursuit of prey) (Parsons *et al.* 1997).

A distinction was made between passes and feeding buzzes to distinguish areas that may be important for foraging. High proportions of feeding buzzes may indicate areas of greater significance for LTBs given their high energy demands.

3 RESULTS AND DISCUSSION

Ten of the 11 ABMs recorded UNs. Bat passes were recorded at nine of those ABMs with UNs (Table 1). Most ABMs recorded a few single passes, which occurred intermittently throughout the survey period.

The highest number of passes was recorded at Piggots Campground (82.5 passes per night) and Waterline Road (45.5 passes per night). Both of these ABMs recorded high numbers of passes periodically, suggesting that a colony or colonies of bats were passing at a time. For example, from 185 passes recorded at Waterline Road on 5 March, 44 passes occurred between 2000 and 2100, and a further 74 passes were recorded between 0200 and 0300 the following morning.

Table 1. Summary of ABM recordings from the Hunua Ranges, 24 February - 18 March

ABM	Site	Date set	Useable nights	Total passes	Nights with passes	Average passes per night	Maximum passes recorded on a night	Total feeding buzzes	Nights with feeding buzzes	Proportion of feeding buzzes
1	Falls Carpark	24-Feb	17	14	10	0.8	2	4	4	28.6
2	Forestry Road	24-Feb	19	5	2	0.3	4	0	0	0
3	Wairoa Hill Road	24-Feb	0	-	-	-	-	-	-	-
4	Waterline Road	24-Feb	19	865	19	45.5	185	135	19	15.6
5	Piggots Campground	25-Feb	16	1320	18	82.5	135	245	18	18.6
6	Lilburne Road	25-Feb	17	117	15	6.9	29	8	3	6.8
7	Acheson Stream	25-Feb	17	62	12	3.6	11	6	5	9.7
8	Milnes Stream	25-Feb	20	39	11	2	10	4	2	10.3
9	Moumoukai Campground	25-Feb	16	20	8	1.3	5	2	2	10
10	Mangatangi Stream Bridge	25-Feb	19	16	8	0.8	5	1	1	6.3
11	Lyons Road	25-Feb	17	0	0	0	0	0	0	0

Most ABMs recorded passes throughout the night, though some locations had stronger patterns of activity. Acheson and Milnes Streams recorded most passes between 2100 and 2300 over the 17-20 day period. Single passes at Piggots Campround were recorded throughout most nights; however multiple recordings of 10+ passes were typically recorded after midnight.

Feeding buzzes were identified at most sites that recorded bats. The greatest proportion of feeding buzzes was recorded at Falls Carpark (28 %). This ABM was positioned alongside the Wairoa River, a potential feeding site. However, this site only recorded a maximum of two passes on any recorded night, indicating that this particular location on the Wairoa River is not as important as other feeding areas may be.

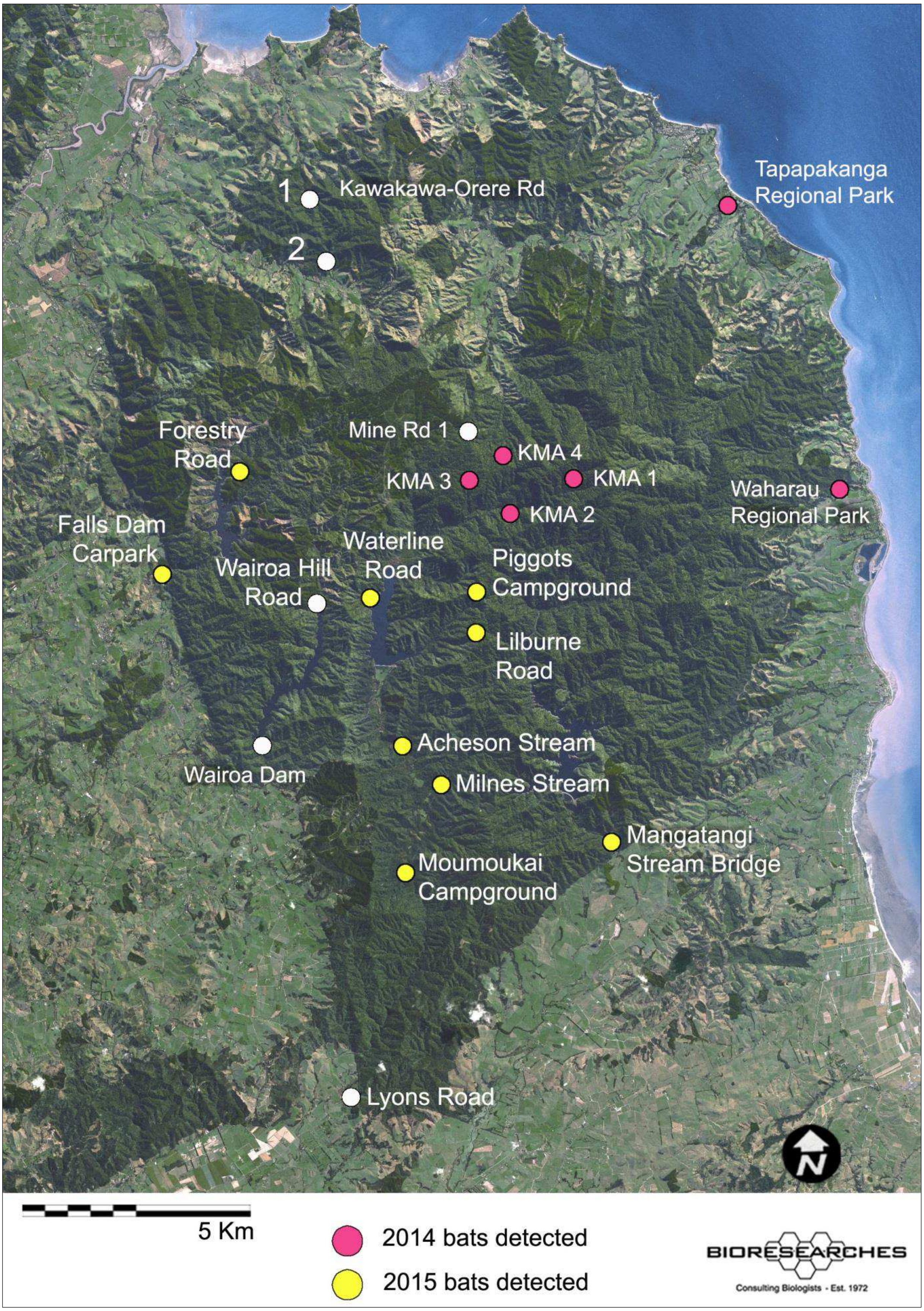

Figure 2. **Location of bats detected in 2014 and 2015.** ***2014 data courtesy of Bioresearches (2014).***

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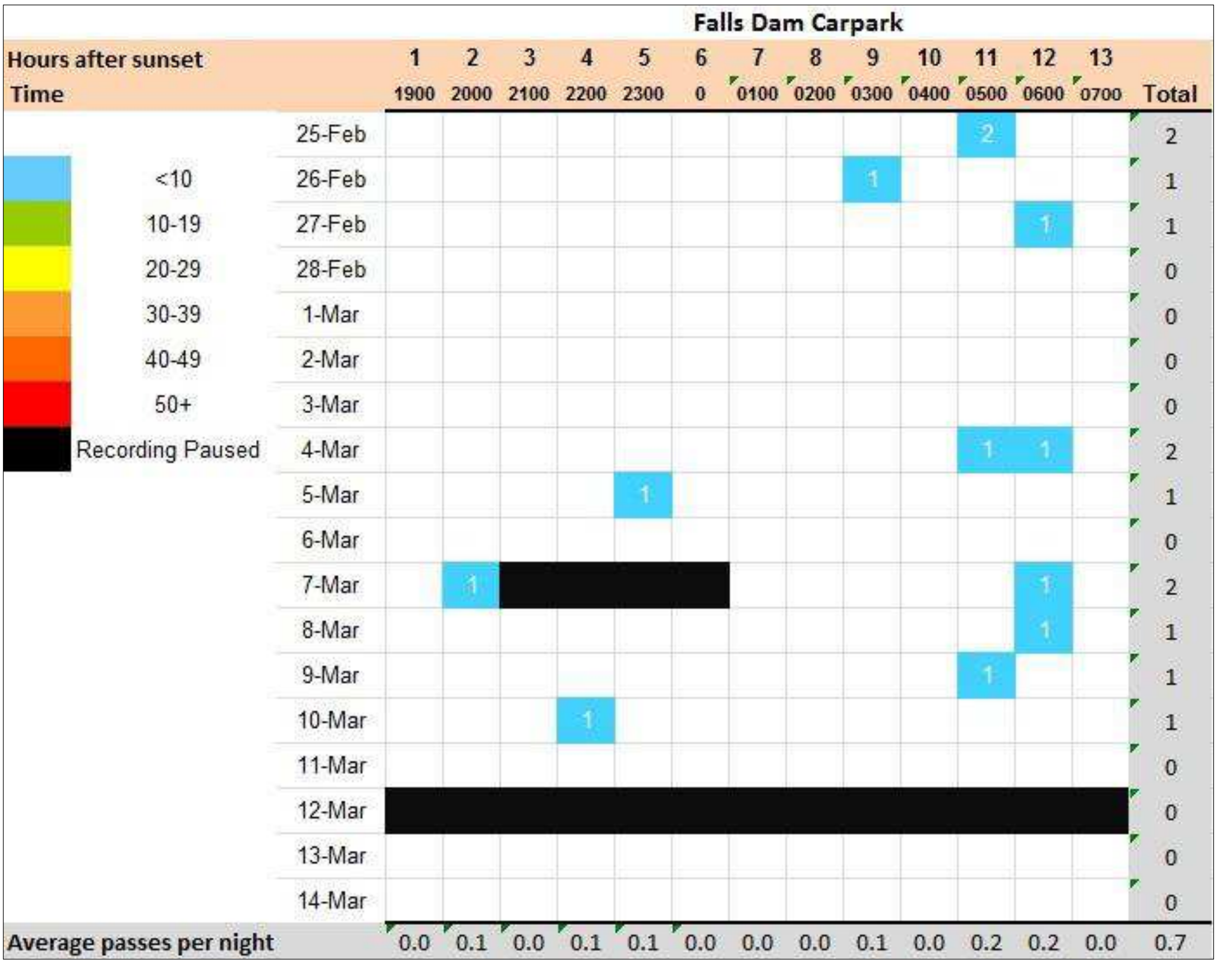
5 APPENDICES

Appendix I. Long-tailed bat nightly activity at sites where bats were present in 2015.



Falls Dam Carpark

Hours after sunset		1	2	3	4	5	6	7	8	9	10	11	12	13	
Time		1900	2000	2100	2200	2300	0	0100	0200	0300	0400	0500	0600	0700	Total
	25-Feb											2			2
🟦 <10	26-Feb									1					1
🟩 10-19	27-Feb												1		1
🟨 20-29	28-Feb														0
🟧 30-39	1-Mar														0
🟧 40-49	2-Mar														0
🟥 50+	3-Mar														0
⬛ Recording Paused	4-Mar											1	1		2
	5-Mar					1									1
	6-Mar														0
	7-Mar		1	⬛	⬛	⬛	⬛						1		2
	8-Mar												1		1
	9-Mar											1			1
	10-Mar				1										1
	11-Mar														0
	12-Mar	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	0
	13-Mar														0
	14-Mar														0
Average passes per night		0.0	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.1	0.0	0.2	0.2	0.0	0.7

Figure 3. Bat passes per hour at Falls Dam Car park, 25 Feb to 14 Mar.

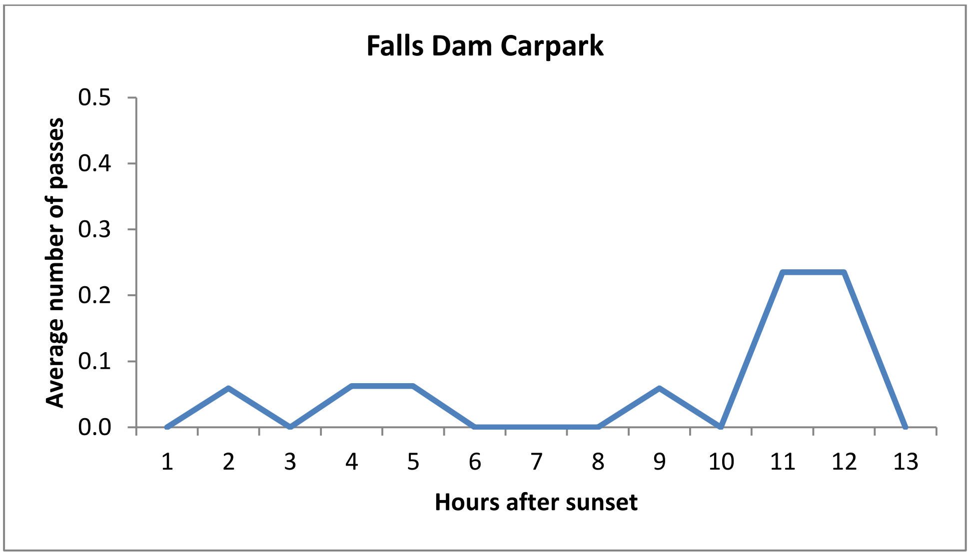
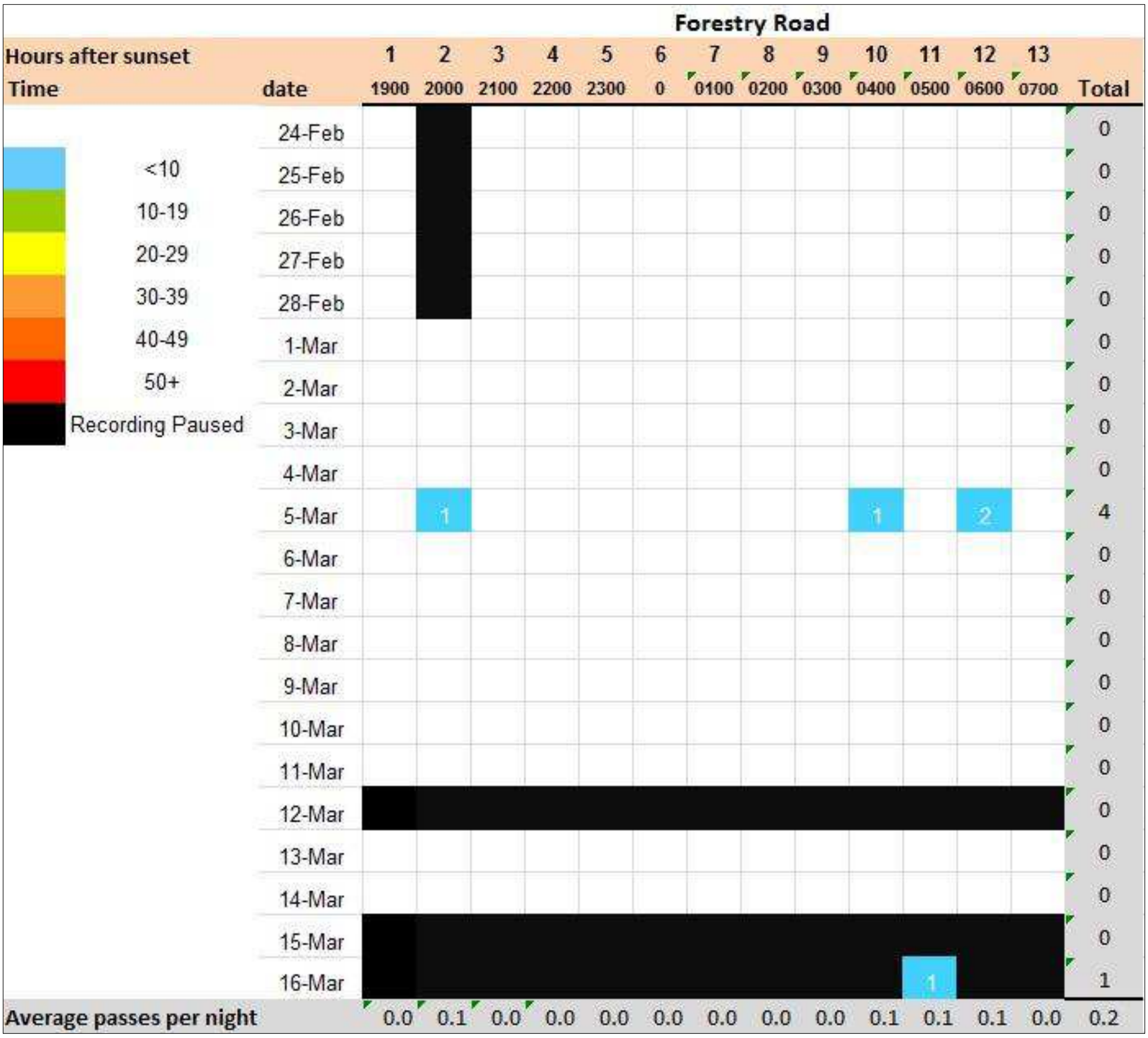


Figure 4. Average number of passes per hour after sunset at Falls Dam Carpark.



Forestry Road

🟦 <10
🟩 10-19
🟨 20-29
🟧 30-39
🟧 40-49
🟥 50+
⬛ Recording Paused

Hours after sunset		1	2	3	4	5	6	7	8	9	10	11	12	13	
Time	date	1900	2000	2100	2200	2300	0	0100	0200	0300	0400	0500	0600	0700	Total
	24-Feb		⬛												0
	25-Feb		⬛												0
	26-Feb		⬛												0
	27-Feb		⬛												0
	28-Feb		⬛												0
	1-Mar														0
	2-Mar														0
	3-Mar														0
	4-Mar														0
	5-Mar		1								1		2		4
	6-Mar														0
	7-Mar														0
	8-Mar														0
	9-Mar														0
	10-Mar														0
	11-Mar														0
	12-Mar	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	0
	13-Mar														0
	14-Mar														0
	15-Mar	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	0
	16-Mar	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	1	⬛	⬛	1
Average passes per night		0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.2

Figure 5. **Bat passes per hour at Forestry Road, 24 Feb to 16 Mar. Note, Cyclone Pam passed through over 15-16 March.**

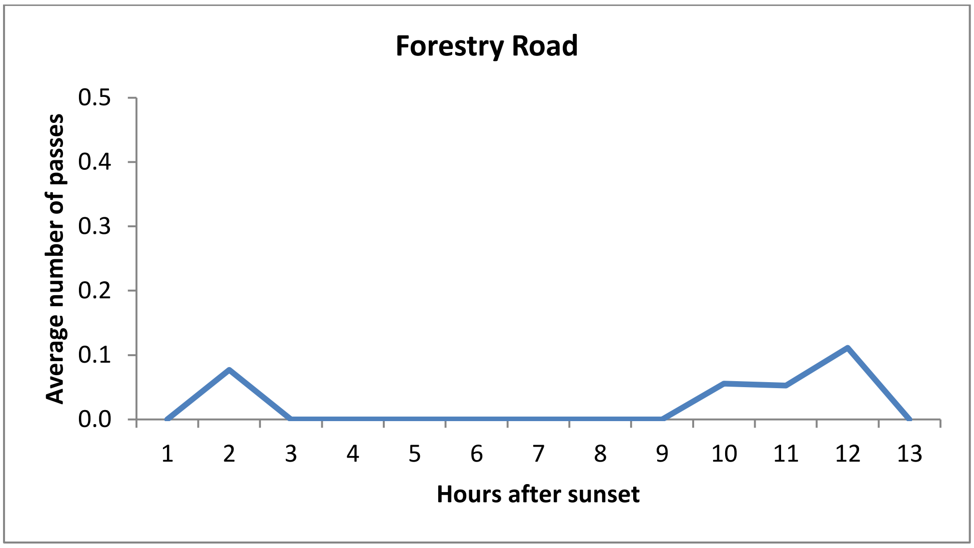
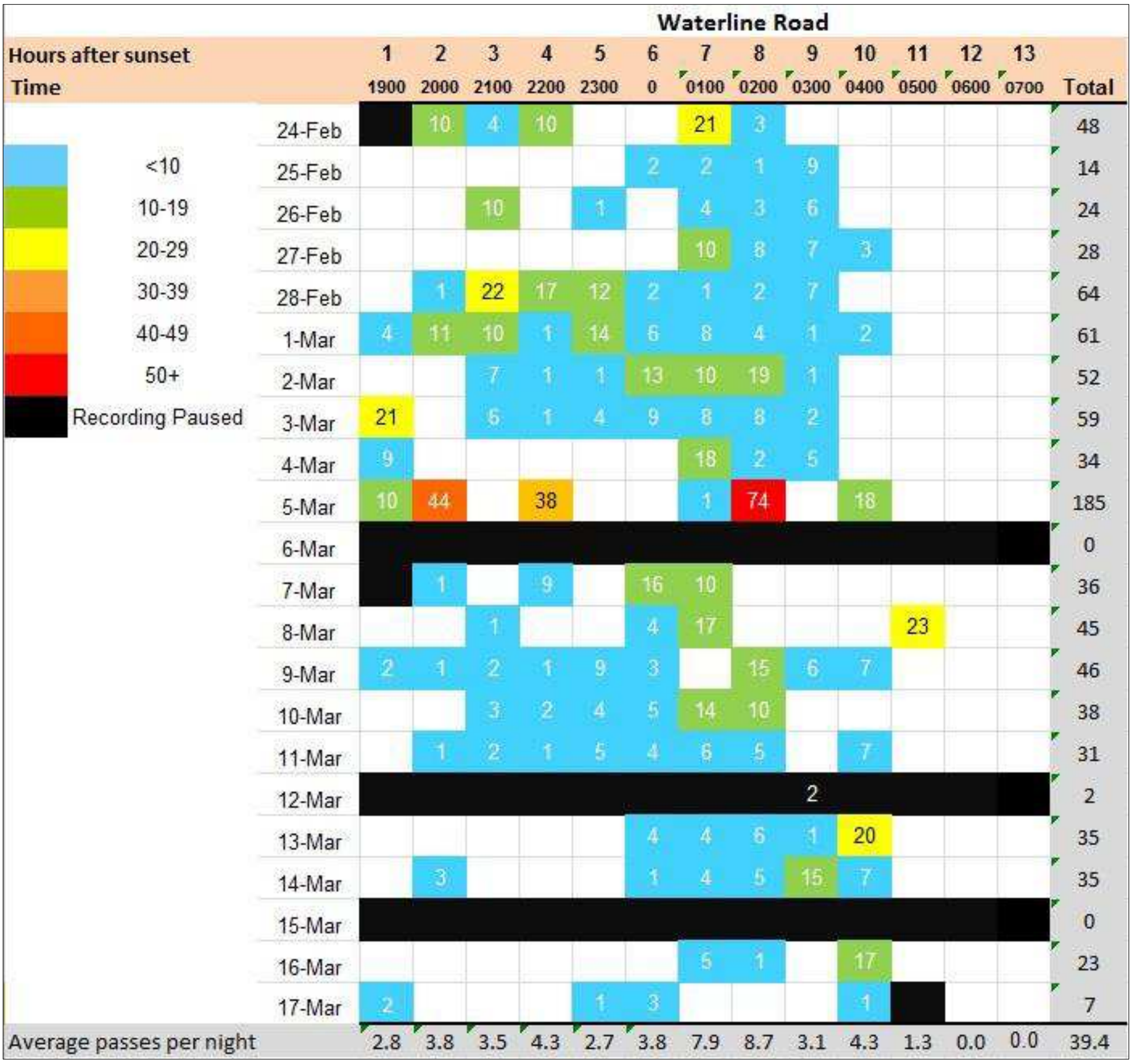


Figure 6. **Average number of passes per hour after sunset at Forestry Road.**



Waterline Road

- 🟦 <10
- 🟩 10-19
- 🟨 20-29
- 🟧 30-39
- 🟧 40-49
- 🟥 50+
- ■ Recording Paused

Hours after sunset	1	2	3	4	5	6	7	8	9	10	11	12	13	
Time	1900	2000	2100	2200	2300	0	0100	0200	0300	0400	0500	0600	0700	Total
24-Feb	■	10	4	10			21	3						48
25-Feb						2	2	1	9					14
26-Feb			10		1		4	3	6					24
27-Feb							10	8	7	3				28
28-Feb		1	22	17	12	2	1	2	7					64
1-Mar	4	11	10	1	14	6	8	4	1	2				61
2-Mar			7	1	1	13	10	19	1					52
3-Mar	21		6	1	4	9	8	8	2					59
4-Mar	9						18	2	5					34
5-Mar	10	44		38			1	74		18				185
6-Mar	■	■	■	■	■	■	■	■	■	■	■	■	■	0
7-Mar	■	1		9		16	10							36
8-Mar			1			4	17				23			45
9-Mar	2	1	2	1	9	3		15	6	7				46
10-Mar			3	2	4	5	14	10						38
11-Mar		1	2	1	5	4	6	5		7				31
12-Mar	■	■	■	■	■	■	■	■	2	■	■	■	■	2
13-Mar						4	4	6	1	20				35
14-Mar		3				1	4	5	15	7				35
15-Mar	■	■	■	■	■	■	■	■	■	■	■	■	■	0
16-Mar							5	1		17				23
17-Mar	2				1	3				1	■			7
Average passes per night	2.8	3.8	3.5	4.3	2.7	3.8	7.9	8.7	3.1	4.3	1.3	0.0	0.0	39.4

Figure 7. Bat passes per hour at Waterline Road, 24 Feb to 17 Mar. Note, Cyclone Pam passed through over 15-16 March.

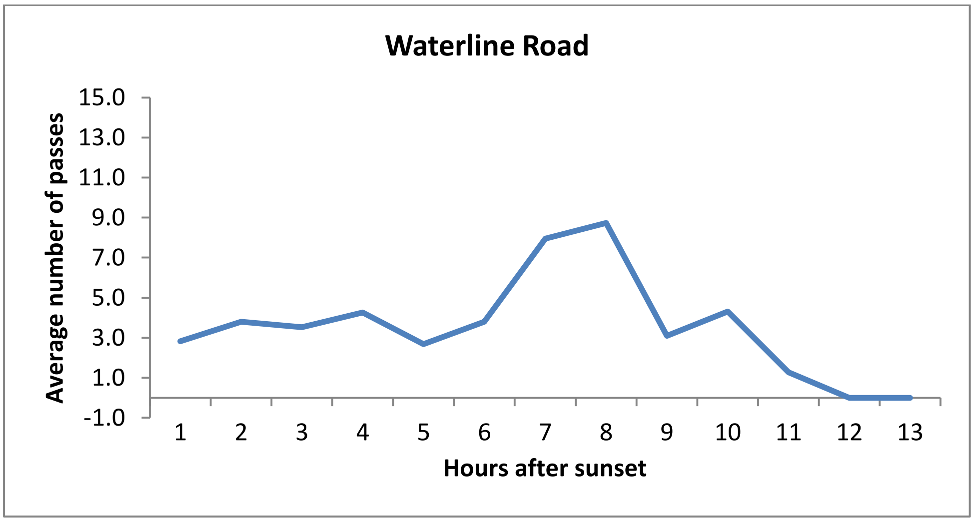
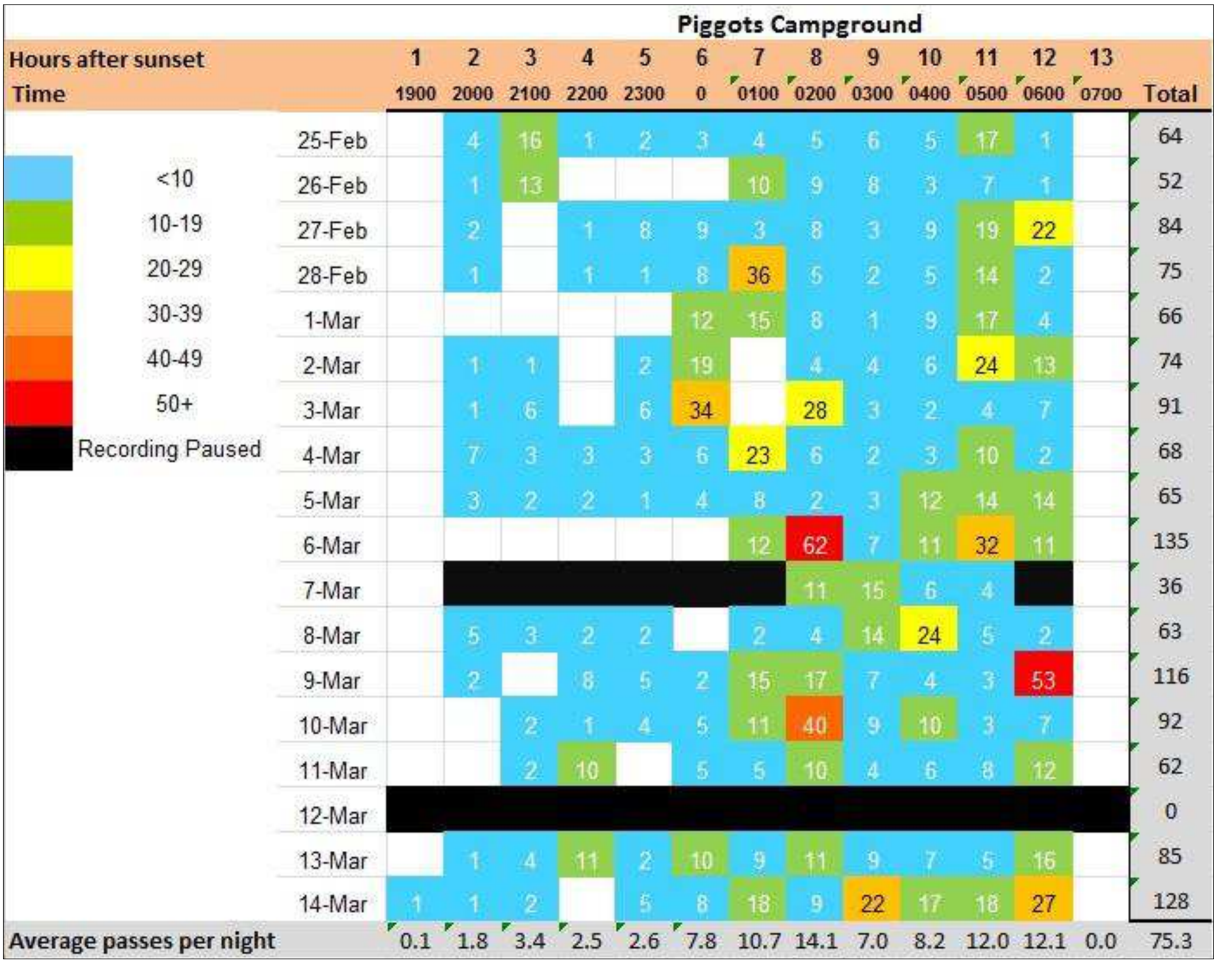


Figure 8. Average number of passes per hour after sunset at Waterline Road.



Piggots Campground

Colour	Bat passes
🟦	<10
🟩	10-19
🟨	20-29
🟧	30-39
🟠	40-49
🟥	50+
⬛	Recording Paused

Hours after sunset	1	2	3	4	5	6	7	8	9	10	11	12	13	
Time	1900	2000	2100	2200	2300	0	0100	0200	0300	0400	0500	0600	0700	Total
25-Feb		4	16	1	2	3	4	5	6	5	17	1		64
26-Feb		1	13				10	9	8	3	7	1		52
27-Feb		2		1	8	9	3	8	3	9	19	22		84
28-Feb		1		1	1	8	36	5	2	5	14	2		75
1-Mar						12	15	8	1	9	17	4		66
2-Mar		1	1		2	19		4	4	6	24	13		74
3-Mar		1	6		6	34		28	3	2	4	7		91
4-Mar		7	3	3	3	6	23	6	2	3	10	2		68
5-Mar		3	2	2	1	4	8	2	3	12	14	14		65
6-Mar							12	62	7	11	32	11		135
7-Mar		⬛	⬛	⬛	⬛	⬛	⬛	11	15	6	4	⬛		36
8-Mar		5	3	2	2		2	4	14	24	5	2		63
9-Mar		2		8	5	2	15	17	7	4	3	53		116
10-Mar			2	1	4	5	11	40	9	10	3	7		92
11-Mar			2	10		5	5	10	4	6	8	12		62
12-Mar	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	0
13-Mar		1	4	11	2	10	9	11	9	7	5	16		85
14-Mar	1	1	2		5	8	18	9	22	17	18	27		128
Average passes per night	0.1	1.8	3.4	2.5	2.6	7.8	10.7	14.1	7.0	8.2	12.0	12.1	0.0	75.3

Figure 9. Bat passes per hour at Piggots Campground, 25 Feb to 14 Mar.

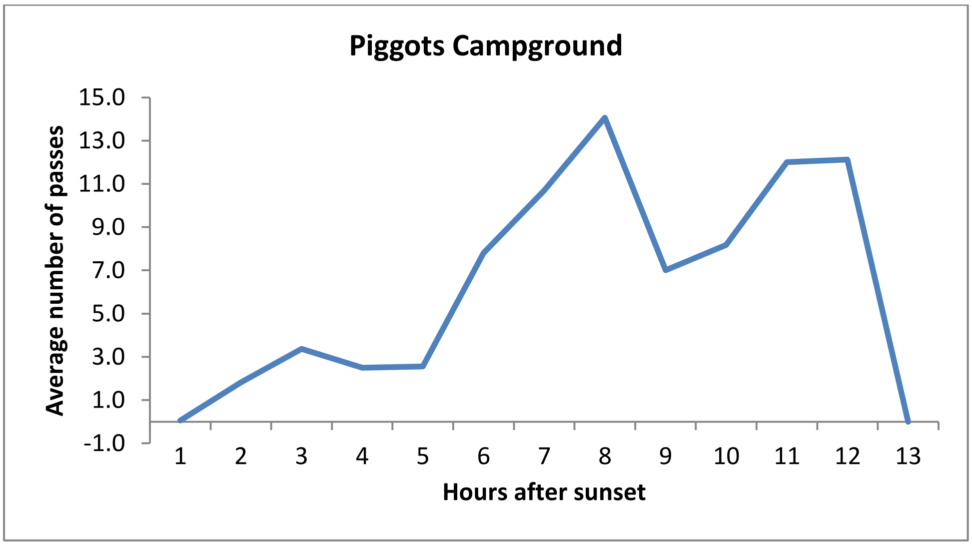
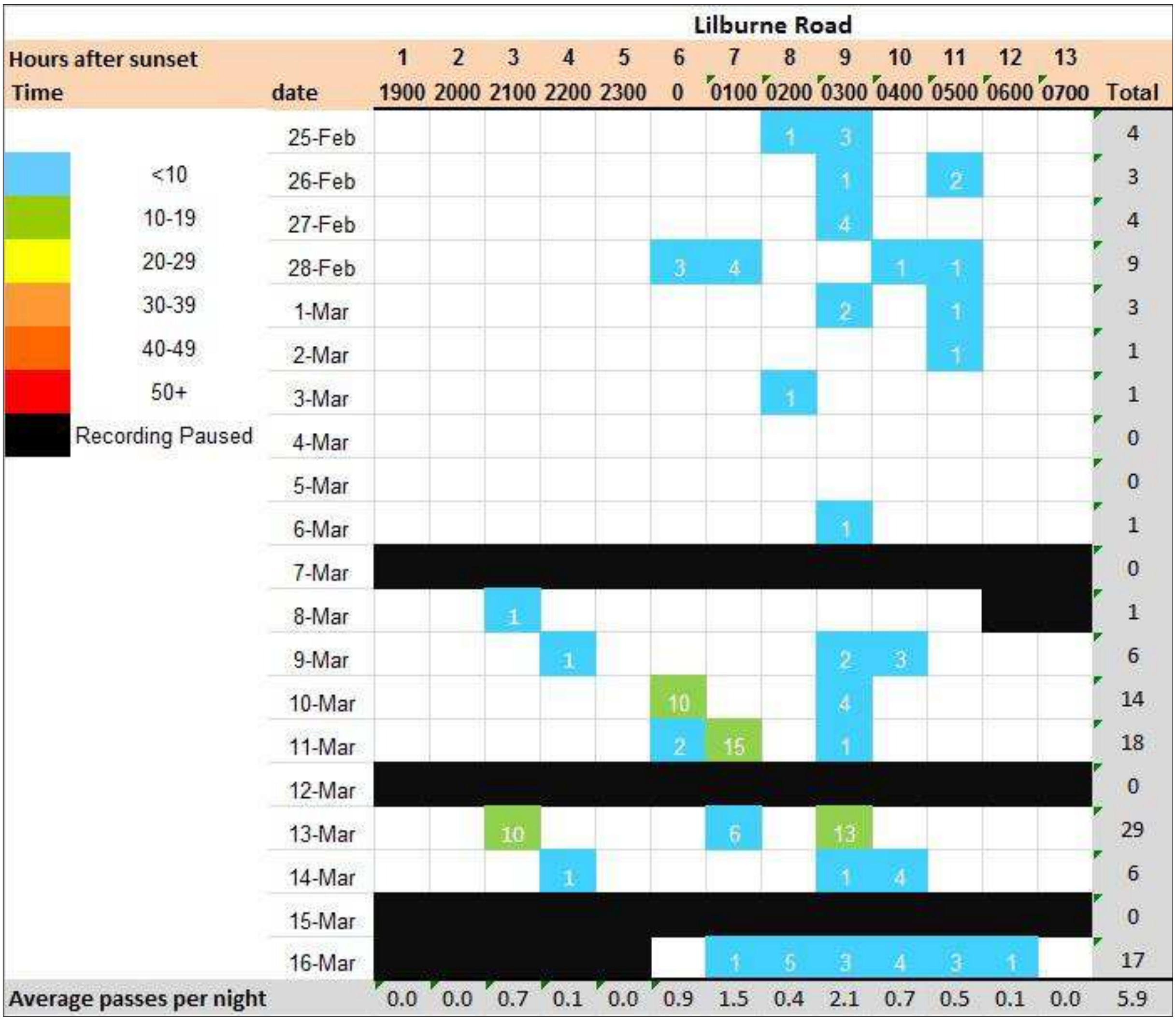


Figure 10. Average number of passes per hour after sunset at Piggots Campground.



Lilburne Road

Hours after sunset		1	2	3	4	5	6	7	8	9	10	11	12	13	
Time	date	1900	2000	2100	2200	2300	0	0100	0200	0300	0400	0500	0600	0700	Total
	25-Feb								1	3					4
🟦 <10	26-Feb									1		2			3
🟩 10-19	27-Feb									4					4
🟨 20-29	28-Feb						3	4			1	1			9
🟧 30-39	1-Mar									2		1			3
🟧 40-49	2-Mar											1			1
🟥 50+	3-Mar								1						1
■ Recording Paused	4-Mar														0
	5-Mar														0
	6-Mar									1					1
	7-Mar	■	■	■	■	■	■	■	■	■	■	■	■	■	0
	8-Mar			1									■	■	1
	9-Mar				1					2	3				6
	10-Mar						10			4					14
	11-Mar						2	15		1					18
	12-Mar	■	■	■	■	■	■	■	■	■	■	■	■	■	0
	13-Mar			10				6		13					29
	14-Mar				1					1	4				6
	15-Mar	■	■	■	■	■	■	■	■	■	■	■	■	■	0
	16-Mar	■	■	■	■	■		1	5	3	4	3	1		17
Average passes per night		0.0	0.0	0.7	0.1	0.0	0.9	1.5	0.4	2.1	0.7	0.5	0.1	0.0	5.9

Figure 11. Bat passes per hour at Lilburne Road, 25 Feb to 16 Mar. Note, Cyclone Pam passed through over 15-16 March.

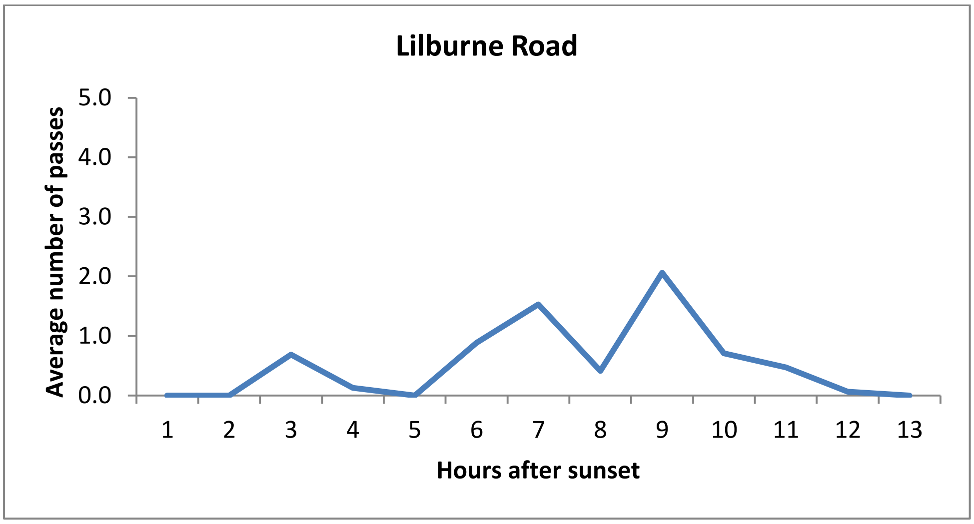
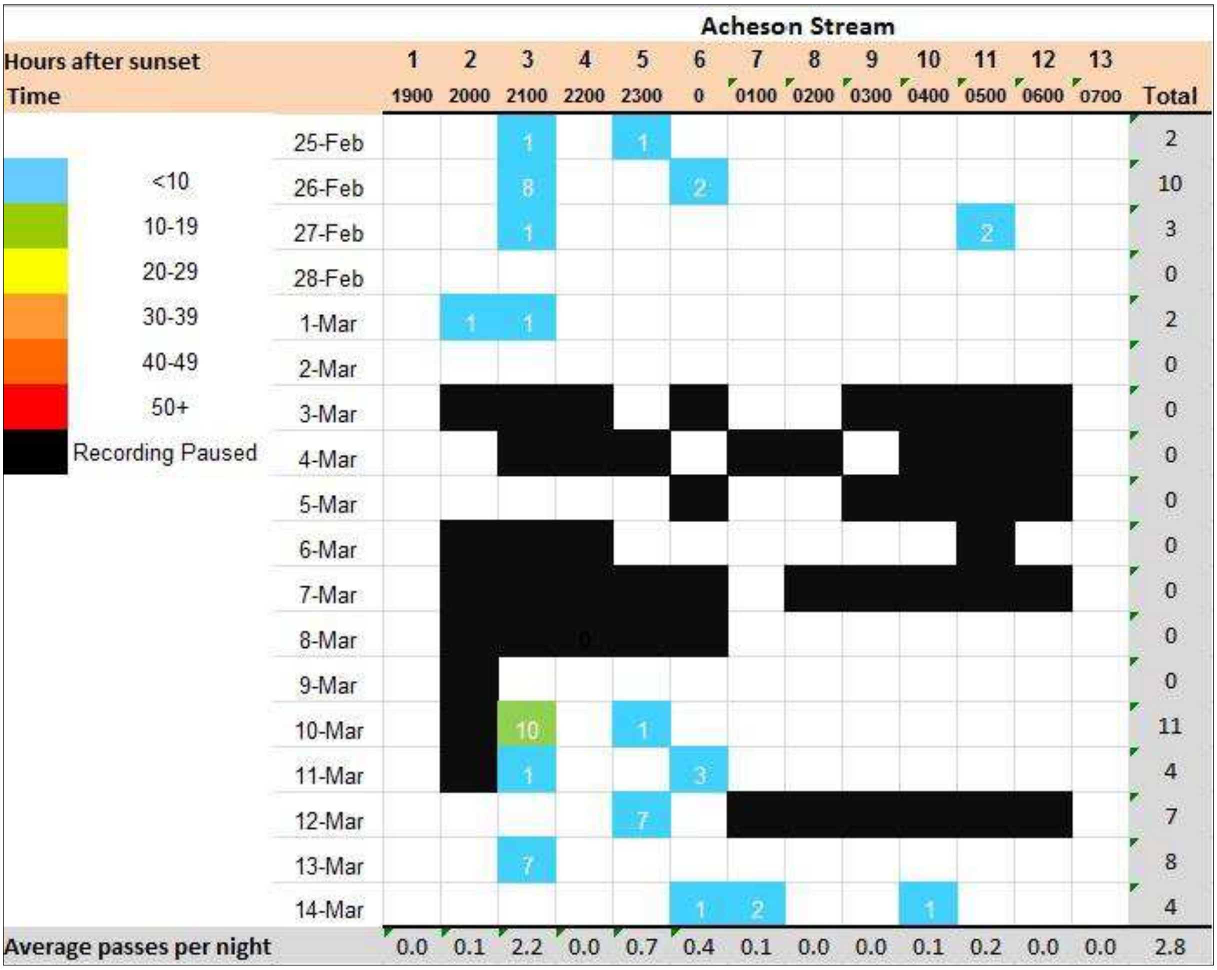


Figure 12. Average number of passes per hour after sunset at Lilburne Road.



Acheson Stream

Hours after sunset		1	2	3	4	5	6	7	8	9	10	11	12	13	
Time		1900	2000	2100	2200	2300	0	0100	0200	0300	0400	0500	0600	0700	Total
	25-Feb			1		1									2
	26-Feb			8			2								10
	27-Feb			1								2			3
	28-Feb														0
	1-Mar		1	1											2
	2-Mar														0
	3-Mar		⬛	⬛	⬛		⬛			⬛	⬛	⬛	⬛		0
	4-Mar			⬛	⬛	⬛		⬛	⬛		⬛	⬛	⬛		0
	5-Mar						⬛			⬛	⬛	⬛	⬛		0
	6-Mar		⬛	⬛	⬛							⬛			0
	7-Mar		⬛	⬛	⬛	⬛	⬛		⬛	⬛	⬛	⬛	⬛		0
	8-Mar		⬛	⬛	⬛	⬛	⬛								0
	9-Mar		⬛												0
	10-Mar		⬛	10		1									11
	11-Mar		⬛	1			3								4
	12-Mar					7		⬛	⬛	⬛	⬛	⬛	⬛		7
	13-Mar			7											8
	14-Mar						1	2			1				4
Average passes per night		0.0	0.1	2.2	0.0	0.7	0.4	0.1	0.0	0.0	0.1	0.2	0.0	0.0	2.8

🟦	<10
🟩	10-19
🟨	20-29
🟧	30-39
🟧	40-49
🟥	50+
⬛	Recording Paused

Figure 13. Bat passes per hour at Acheson Stream, 25 Feb to 14 Mar.

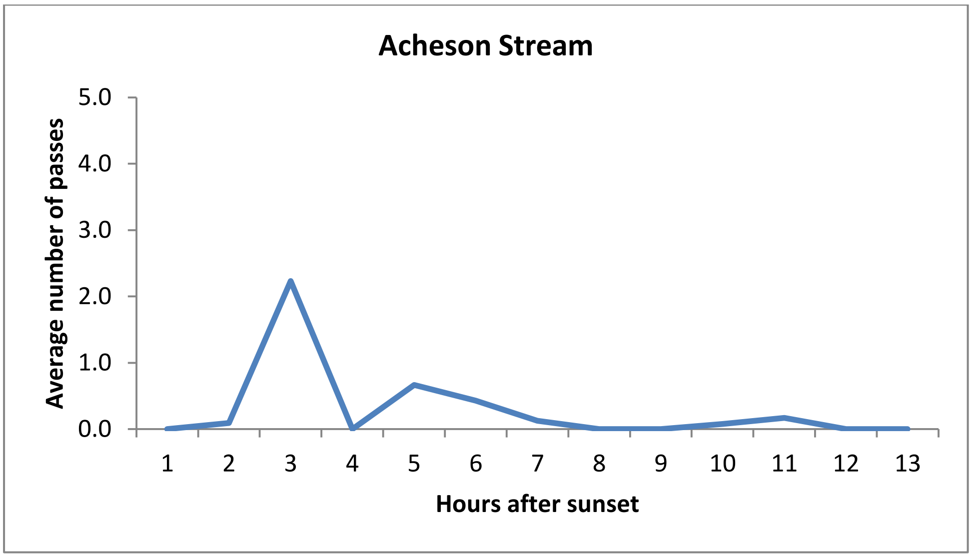
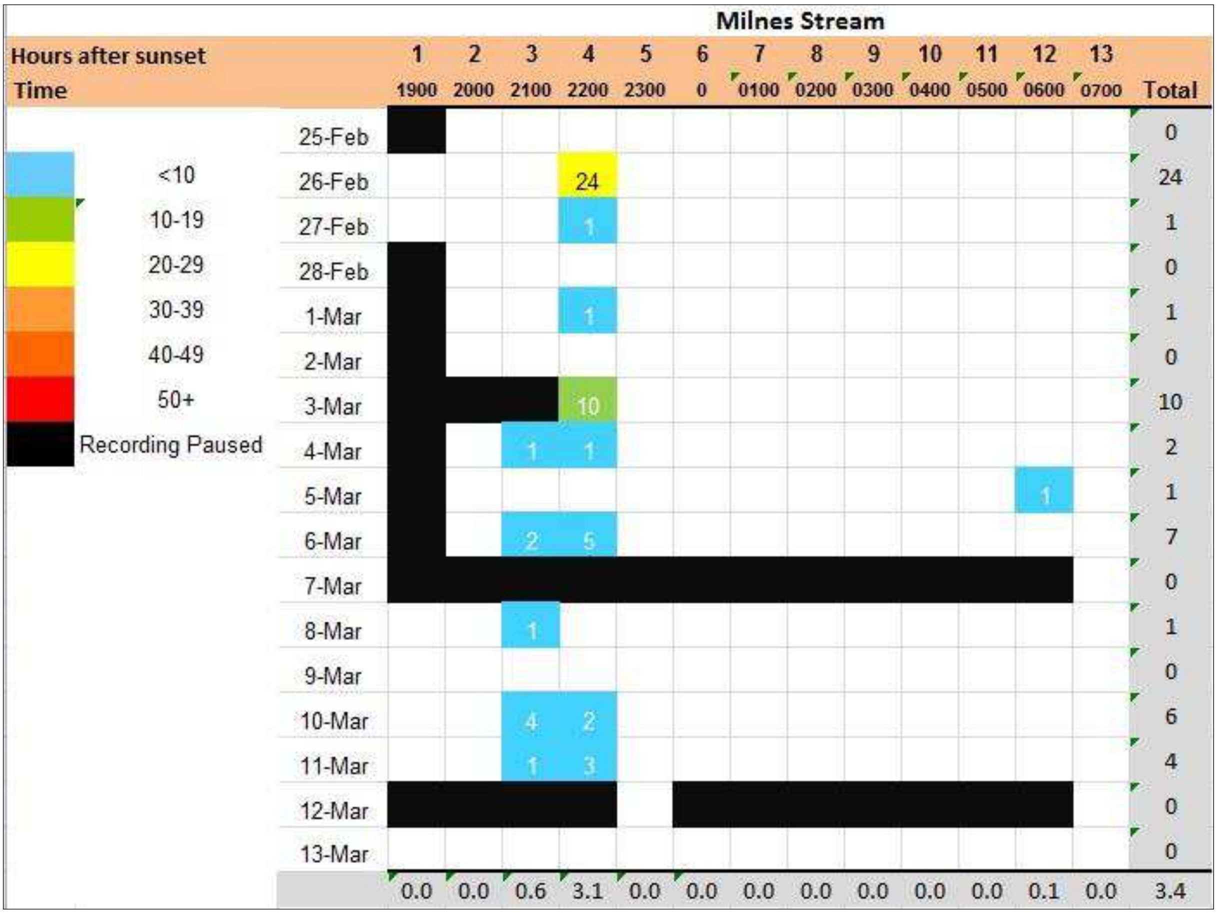


Figure 14. Average number of passes per hour after sunset at Acheson Stream.



Milnes Stream														
Hours after sunset	1	2	3	4	5	6	7	8	9	10	11	12	13	
Time	1900	2000	2100	2200	2300	0	0100	0200	0300	0400	0500	0600	0700	Total
25-Feb	■													0
26-Feb				24										24
27-Feb				1										1
28-Feb	■													0
1-Mar	■			1										1
2-Mar	■													0
3-Mar	■	■	■	10										10
4-Mar	■		1	1										2
5-Mar	■											1		1
6-Mar	■		2	5										7
7-Mar	■	■	■	■	■	■	■	■	■	■	■	■		0
8-Mar			1											1
9-Mar														0
10-Mar			4	2										6
11-Mar			1	3										4
12-Mar	■	■	■	■		■	■	■	■	■	■	■		0
13-Mar														0
	0.0	0.0	0.6	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	3.4

🟦	<10
🟩	10-19
🟨	20-29
🟧	30-39
🟧	40-49
🟥	50+
■	Recording Paused

Figure 15. Bat passes per hour at Milnes Stream, 25 Feb to 13 Mar.

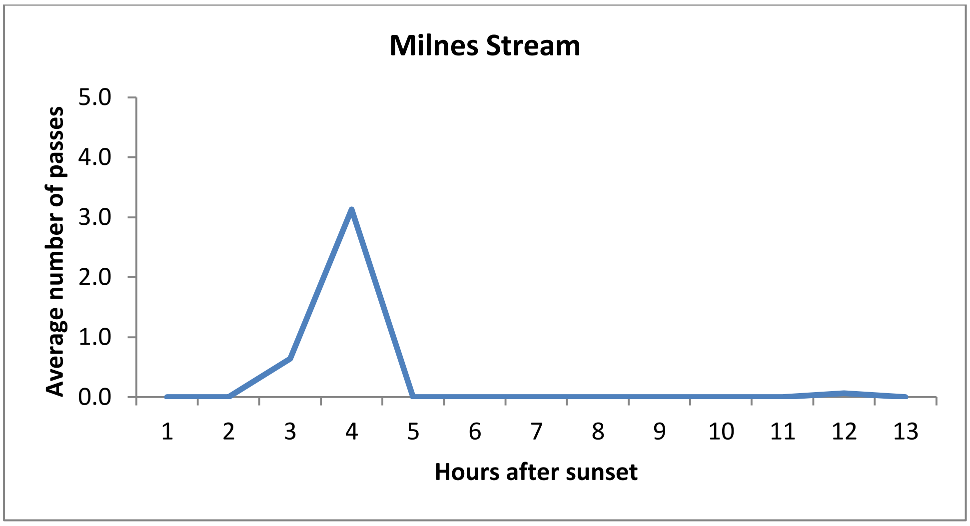
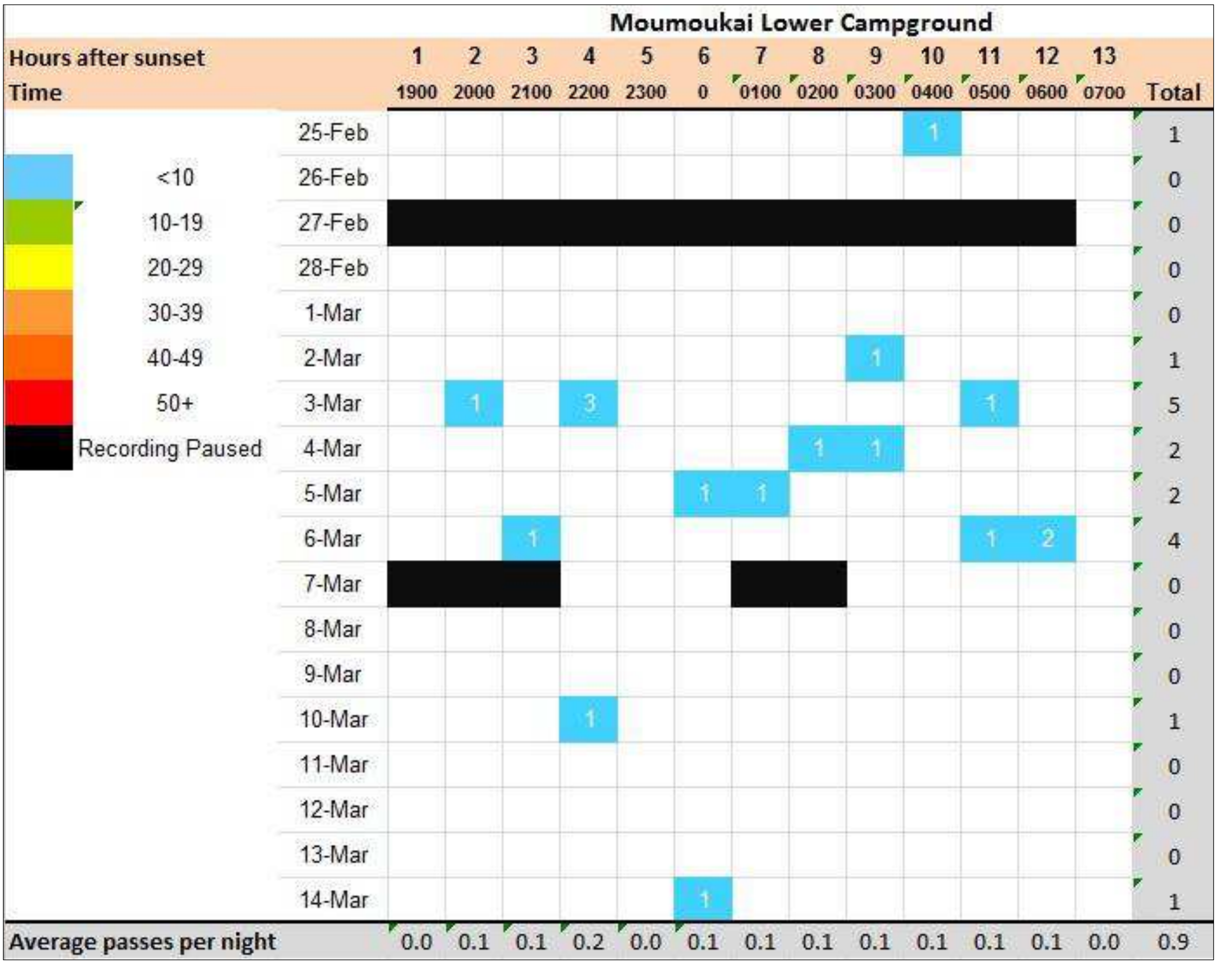


Figure 16. Average number of passes per hour after sunset at Milnes Stream.



Moumoukai Lower Campground

🟦	<10
🟩	10-19
🟨	20-29
🟧	30-39
🟧	40-49
🟥	50+
⬛	Recording Paused

Hours after sunset	1	2	3	4	5	6	7	8	9	10	11	12	13	
Time	1900	2000	2100	2200	2300	0	0100	0200	0300	0400	0500	0600	0700	Total
25-Feb										1				1
26-Feb														0
27-Feb	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛		0
28-Feb														0
1-Mar														0
2-Mar									1					1
3-Mar		1		3							1			5
4-Mar								1	1					2
5-Mar						1	1							2
6-Mar			1								1	2		4
7-Mar	⬛	⬛	⬛				⬛	⬛						0
8-Mar														0
9-Mar														0
10-Mar				1										1
11-Mar														0
12-Mar														0
13-Mar														0
14-Mar						1								1
Average passes per night	0.0	0.1	0.1	0.2	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.9

Figure 17. Bat passes per hour at Moumoukai Campground, 25 Feb to 14 Mar.

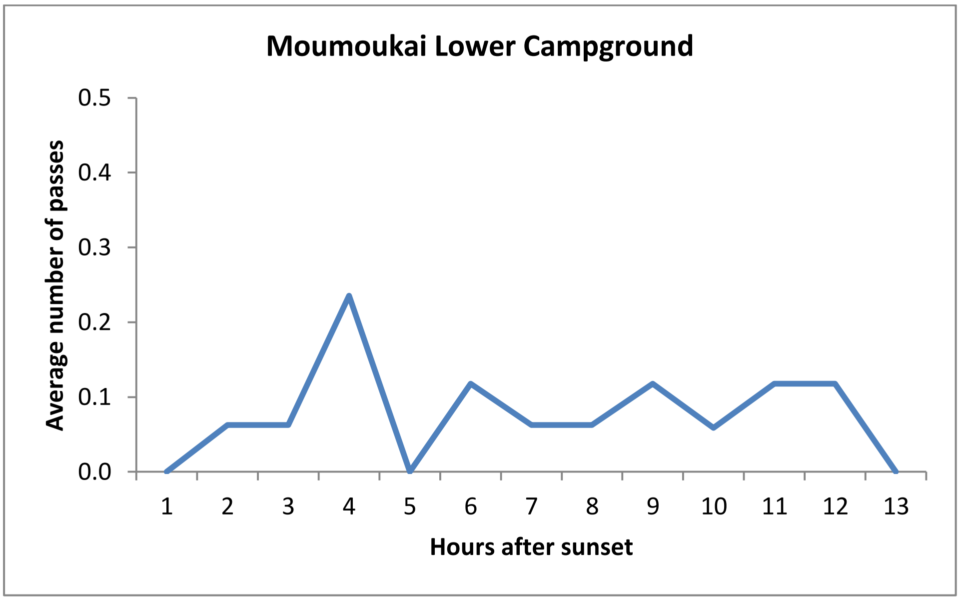
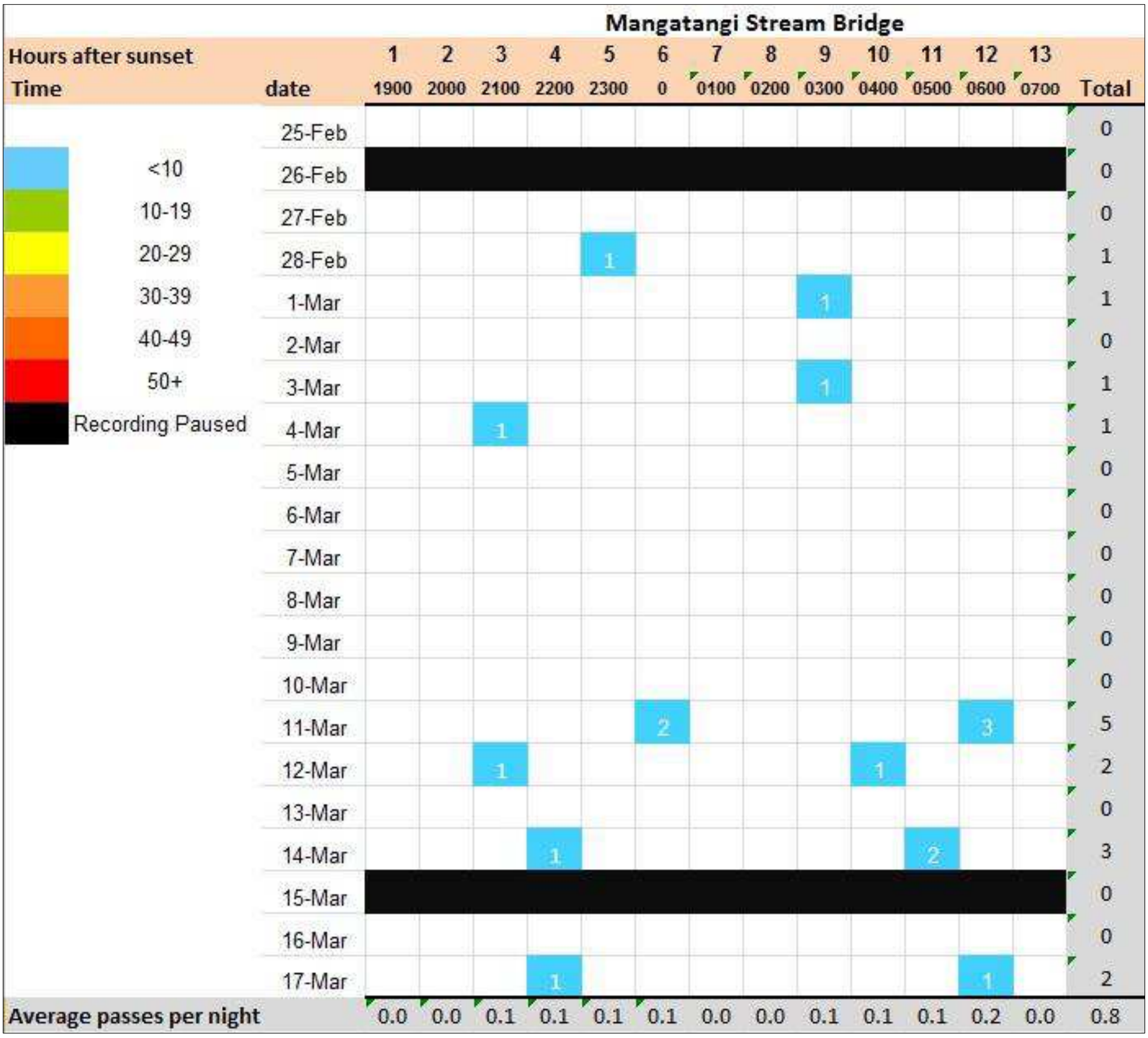


Figure 18. Average number of passes per hour after sunset at Moumoukai Campground.



Mangatangi Stream Bridge

🟦 <10
🟩 10-19
🟨 20-29
🟧 30-39
🟧 40-49
🟥 50+
⬛ Recording Paused

Hours after sunset		1	2	3	4	5	6	7	8	9	10	11	12	13	
Time	date	1900	2000	2100	2200	2300	0	0100	0200	0300	0400	0500	0600	0700	Total
	25-Feb														0
	26-Feb	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	0
	27-Feb														0
	28-Feb					1									1
	1-Mar									1					1
	2-Mar														0
	3-Mar									1					1
	4-Mar			1											1
	5-Mar														0
	6-Mar														0
	7-Mar														0
	8-Mar														0
	9-Mar														0
	10-Mar														0
	11-Mar						2						3		5
	12-Mar			1							1				2
	13-Mar														0
	14-Mar				1							2			3
	15-Mar	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	0
	16-Mar														0
	17-Mar				1								1		2
Average passes per night		0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.1	0.2	0.0	0.8

Figure 19. **Bat passes per hour at Mangatangi Stream Bridge, 25 Feb to 17 Mar. Note, Cyclone Pam passed through over 15-16 March.**

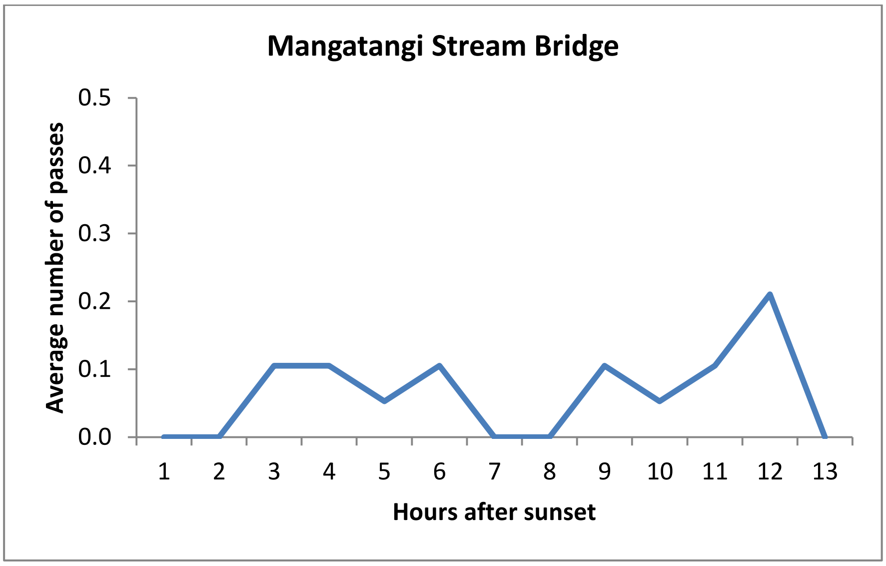


Figure 20. **Average number of passes per hour after sunset at Mangatangi Stream Bridge.**

Appendix II. Locations of ABMs in 2015.

Figure 21. **Location of Falls Dam Carpark ABM.**

Figure 22. **Location of Forestry Road ABM.**

Figure 23. **Location of Wairoa Hill Road ABM.**

Figure 24. **Location of Waterline Road ABM.**

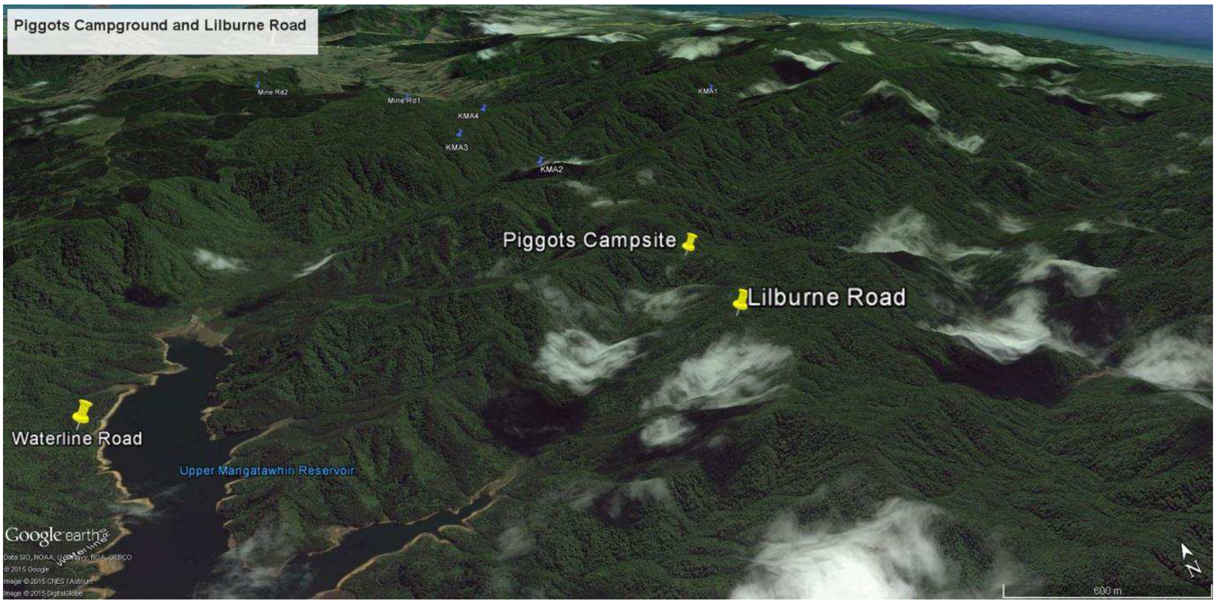


Figure 25. **Location of Piggots Campground and Lilburne Road ABMs.**

Figure 26. **Location of Acheson and Milnes Streams ABMs.**

Figure 27. Location of Moumoukai Lower Campground ABM.

Figure 28. Location of Mangatangi Stream Bridge ABM.

Figure 29. **Location of Lyons Road ABM.**

Attachment 7-2 - 15197 Hunua bat REPORT 2016

AUCKLAND COUNCIL

LONG-TAILED BAT SURVEYS
IN THE HUNUA RANGES
2016

www.bioresearches.co.nz

BIORESEARCHES

Consulting Biologists - Established 1972

Auckland Council

Long-tailed Bat Surveys in the Hunua Ranges 2016

May 2016

FOR: Auckland Council

BY: BIORESEARCHES GROUP LIMITED

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EXECUTIVE SUMMARY

A long-tailed bat (LTB) survey was undertaken within the Hunua Ranges at 11 fixed locations using Automatic Bat Monitoring (ABM) detectors. The locations were a post-1080 application repeat of a 2015 survey undertaken by Bioresearches Group.

This study recorded LTBs at all ABMs throughout the Hunua Ranges. Most ABMs recorded a few single passes which occurred intermittently throughout the survey period. The highest number of bat passes were recorded at Piggots Campground (51.2 passes per night), Waterline Road (44.3 passes per night) and Lilburne Road (20.7 passes per night). These ABMs recorded high numbers of passes periodically, suggesting that large groups of bats were passing at a time.

LTB activity in 2016 was generally consistent with 2015. Patterns of activity generally remained the same across all sites, with most sites recording activity peaks at similar times in 2016 to 2015. Activity peaks were more pronounced in 2016 at Falls Dam Carpark, Forestry Road, Lilburne Road, Moumoukai Lower Campground and Mangatangi Stream Bridge, though overall activity in 2016 was slightly lower at Piggots Campground and Waterline Road.

1 INTRODUCTION

The long-tailed bat (LTB; *Chalinolobus tuberculatus*) is one of two bat species in New Zealand and is classified as 'Nationally Vulnerable' in the North Island (O'Donnell et al. 2012). This classification is given the qualifier "Data Poor" which indicates that there is low confidence in the rating due to poor data available on the species populations and distribution (Townsend et al. 2008). Within the Auckland Region, records from the Waitākere Ranges, Dome Valley and the Hunua Ranges represent the better known populations.

A 2015 survey of the Hunua Ranges (Bioresearches 2015), undertaken prior to a 1080 application to manage pest mammals in the Hunua Ranges, found that LTB activity was variable and recorded across most sites surveyed. However, regular activity, including periods of high activity (>30 passes per hour) was recorded at Piggots Campground and Waterline Roads only.

The current survey was a repeat of that undertaken in 2015, with recorders placed at the same locations. The data collected is intended to be comparable with that obtained in 2015.

1.1 Long-tailed bat habitat requirements

LTBs require large trees (including standing dead trees) with cavities (e.g. deep knot holes), epiphytes or loose bark for roosting, and typically use linear landscape features such as bush edges, gullies, watercourses and roadways to transit between roosting and feeding sites (Borkin and Parsons 2009; Griffiths 1996).

They tend to forage in open areas, including clearings (Borkin and Parsons 2009; Griffiths 1996), wetlands, open water and along rivers and roadways (Borkin and Parsons 2009; Griffiths 1996).

Long-tailed bats are highly mobile, regularly change roost sites (Griffiths 1996) and can fly at 60 km/hr over very large home ranges (up to 5629 ha; O'Donnell 2001). LTB activity is significantly reduced in winter, though usually does not cease completely.

1.2 Survey aims

The survey reported here is a repeat of a 2015 survey that was undertaken pre-application of sodium fluoroacetate (1080). The data collected in the current survey aimed to compare activity levels at the same locations post and pre-application in the Hunua Ranges Regional Park.

2 METHODS

2.1 Automatic Bat Monitoring (ABM) detectors

Automatic Bat Monitoring (ABM) detectors were used to record ultrasonic echolocation calls emitted by bats. The ABM converts these calls to frequencies that are audible to humans (Parsons & Szewczak, 2009).

An ABM is comprised of two ultrasound sensors and microphones, a sound-activated recording device, a timer to turn the system on and off each day, and a rain-noise detector that turns the system off in the event of persistent rainfall. ABMs record and store data passively and remotely, and have the capacity to record both long-tailed (40 kHz) and lesser short-tailed (28 kHz) bat calls. The ABMs were set to begin recording 30 minutes before sunset and turn off 30 minutes after sunrise, during February and March 2016.

2.2 Survey Sites

Eleven (11) ABMs were set at fixed locations (Figure 1) alongside roadways, wetlands, watercourses and other forest edges. The sites selected were a repeat of those surveyed in 2015.

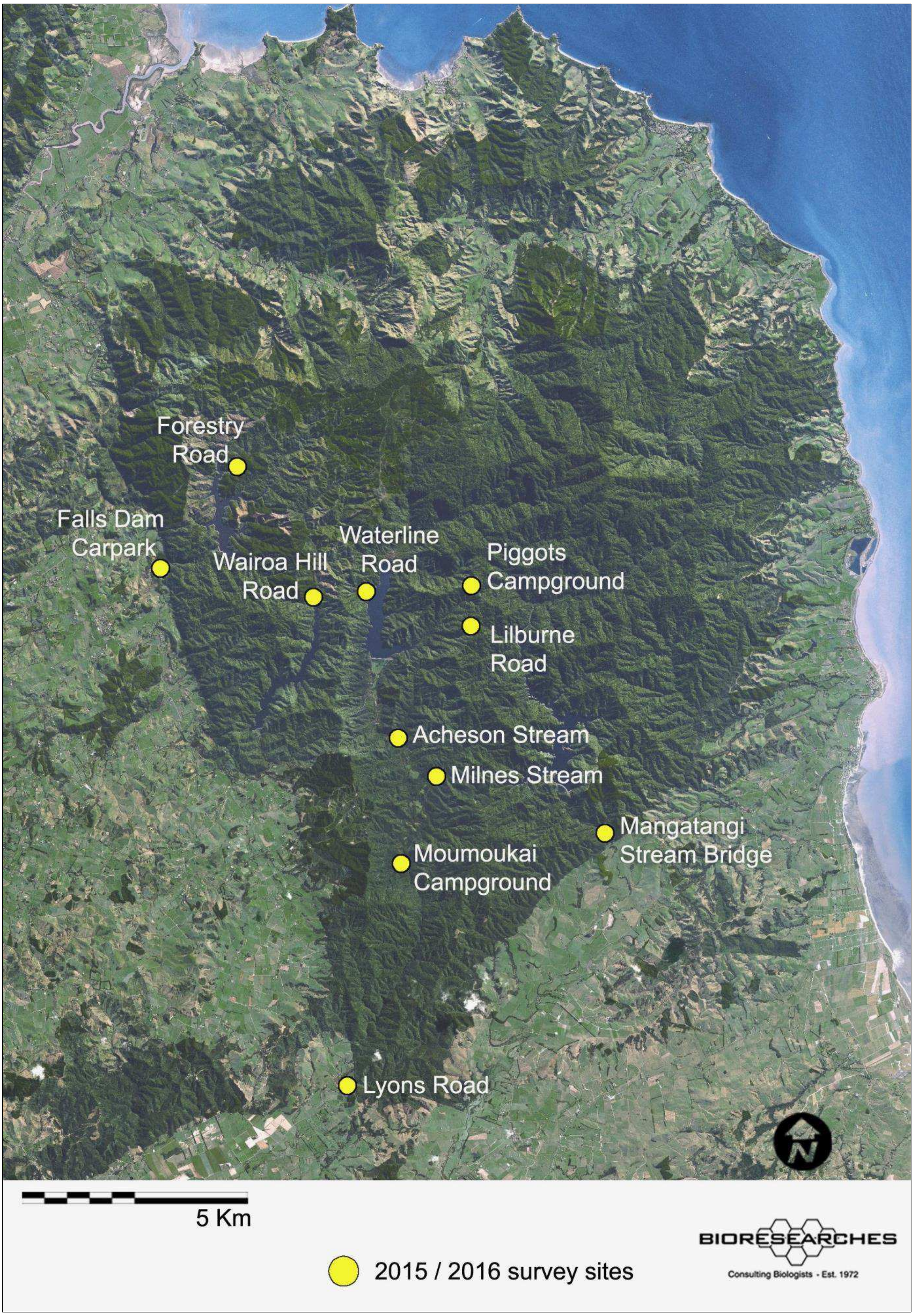

Figure 1. **Location of 11 ABMs set in 2015 and 2016.**

2.3 Data analysis

ABM data were downloaded and the waveforms analysed using Bat Box 1.0 software (Department of Conservation, 2008). The total number of 'usable nights' (UNs) was determined using climate data (CliFlo, New Zealand's National Climate Database, NIWA) and recording analyses (e.g. when the recorder log indicated a noise switch- pause for a period of more than half the night). Nights were considered 'useable' if the temperature remained above 5°C and more than half the night was free of rain or insect noise. Up to 10 UNs were analysed for bat activity at each location.

Each echolocation pass was time (hour/minute/second) and date (year/month/day) stamped providing timing information for activity. This information was tabulated and provided as Appendix I.

Each bat pass was further distinguished as one of two echolocation categories:

1. 'bat pass' (i.e. short pulse(s) at low repetition rates, indicating a bat using its echolocation to navigate as it flies by the recorder [mean inter-pulse interval of c. 104 ms]);
2. 'feeding buzz' (i.e. series of pulses emitted rapidly over a short duration [mean inter-pulse durations of 4.5 ms], indicating the pursuit of prey) (Parsons *et al.* 1997).

A distinction was made between passes and feeding buzzes to distinguish areas that may be important for foraging. High proportions of feeding buzzes may indicate areas of greater significance for LTBs given their high energy demands.

3 RESULTS AND DISCUSSION

All 11 ABMs recorded UNs and bat passes were recorded at all of these locations. The ABM at Lyons road only recorded eight UNs rather than the target of 10 and only recorded one bat pass. Most other ABMs recorded a few single passes, which occurred intermittently throughout the survey period.

The highest number of bat passes were recorded at Piggots Campground (51.2 passes per night), Waterline Road (44.3 passes per night) and Lilburne Road (20.7 passes per night). These ABMs recorded high numbers of passes periodically, suggesting that a colony or colonies of bats were passing at a time. For example, from 124 passes recorded at Waterline Road on 1 March, 52 passes occurred between midnight and 0200, and a further 27 passes were recorded between 0400 and 0500 the same night.

Table 1. Summary of ABM recordings from the Hunua Ranges from 16 February 2016

ABM	Site	Date set	Useable nights	Total passes	Nights with passes	Average passes per night	Maximum passes recorded on a night	Total feeding buzzes	Nights with feeding buzzes	Proportion of feeding buzzes (%)
1	Falls Carpark	16-Feb	10	12	5	1.2	4	2	1	17
2	Forestry Road	16-Feb	10	9	2	0.9	8	0	0	0
3	Wairoa Hill Road	16-Feb	10	52	9	5.2	31	13	5	25
4	Waterline Road	16-Feb	10	443	10	44.3	124	212	9	48
5	Piggots Campground	16-Feb	10	512	10	51.2	112	96	10	19
6	Lilburne Road	16-Feb	10	207	9	20.7	56	16	8	8
7	Acheson Stream	16-Feb	10	7	3	0.7	4	0	0	0
8	Milnes Stream	16-Feb	10	11	5	1.1	6	2	1	18
9	Moumoukai Campground	16-Feb	10	13	5	1.3	5	5	3	38
10	Mangatangi Stream Bridge	16-Feb	10	55	9	5.5	10	16	8	29
11	Lyons Road	16-Feb	8	1	1	0.1	1	0	0	0

Most ABMs recorded passes throughout the night, though some locations had stronger patterns of activity. Acheson Stream recorded most passes between 2100 and midnight while Milnes Stream recorded passes on multiple nights between 2100 and 2200 and then again at 0500 and 0600 the following morning. Single passes at Piggots Campround and

Lilburne Road were recorded throughout most nights; however multiple recordings of 10+ passes were typically logged after 0100.

Feeding buzzes were identified at most sites that recorded bats. However, high proportions of feeding buzzes were recorded at Waterline Road (48%); Moumoukai Campground (38%); Mangatangi Stream Bridge (29%) and Wairoa Hill Road (25%).

3.1 Summary of Comparisons between 2015 & 2016

LTB activity in 2016 was generally consistent with 2015. Refer to Appendix I for comparative graphs.

In 2016, slightly higher activity was recorded at Forestry Road, Lilburne Road and Mangatangi Stream Bridge. Further, a single pass was recorded at Lyon Road, where passes were not recorded in 2015.

Slightly lower activity was recorded at Waterline Road and Piggots Campground, though much of this was due to fewer and smaller clusters of passes at both sites.

Patterns of activity generally remained the same across all sites, with most sites recording activity peaks at similar times in 2016 to 2015. Clusters of passes in 2016 produced additional activity peaks at Forestry Road (one period recording 19 passes)\. Activity peaks were more pronounced in 2016 at Falls Dam Carpark, Forestry Road, Lilburne Road, Moumoukai Lower Campground and Mangatangi Stream Bridge.

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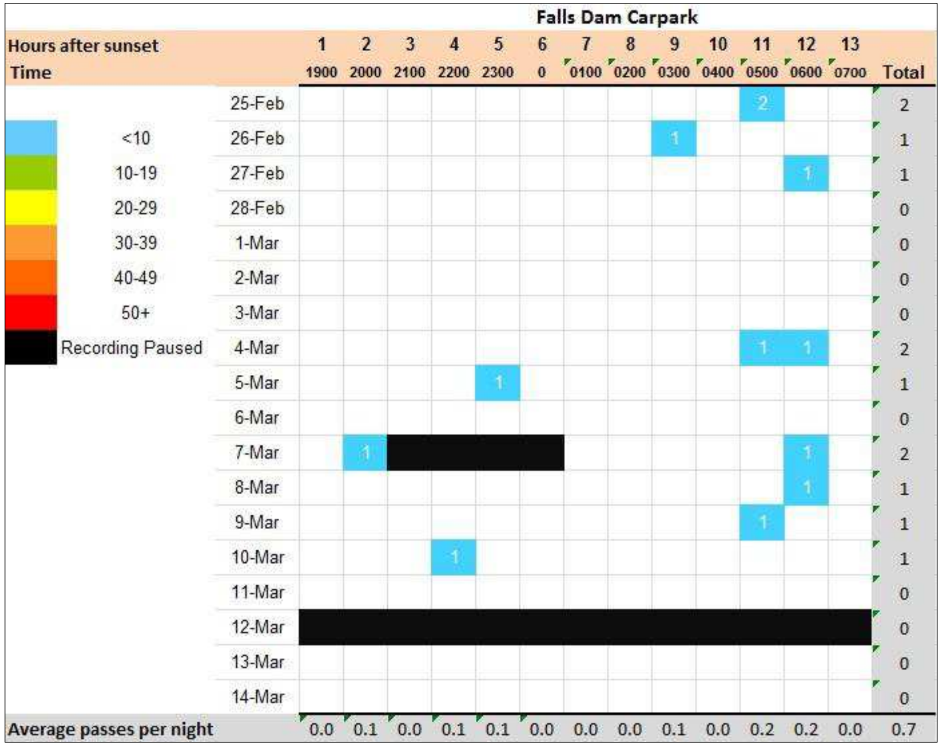
BGL REF: CD\15197 HUNUA REPORT

5 APPENDIX I:

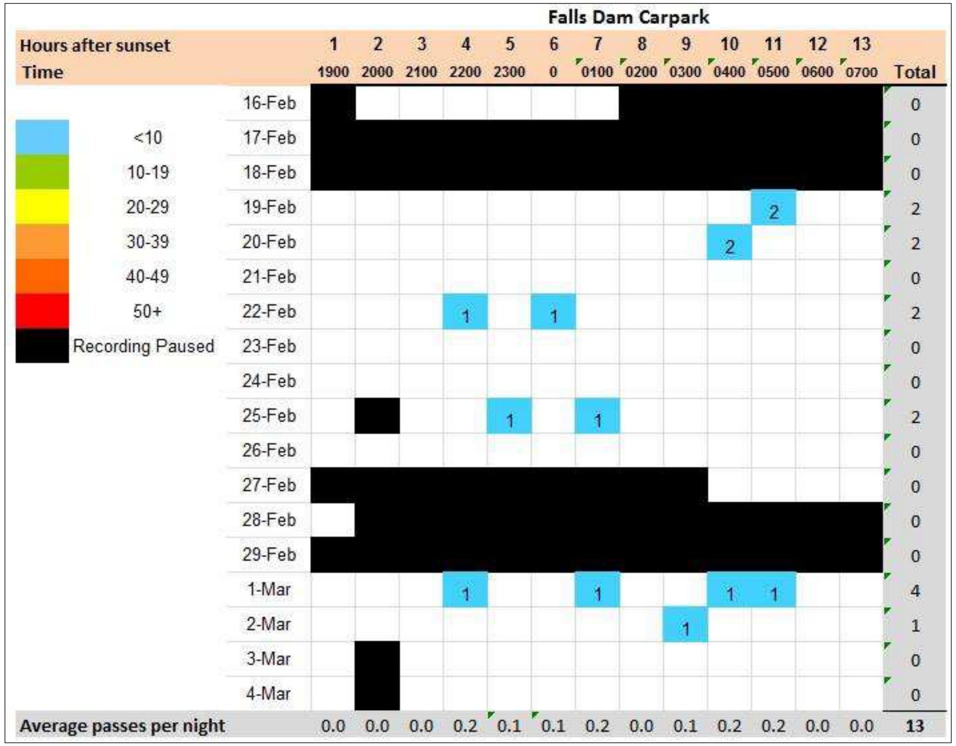
Long-tailed bat activity in 2015 / 2016.



Falls Dam Carpark

Hours after sunset	1	2	3	4	5	6	7	8	9	10	11	12	13	
Time	1900	2000	2100	2200	2300	0	0100	0200	0300	0400	0500	0600	0700	Total
25-Feb											2			2
26-Feb									1					1
27-Feb												1		1
28-Feb														0
1-Mar														0
2-Mar														0
3-Mar														0
4-Mar											1	1		2
5-Mar					1									1
6-Mar														0
7-Mar		1	■	■	■	■						1		2
8-Mar												1		1
9-Mar											1			1
10-Mar				1										1
11-Mar														0
12-Mar	■	■	■	■	■	■	■	■	■	■	■	■	■	0
13-Mar														0
14-Mar														0
Average passes per night	0.0	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.1	0.0	0.2	0.2	0.0	0.7

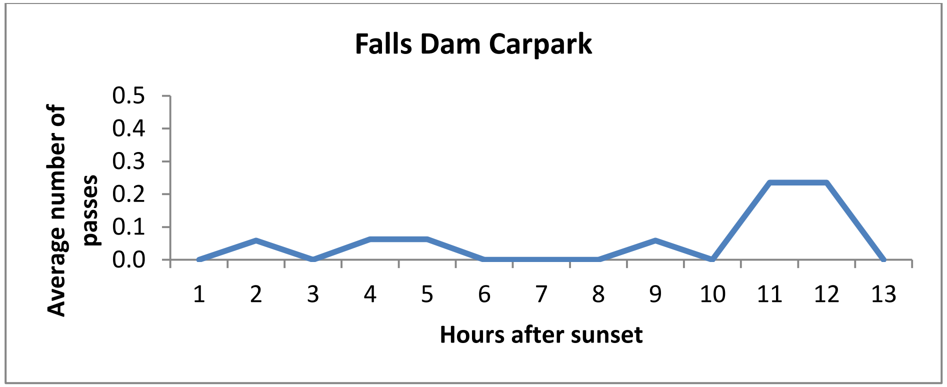
🟦	<10
🟩	10-19
🟨	20-29
🟧	30-39
🟧	40-49
🟥	50+
■	Recording Paused



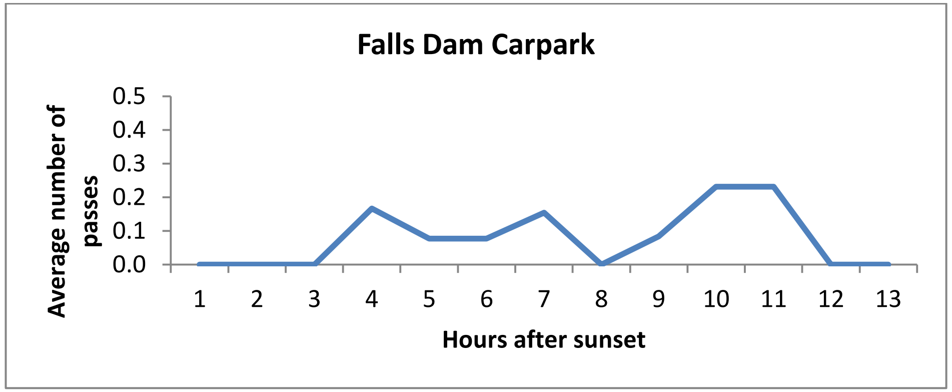
Falls Dam Carpark

Hours after sunset	1	2	3	4	5	6	7	8	9	10	11	12	13	
Time	1900	2000	2100	2200	2300	0	0100	0200	0300	0400	0500	0600	0700	Total
16-Feb	■							■	■	■	■	■	■	0
17-Feb	■	■	■	■	■	■	■	■	■	■	■	■	■	0
18-Feb	■	■	■	■	■	■	■	■	■	■	■	■	■	0
19-Feb											2			2
20-Feb										2				2
21-Feb														0
22-Feb				1		1								2
23-Feb														0
24-Feb														0
25-Feb		■			1		1							2
26-Feb														0
27-Feb	■	■	■	■	■	■	■	■	■					0
28-Feb		■	■	■	■	■	■	■	■	■	■	■	■	0
29-Feb	■	■	■	■	■	■	■	■	■	■	■	■	■	0
1-Mar				1			1			1	1			4
2-Mar									1					1
3-Mar		■												0
4-Mar		■												0
Average passes per night	0.0	0.0	0.0	0.2	0.1	0.1	0.2	0.0	0.1	0.2	0.2	0.0	0.0	13

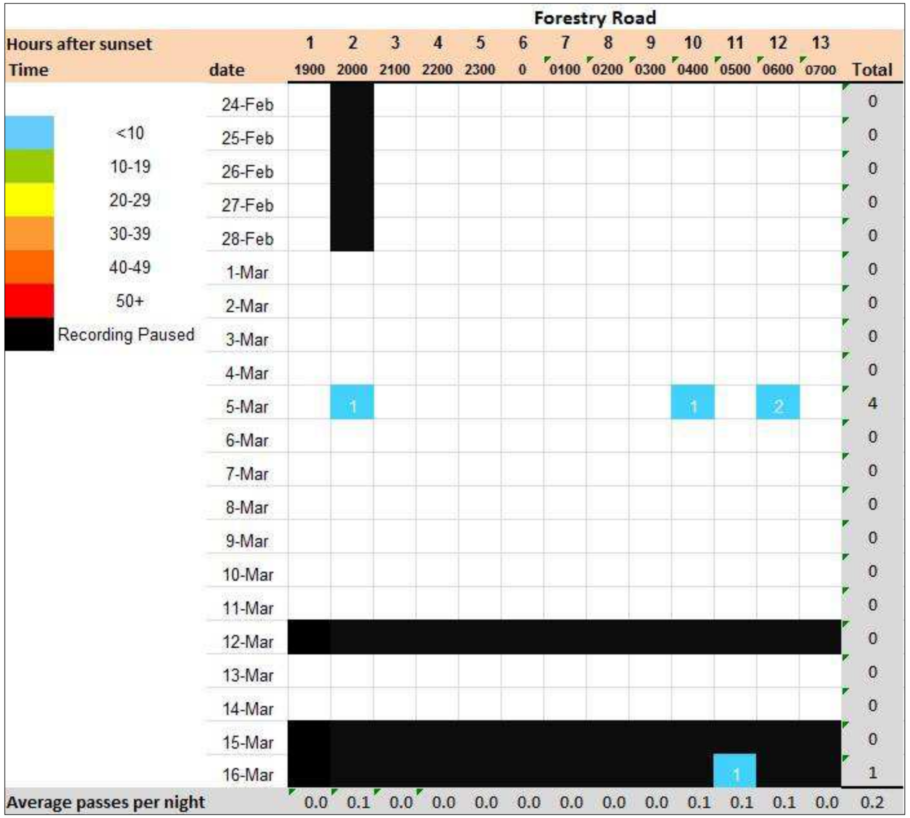
🟦	<10
🟩	10-19
🟨	20-29
🟧	30-39
🟧	40-49
🟥	50+
■	Recording Paused



Long tailed bat activity at Falls Dam, 2015

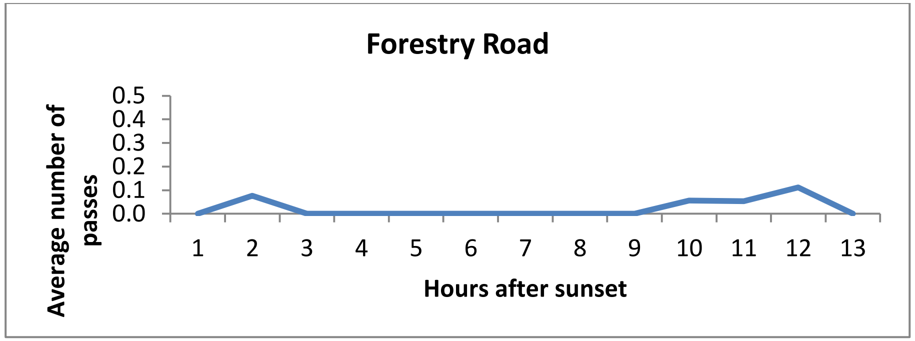


Long tailed bat activity at Falls Dam, 2016

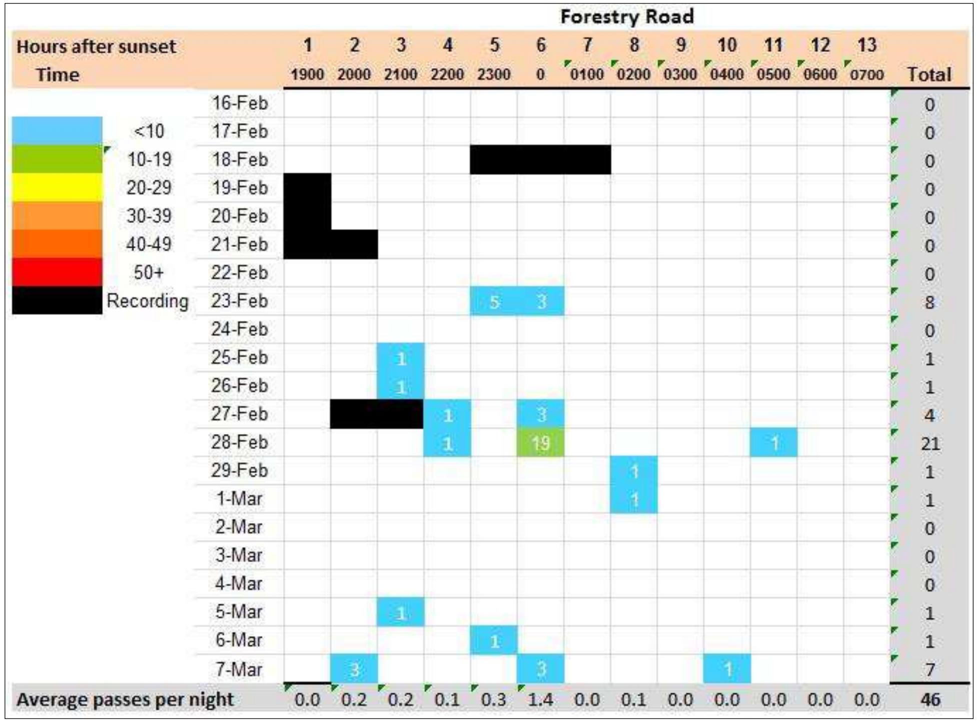


Forestry Road

Hours after sunset		1	2	3	4	5	6	7	8	9	10	11	12	13	
Time	date	1900	2000	2100	2200	2300	0	0100	0200	0300	0400	0500	0600	0700	Total
	24-Feb		⬛												0
🟦 <10	25-Feb		⬛												0
🟩 10-19	26-Feb		⬛												0
🟨 20-29	27-Feb		⬛												0
🟧 30-39	28-Feb		⬛												0
🟧 40-49	1-Mar														0
🟥 50+	2-Mar														0
⬛ Recording Paused	3-Mar														0
	4-Mar														0
	5-Mar		1								1		2		4
	6-Mar														0
	7-Mar														0
	8-Mar														0
	9-Mar														0
	10-Mar														0
	11-Mar														0
	12-Mar	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	0
	13-Mar														0
	14-Mar														0
	15-Mar	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	0
	16-Mar	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	1	⬛	⬛	1
Average passes per night		0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.2

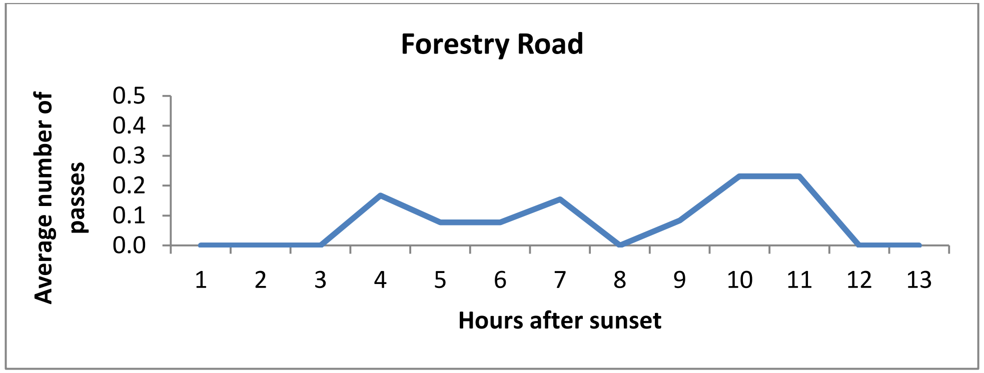


Long tailed bat activity at Forestry Road, 2015

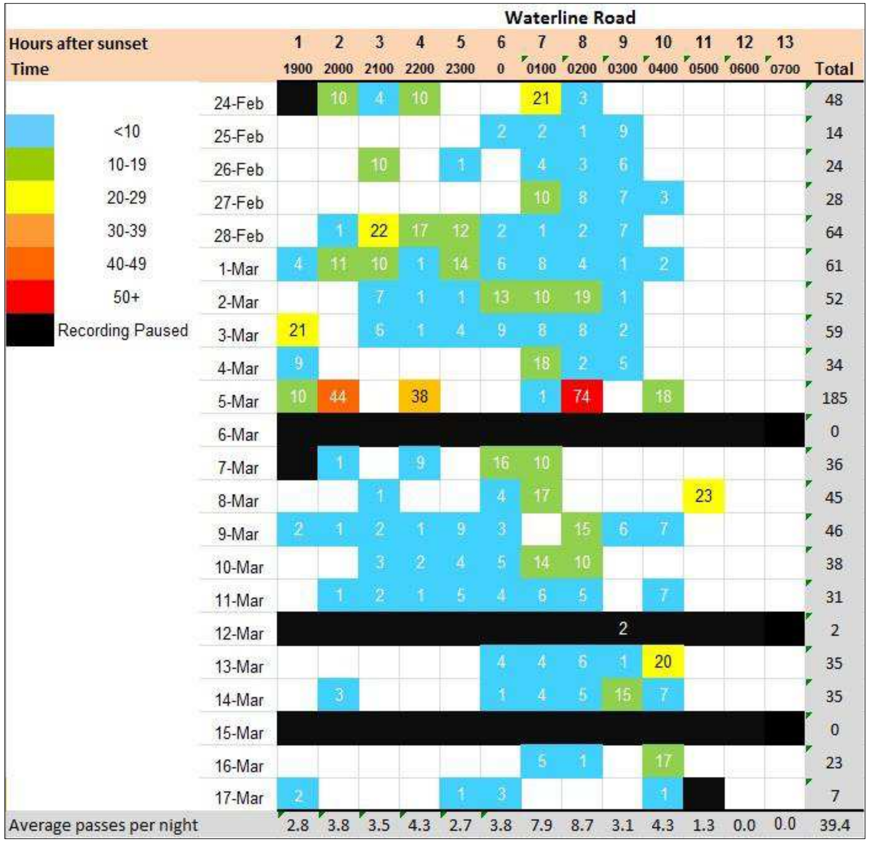


Forestry Road

Hours after sunset		1	2	3	4	5	6	7	8	9	10	11	12	13	
Time		1900	2000	2100	2200	2300	0	0100	0200	0300	0400	0500	0600	0700	Total
	16-Feb														0
🟦 <10	17-Feb														0
🟩 10-19	18-Feb					⬛	⬛	⬛							0
🟨 20-29	19-Feb	⬛													0
🟧 30-39	20-Feb	⬛													0
🟧 40-49	21-Feb	⬛	⬛												0
🟥 50+	22-Feb														0
⬛ Recording	23-Feb					5	3								8
	24-Feb														0
	25-Feb			1											1
	26-Feb			1											1
	27-Feb		⬛	⬛	1		3								4
	28-Feb				1		19					1			21
	29-Feb								1						1
	1-Mar								1						1
	2-Mar														0
	3-Mar														0
	4-Mar														0
	5-Mar			1											1
	6-Mar					1									1
	7-Mar		3				3				1				7
Average passes per night		0.0	0.2	0.2	0.1	0.3	1.4	0.0	0.1	0.0	0.0	0.0	0.0	0.0	46



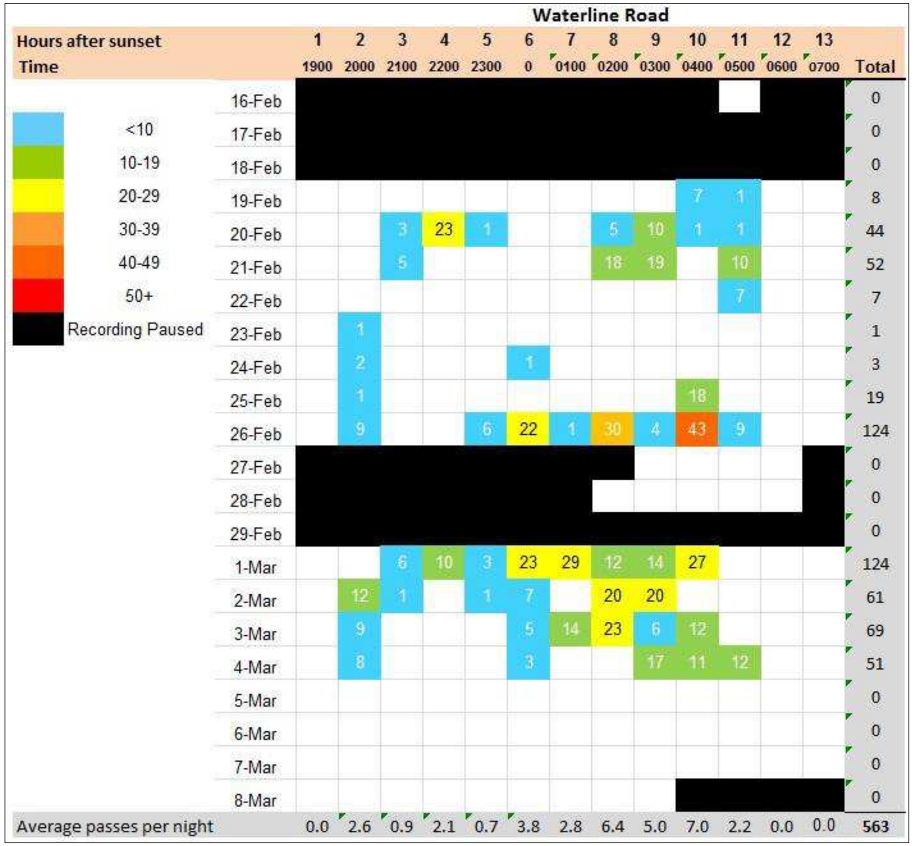
Long tailed bat activity at Forestry Road, 2016



Waterline Road

- 🟦 <10
- 🟩 10-19
- 🟨 20-29
- 🟧 30-39
- 🟧 40-49
- 🟥 50+
- ⬛ Recording Paused

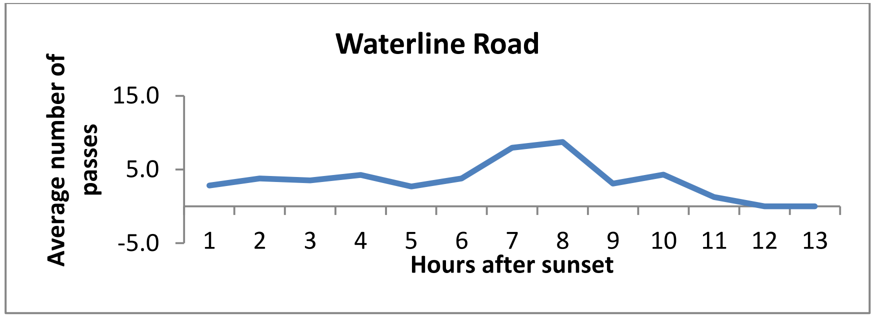
Hours after sunset	1	2	3	4	5	6	7	8	9	10	11	12	13	
Time	1900	2000	2100	2200	2300	0	0100	0200	0300	0400	0500	0600	0700	Total
24-Feb	⬛	10	4	10			21	3						48
25-Feb						2	2	1	9					14
26-Feb			10		1		4	3	6					24
27-Feb							10	8	7	3				28
28-Feb		1	22	17	12	2	1	2	7					64
1-Mar	4	11	10	1	14	6	8	4	1	2				61
2-Mar			7	1	1	13	10	19	1					52
3-Mar	21		6	1	4	9	8	8	2					59
4-Mar	9						18	2	5					34
5-Mar	10	44		38			1	74		18				185
6-Mar	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	0
7-Mar	⬛	1		9		16	10							36
8-Mar			1			4	17				23			45
9-Mar	2	1	2	1	9	3		15	6	7				46
10-Mar			3	2	4	5	14	10						38
11-Mar		1	2	1	5	4	6	5		7				31
12-Mar	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	2	⬛	⬛	⬛	⬛	2
13-Mar						4	4	6	1	20				35
14-Mar		3				1	4	5	15	7				35
15-Mar	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	0
16-Mar							5	1		17				23
17-Mar	2				1	3				1	⬛			7
Average passes per night	2.8	3.8	3.5	4.3	2.7	3.8	7.9	8.7	3.1	4.3	1.3	0.0	0.0	39.4



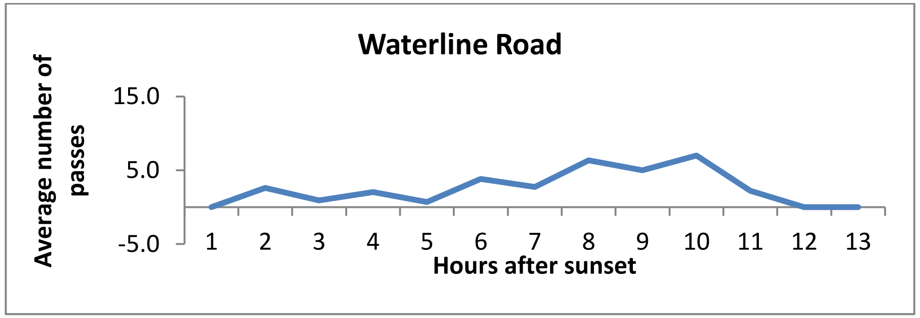
Waterline Road

- 🟦 <10
- 🟩 10-19
- 🟨 20-29
- 🟧 30-39
- 🟧 40-49
- 🟥 50+
- ⬛ Recording Paused

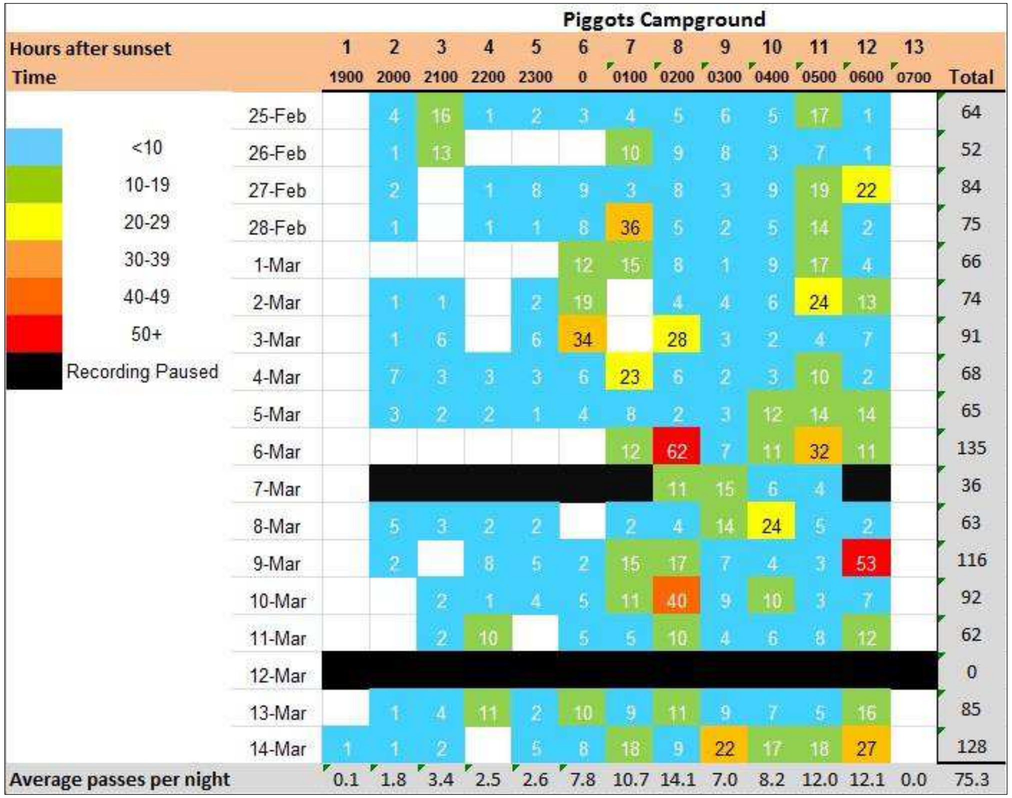
Hours after sunset	1	2	3	4	5	6	7	8	9	10	11	12	13	
Time	1900	2000	2100	2200	2300	0	0100	0200	0300	0400	0500	0600	0700	Total
16-Feb	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛		⬛	⬛	0
17-Feb	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	0
18-Feb	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	0
19-Feb										7	1			8
20-Feb			3	23	1			5	10	1	1			44
21-Feb			5					18	19		10			52
22-Feb											7			7
23-Feb		1												1
24-Feb		2				1								3
25-Feb		1								18				19
26-Feb		9			6	22	1	30	4	43	9			124
27-Feb	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛					⬛	0
28-Feb	⬛	⬛	⬛	⬛	⬛	⬛	⬛						⬛	0
29-Feb	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	0
1-Mar			6	10	3	23	29	12	14	27				124
2-Mar		12	1		1	7		20	20					61
3-Mar		9				5	14	23	6	12				69
4-Mar		8				3			17	11	12			51
5-Mar														0
6-Mar														0
7-Mar														0
8-Mar										⬛	⬛	⬛	⬛	0
Average passes per night	0.0	2.6	0.9	2.1	0.7	3.8	2.8	6.4	5.0	7.0	2.2	0.0	0.0	563



Long tailed bat activity at Waterline Road, 2015



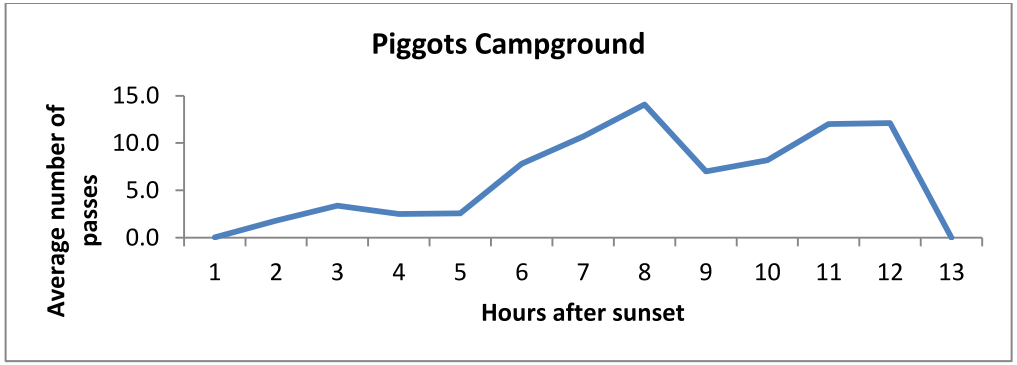
Long tailed bat activity at Waterline Road, 2016



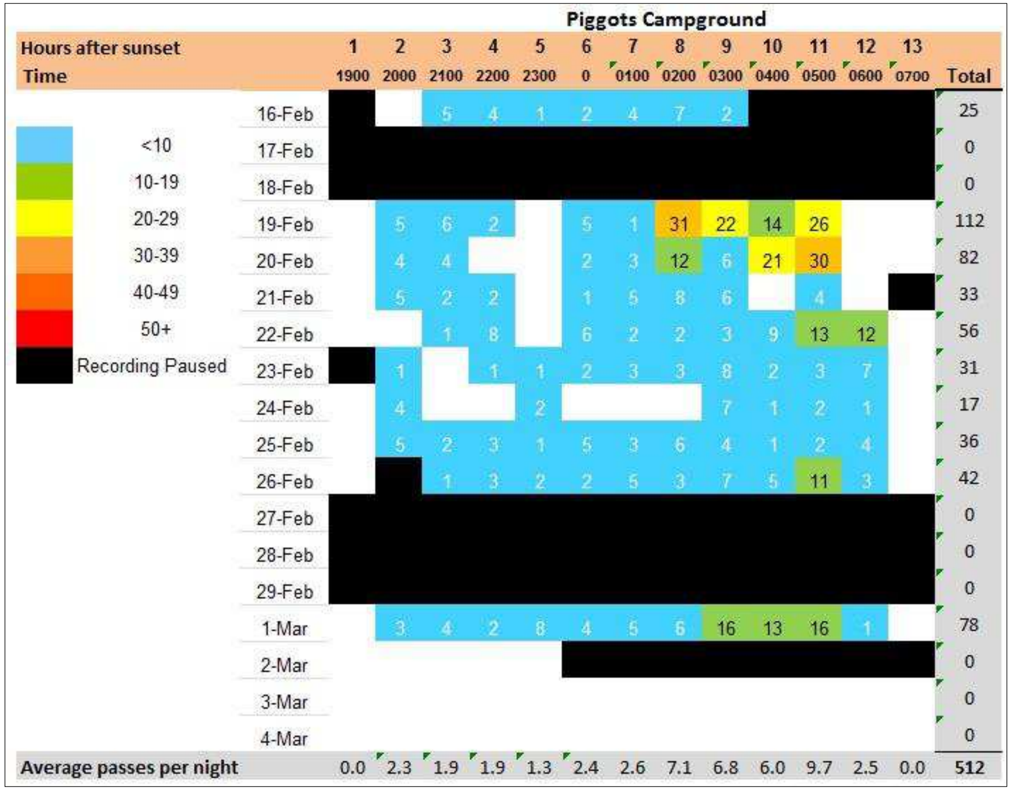
Piggots Campground

🟦	<10
🟩	10-19
🟨	20-29
🟧	30-39
🟧	40-49
🟥	50+
⬛	Recording Paused

Hours after sunset	1	2	3	4	5	6	7	8	9	10	11	12	13	
Time	1900	2000	2100	2200	2300	0	0100	0200	0300	0400	0500	0600	0700	Total
25-Feb		4	16	1	2	3	4	5	6	5	17	1		64
26-Feb		1	13				10	9	8	3	7	1		52
27-Feb		2		1	8	9	3	8	3	9	19	22		84
28-Feb		1		1	1	8	36	5	2	5	14	2		75
1-Mar						12	15	8	1	9	17	4		66
2-Mar		1	1		2	19		4	4	6	24	13		74
3-Mar		1	6		6	34		28	3	2	4	7		91
4-Mar		7	3	3	3	6	23	6	2	3	10	2		68
5-Mar		3	2	2	1	4	8	2	3	12	14	14		65
6-Mar							12	62	7	11	32	11		135
7-Mar		⬛	⬛	⬛	⬛	⬛	⬛	11	15	6	4	⬛		36
8-Mar		5	3	2	2		2	4	14	24	5	2		63
9-Mar		2		8	5	2	15	17	7	4	3	53		116
10-Mar			2	1	4	5	11	40	9	10	3	7		92
11-Mar			2	10		5	5	10	4	6	8	12		62
12-Mar	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	0
13-Mar		1	4	11	2	10	9	11	9	7	5	16		85
14-Mar	1	1	2		5	8	18	9	22	17	18	27		128
Average passes per night	0.1	1.8	3.4	2.5	2.6	7.8	10.7	14.1	7.0	8.2	12.0	12.1	0.0	75.3



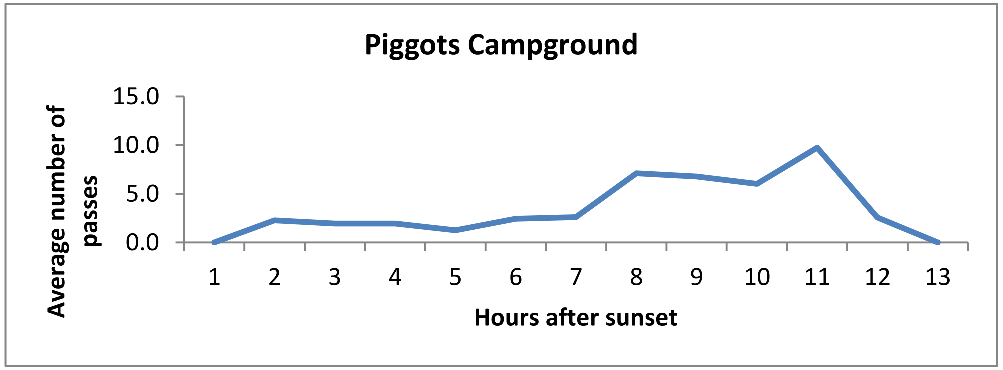
Long tailed bat activity at Piggots Campground, 2015



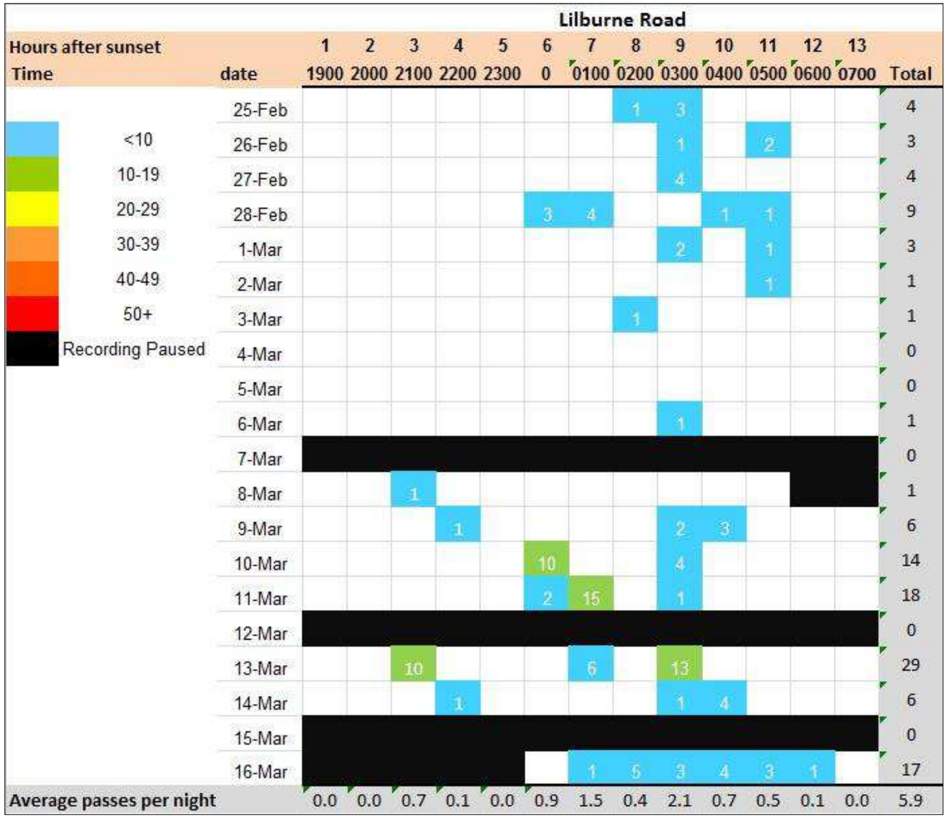
Piggots Campground

🟦	<10
🟩	10-19
🟨	20-29
🟧	30-39
🟧	40-49
🟥	50+
⬛	Recording Paused

Hours after sunset	1	2	3	4	5	6	7	8	9	10	11	12	13	
Time	1900	2000	2100	2200	2300	0	0100	0200	0300	0400	0500	0600	0700	Total
16-Feb	⬛		5	4	1	2	4	7	2	⬛	⬛	⬛	⬛	25
17-Feb	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	0
18-Feb	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	0
19-Feb		5	6	2		5	1	31	22	14	26			112
20-Feb		4	4			2	3	12	6	21	30			82
21-Feb		5	2	2		1	5	8	6		4		⬛	33
22-Feb			1	8		6	2	2	3	9	13	12		56
23-Feb	⬛	1		1	1	2	3	3	8	2	3	7		31
24-Feb		4			2				7	1	2	1		17
25-Feb		5	2	3	1	5	3	6	4	1	2	4		36
26-Feb		⬛	1	3	2	2	5	3	7	5	11	3		42
27-Feb	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	0
28-Feb	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	0
29-Feb	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	0
1-Mar		3	4	2	8	4	5	6	16	13	16	1		78
2-Mar						⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	0
3-Mar														0
4-Mar														0
Average passes per night	0.0	2.3	1.9	1.9	1.3	2.4	2.6	7.1	6.8	6.0	9.7	2.5	0.0	512



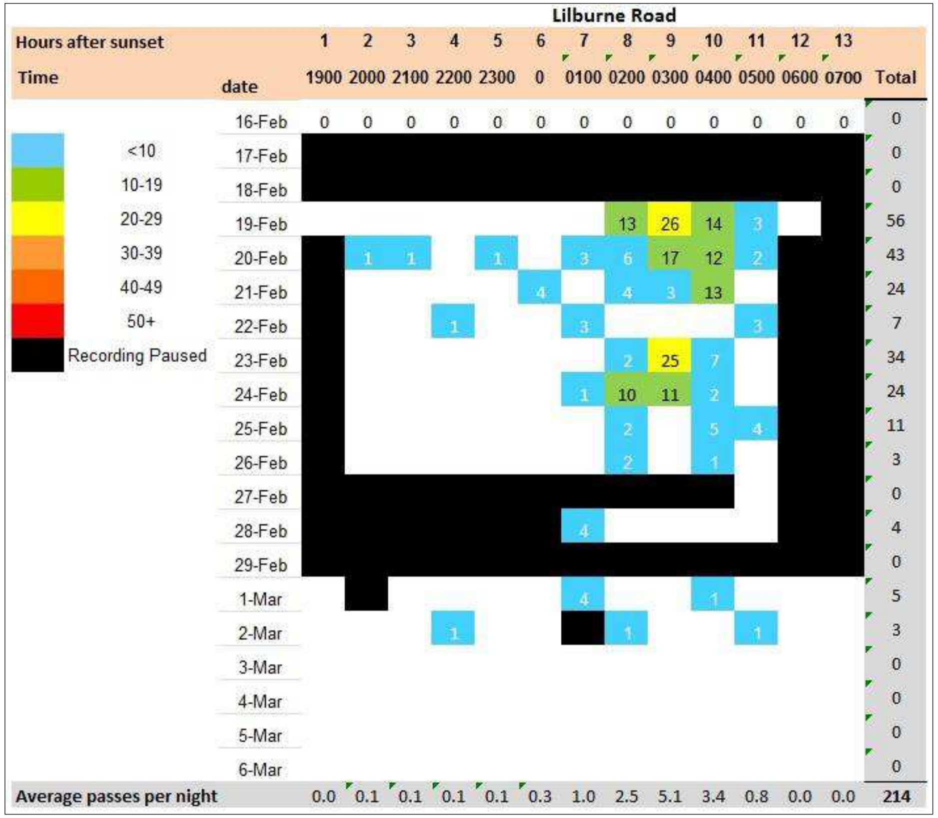
Long tailed bat activity at Piggots Campground, 2016



Lilburne Road

🟦 <10
🟩 10-19
🟨 20-29
🟧 30-39
🟧 40-49
🟥 50+
⬛ Recording Paused

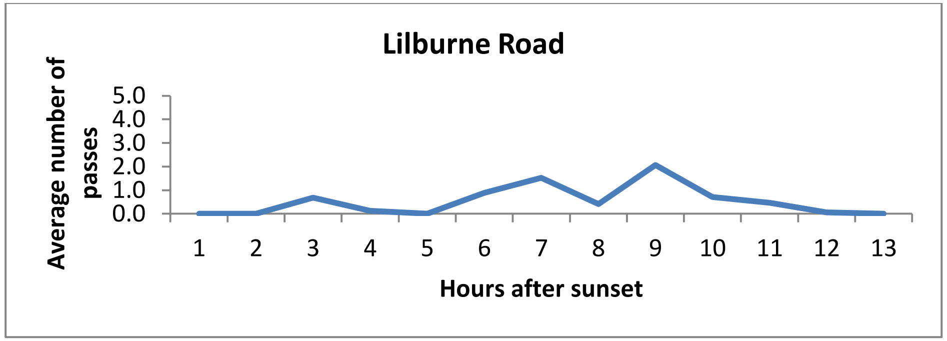
Hours after sunset		1	2	3	4	5	6	7	8	9	10	11	12	13	
Time	date	1900	2000	2100	2200	2300	0	0100	0200	0300	0400	0500	0600	0700	Total
	25-Feb								1	3					4
	26-Feb									1		2			3
	27-Feb									4					4
	28-Feb						3	4			1	1			9
	1-Mar									2		1			3
	2-Mar											1			1
	3-Mar								1						1
	4-Mar														0
	5-Mar														0
	6-Mar									1					1
	7-Mar	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	0
	8-Mar			1									⬛	⬛	1
	9-Mar				1					2	3				6
	10-Mar						10			4					14
	11-Mar						2	15		1					18
	12-Mar	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	0
	13-Mar			10				6		13					29
	14-Mar				1					1	4				6
	15-Mar	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	0
	16-Mar	⬛	⬛	⬛	⬛	⬛		1	5	3	4	3	1		17
Average passes per night		0.0	0.0	0.7	0.1	0.0	0.9	1.5	0.4	2.1	0.7	0.5	0.1	0.0	5.9



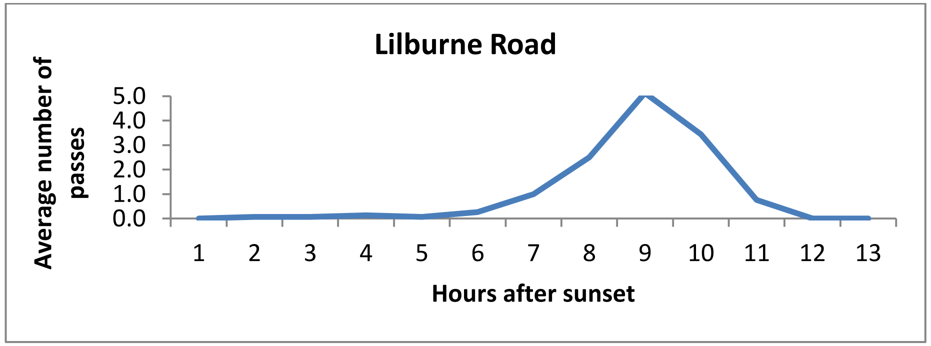
Lilburne Road

🟦 <10
🟩 10-19
🟨 20-29
🟧 30-39
🟧 40-49
🟥 50+
⬛ Recording Paused

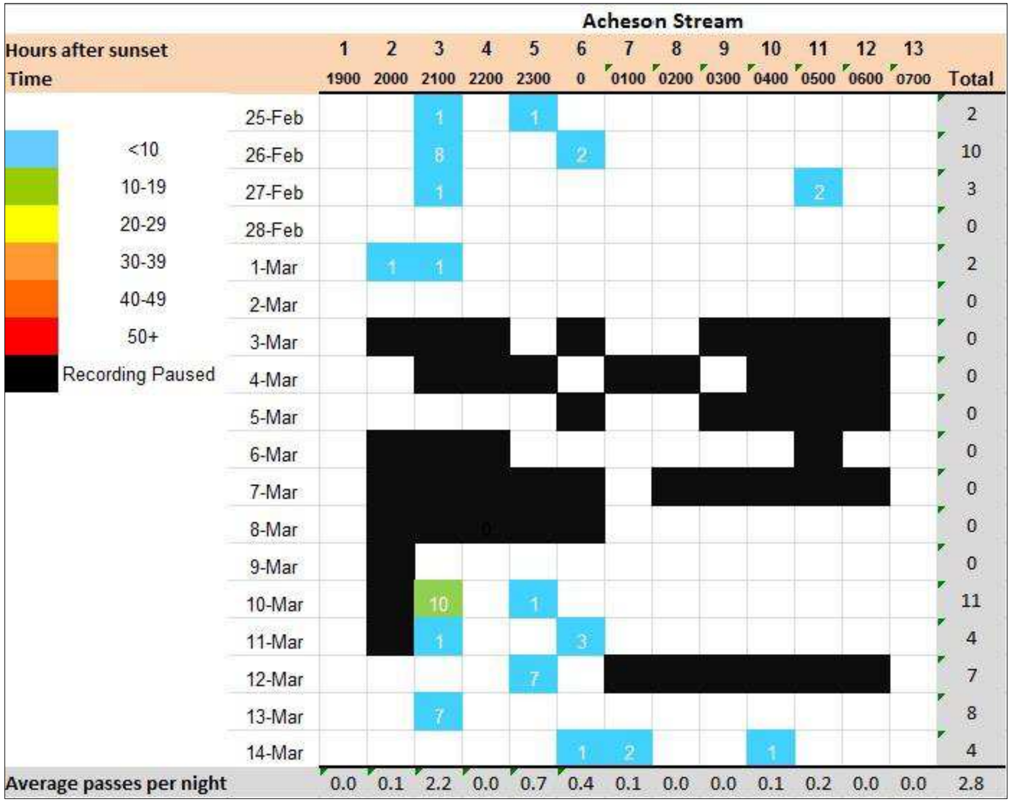
Hours after sunset		1	2	3	4	5	6	7	8	9	10	11	12	13	
Time	date	1900	2000	2100	2200	2300	0	0100	0200	0300	0400	0500	0600	0700	Total
	16-Feb	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	17-Feb	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	0
	18-Feb	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	0
	19-Feb								13	26	14	3		⬛	56
	20-Feb	⬛	1	1		1		3	6	17	12	2	⬛	⬛	43
	21-Feb	⬛					4		4	3	13		⬛	⬛	24
	22-Feb	⬛			1			3				3	⬛	⬛	7
	23-Feb	⬛							2	25	7		⬛	⬛	34
	24-Feb	⬛						1	10	11	2		⬛	⬛	24
	25-Feb	⬛							2		5	4	⬛	⬛	11
	26-Feb	⬛							2		1		⬛	⬛	3
	27-Feb	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛		⬛	⬛	0
	28-Feb	⬛	⬛	⬛	⬛	⬛	⬛	4					⬛	⬛	4
	29-Feb	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	0
	1-Mar		⬛					4			1				5
	2-Mar				1			⬛	1			1			3
	3-Mar														0
	4-Mar														0
	5-Mar														0
	6-Mar														0
Average passes per night		0.0	0.1	0.1	0.1	0.1	0.3	1.0	2.5	5.1	3.4	0.8	0.0	0.0	214



Long tailed bat activity at Lilburne Road, 2015



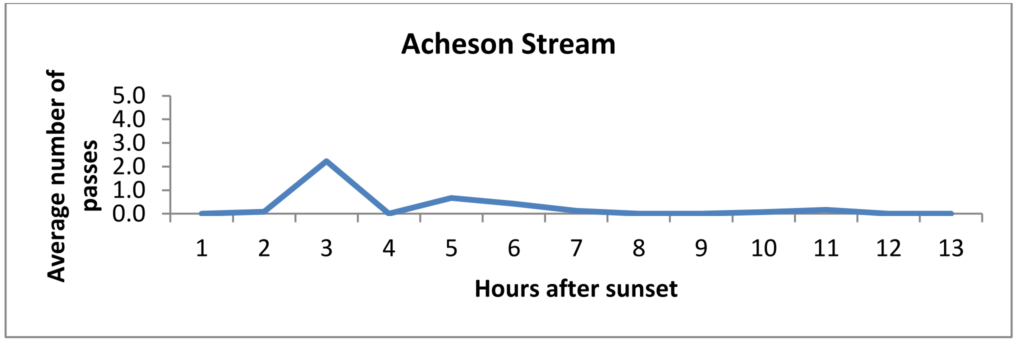
Long tailed bat activity at Lilburne Road, 2016



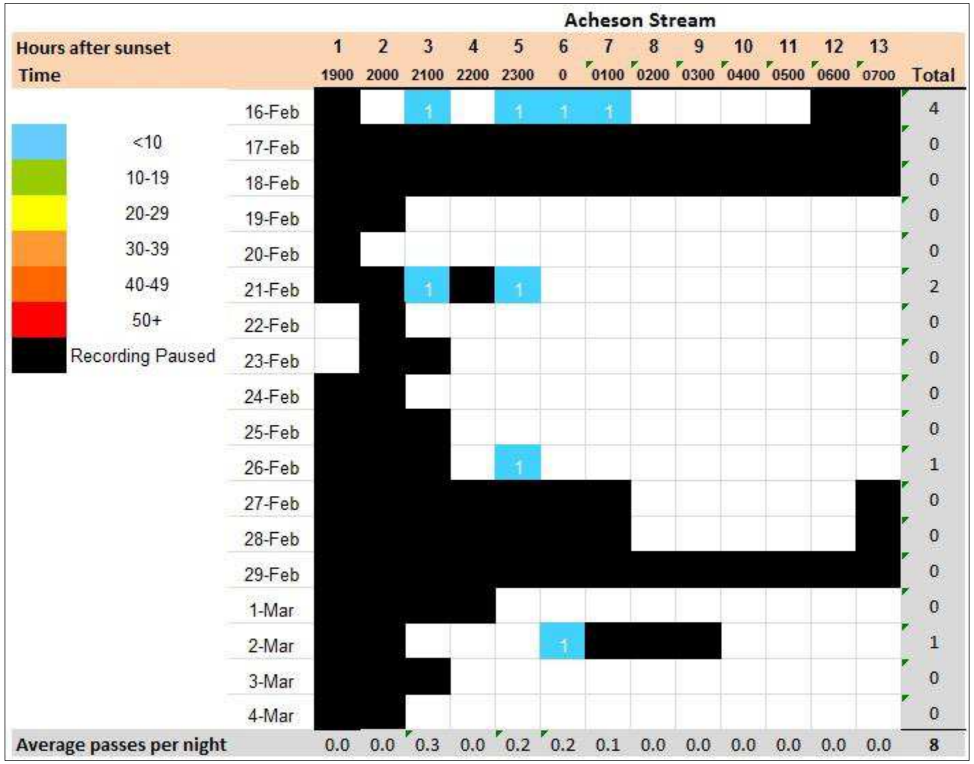
Acheson Stream

🟦 <10
🟩 10-19
🟨 20-29
🟧 30-39
🟧 40-49
🟥 50+
■ Recording Paused

Hours after sunset	1	2	3	4	5	6	7	8	9	10	11	12	13	
Time	1900	2000	2100	2200	2300	0	0100	0200	0300	0400	0500	0600	0700	Total
25-Feb			1		1									2
26-Feb			8			2								10
27-Feb			1								2			3
28-Feb														0
1-Mar		1	1											2
2-Mar														0
3-Mar		■	■	■		■			■	■	■	■		0
4-Mar			■	■	■		■	■		■	■	■		0
5-Mar						■			■	■	■	■		0
6-Mar		■	■	■							■			0
7-Mar		■	■	■	■	■		■	■	■	■	■		0
8-Mar		■	■	■	■	■								0
9-Mar		■												0
10-Mar		■	10		1									11
11-Mar		■	1			3								4
12-Mar					7		■	■	■	■	■	■		7
13-Mar			7											8
14-Mar						1	2			1				4
Average passes per night	0.0	0.1	2.2	0.0	0.7	0.4	0.1	0.0	0.0	0.1	0.2	0.0	0.0	2.8



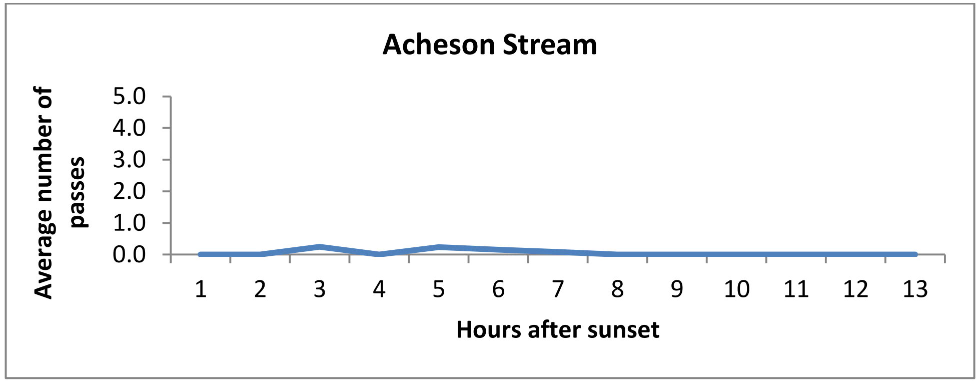
Long tailed bat activity at Acheson Stream, 2015



Acheson Stream

🟦 <10
🟩 10-19
🟨 20-29
🟧 30-39
🟧 40-49
🟥 50+
■ Recording Paused

Hours after sunset	1	2	3	4	5	6	7	8	9	10	11	12	13	
Time	1900	2000	2100	2200	2300	0	0100	0200	0300	0400	0500	0600	0700	Total
16-Feb	■		1		1	1	1					■	■	4
17-Feb	■	■	■	■	■	■	■	■	■	■	■	■	■	0
18-Feb	■	■	■	■	■	■	■	■	■	■	■	■	■	0
19-Feb	■	■												0
20-Feb	■													0
21-Feb	■	■	1	■	1									2
22-Feb		■												0
23-Feb		■	■											0
24-Feb	■	■												0
25-Feb	■	■	■											0
26-Feb	■	■	■		1									1
27-Feb	■	■	■	■	■	■	■						■	0
28-Feb	■	■	■	■	■	■	■						■	0
29-Feb	■	■	■	■	■	■	■	■	■	■	■	■	■	0
1-Mar	■	■	■	■										0
2-Mar	■	■				1	■	■	■					1
3-Mar	■	■	■											0
4-Mar	■	■												0
Average passes per night	0.0	0.0	0.3	0.0	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	8

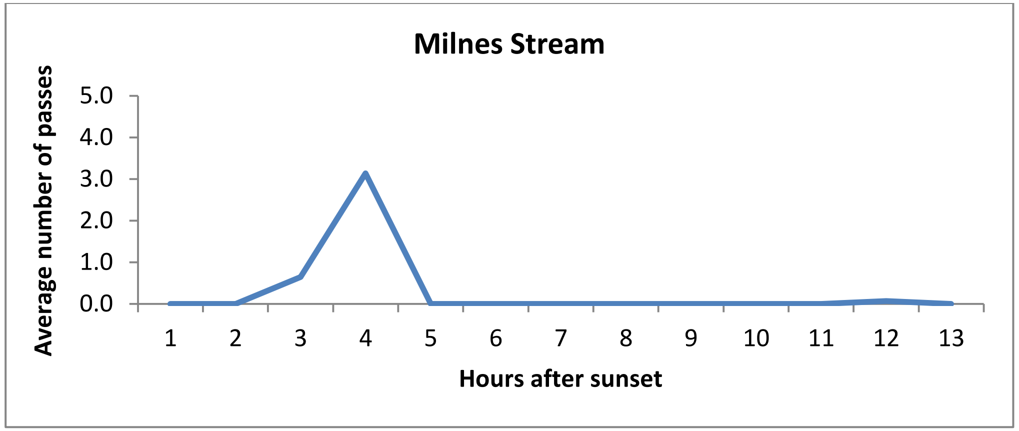


Long tailed bat activity at Acheson Stream, 2016

Milnes Stream

- 🟦 <10
- 🟩 10-19
- 🟨 20-29
- 🟧 30-39
- 🟧 40-49
- 🟥 50+
- ■ Recording Paused

Hours after sunset	1	2	3	4	5	6	7	8	9	10	11	12	13	
Time	1900	2000	2100	2200	2300	0	0100	0200	0300	0400	0500	0600	0700	Total
25-Feb	■													0
26-Feb				24										24
27-Feb				1										1
28-Feb	■													0
1-Mar	■			1										1
2-Mar	■													0
3-Mar	■	■	■	10										10
4-Mar	■		1	1										2
5-Mar	■											1		1
6-Mar	■		2	5										7
7-Mar	■	■	■	■	■	■	■	■	■	■	■	■		0
8-Mar			1											1
9-Mar														0
10-Mar			4	2										6
11-Mar			1	3										4
12-Mar	■	■	■	■		■	■	■	■	■	■	■		0
13-Mar														0
	0.0	0.0	0.6	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	3.4

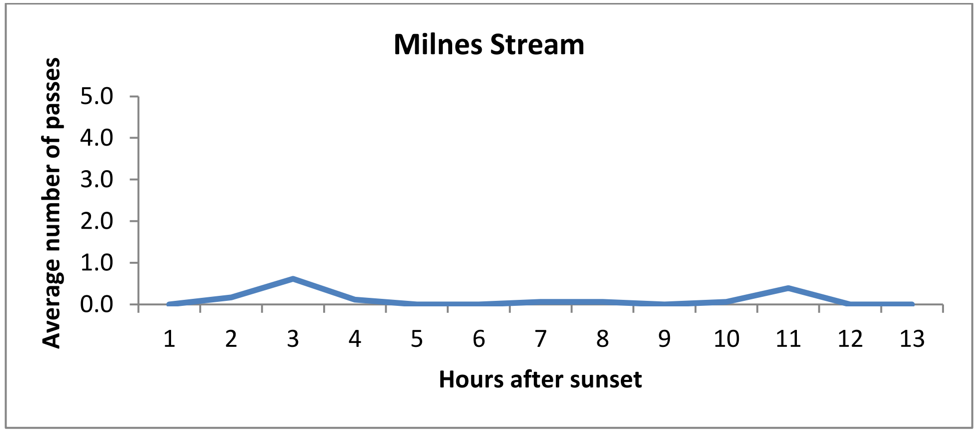


Long tailed bat activity at Milnes Stream, 2015

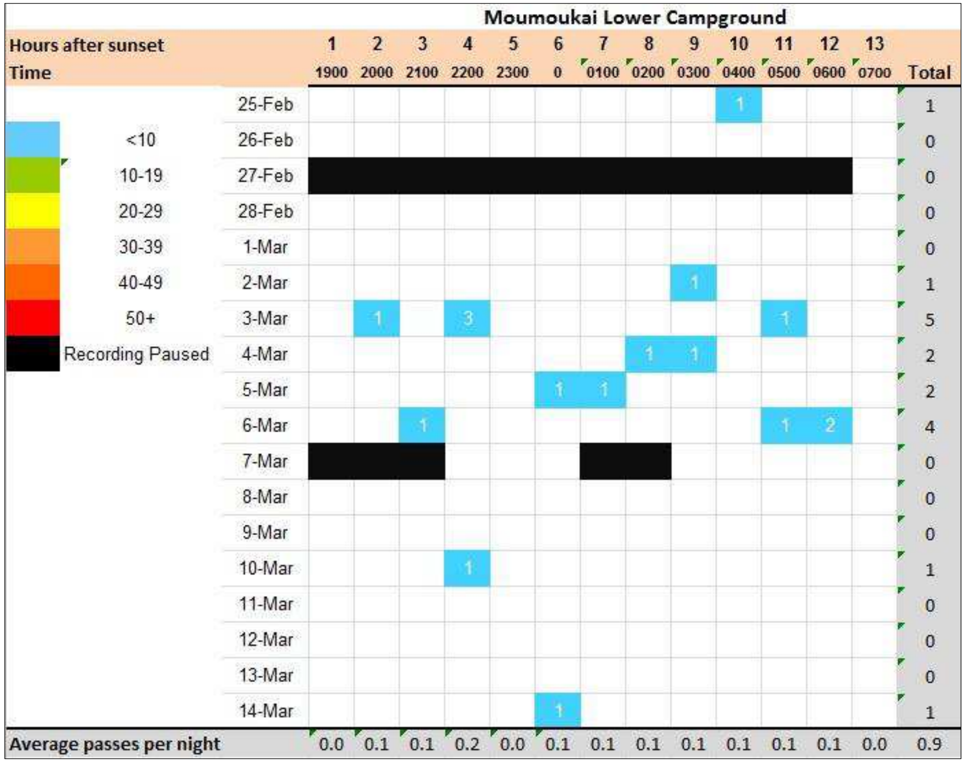
Milnes Stream

- 🟦 <10
- 🟩 10-19
- 🟨 20-29
- 🟧 30-39
- 🟧 40-49
- 🟥 50+
- ■ Recording Paused

Hours after sunset	1	2	3	4	5	6	7	8	9	10	11	12	13	
Time	1900	2000	2100	2200	2300	0	0100	0200	0300	0400	0500	0600	0700	Total
16-Feb			1								5			6
17-Feb			1											1
18-Feb														0
19-Feb			1											1
20-Feb											2			2
21-Feb							1							1
22-Feb														0
23-Feb														0
24-Feb														0
25-Feb														0
26-Feb														0
27-Feb														0
28-Feb														0
29-Feb														0
1-Mar		1		2										3
2-Mar														0
3-Mar			1					1						2
4-Mar		2	7							1				10
Average passes per night	0.0	0.2	0.6	0.1	0.0	0.0	0.1	0.1	0.0	0.1	0.4	0.0	0.0	26



Long tailed bat activity at Milnes Stream, 2016



Moumoukai Lower Campground

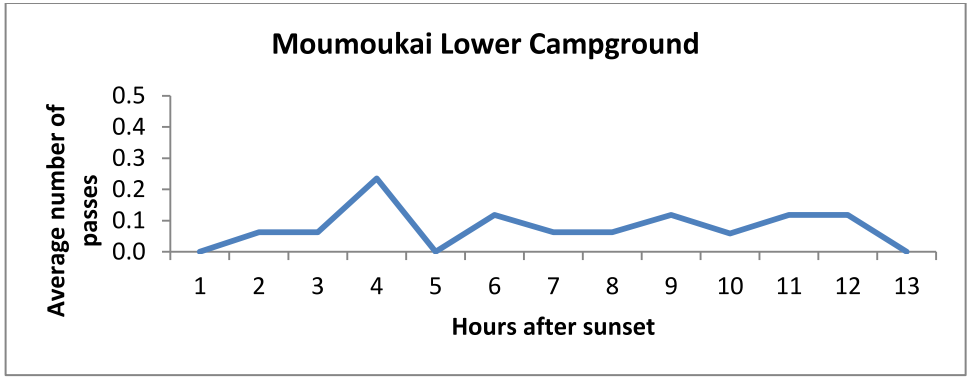
🟦 <10
🟩 10-19
🟨 20-29
🟧 30-39
🟧 40-49
🟥 50+
■ Recording Paused

Hours after sunset	1	2	3	4	5	6	7	8	9	10	11	12	13	
Time	1900	2000	2100	2200	2300	0	0100	0200	0300	0400	0500	0600	0700	Total
25-Feb										1				1
26-Feb														0
27-Feb	■	■	■	■	■	■	■	■	■	■	■	■		0
28-Feb														0
1-Mar														0
2-Mar									1					1
3-Mar		1		3							1			5
4-Mar								1	1					2
5-Mar						1	1							2
6-Mar			1								1	2		4
7-Mar	■	■	■				■	■						0
8-Mar														0
9-Mar														0
10-Mar				1										1
11-Mar														0
12-Mar														0
13-Mar														0
14-Mar						1								1
Average passes per night	0.0	0.1	0.1	0.2	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.9

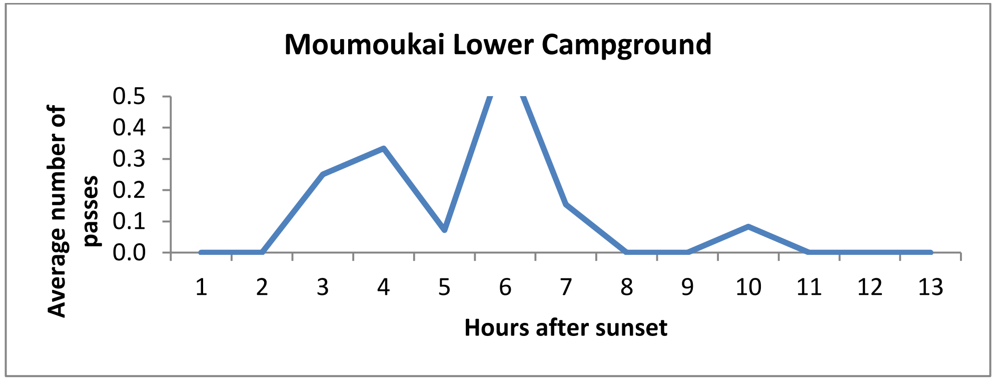
Moumoukai Lower Campground

🟦 <10
🟩 10-19
🟨 20-29
🟧 30-39
🟧 40-49
🟥 50+
■ Recording Paused

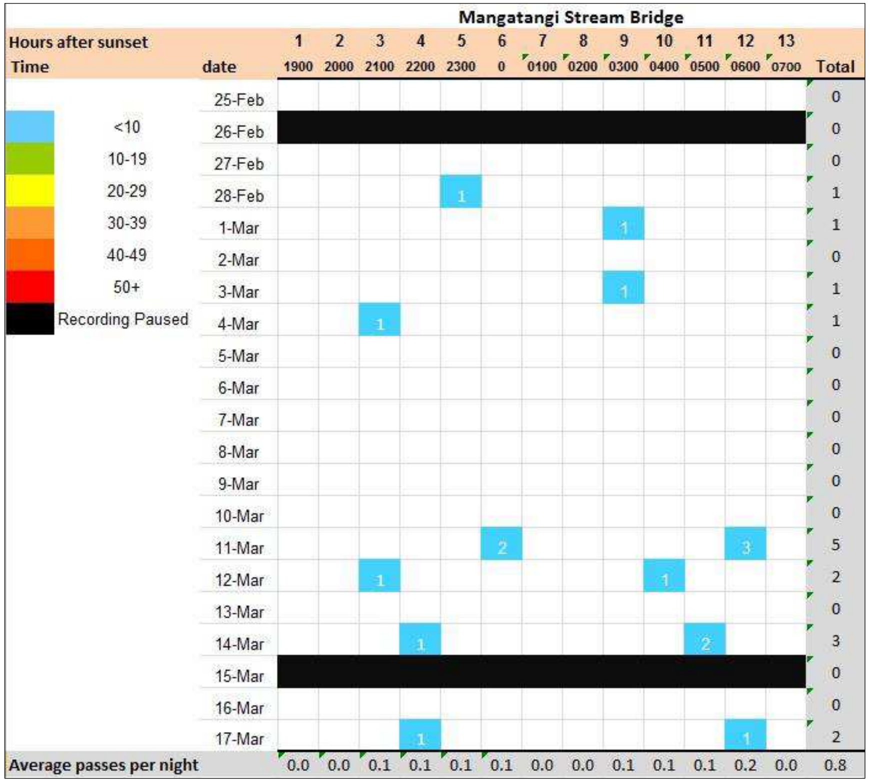
Hours after sunset	1	2	3	4	5	6	7	8	9	10	11	12	13	
Time	1900	2000	2100	2200	2300	0	0100	0200	0300	0400	0500	0600	0700	Total
16-Feb	■	■								1			■	1
17-Feb	■	■	■	■	■	■	■	■	■	■	■	■	■	0
18-Feb	■	■	■	■	■	■	■	■	■	■	■	■	■	0
19-Feb	■	■												0
20-Feb	■	■		1										1
21-Feb	■			■										0
22-Feb														0
23-Feb			1			1								2
24-Feb														0
25-Feb						4								4
26-Feb		■	2		1	2								5
27-Feb	■	■	■	■	■	■	■	■		■	■	■	■	0
28-Feb		■							■	■	■	■		0
29-Feb	■	■	■	■	■	■	■	■	■	■	■	■	■	0
1-Mar		■	■	1		2	2	■						5
2-Mar				2			■	■	■	■	■	■	■	2
3-Mar														0
4-Mar		■	■											0
Average passes per night	0.0	0.0	0.3	0.3	0.1	0.6	0.2	0.0	0.0	0.1	0.0	0.0	0.0	20.0



Long tailed bat activity at Moumoukai Lower Campground, 2015



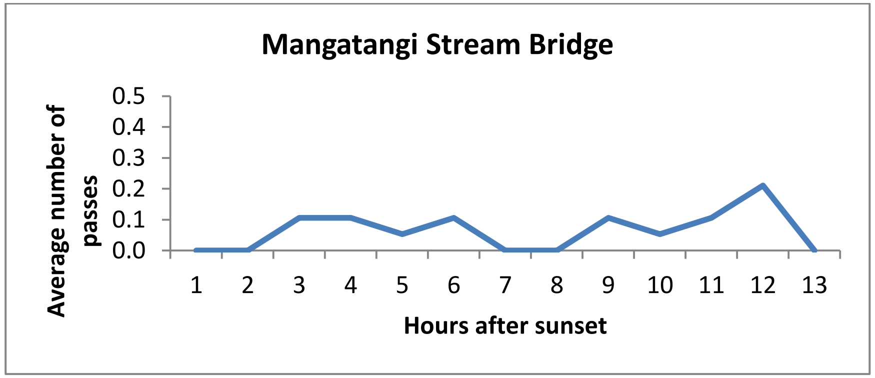
Long tailed bat activity at Moumoukai Lower Campground, 2016



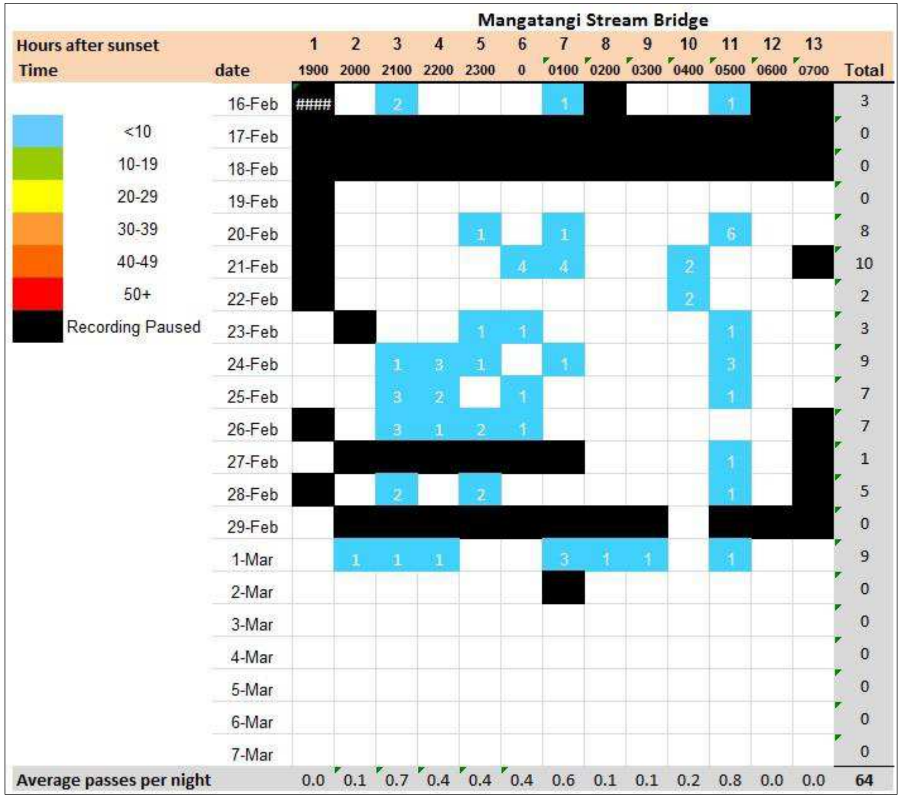
Mangatangi Stream Bridge

- 🟦 <10
- 🟩 10-19
- 🟨 20-29
- 🟧 30-39
- 🟧 40-49
- 🟥 50+
- ⬛ Recording Paused

Hours after sunset		1	2	3	4	5	6	7	8	9	10	11	12	13	
Time	date	1900	2000	2100	2200	2300	0	0100	0200	0300	0400	0500	0600	0700	Total
	25-Feb														0
	26-Feb	■	■	■	■	■	■	■	■	■	■	■	■	■	0
	27-Feb														0
	28-Feb					1									1
	1-Mar									1					1
	2-Mar														0
	3-Mar									1					1
	4-Mar			1											1
	5-Mar														0
	6-Mar														0
	7-Mar														0
	8-Mar														0
	9-Mar														0
	10-Mar														0
	11-Mar						2						3		5
	12-Mar			1							1				2
	13-Mar														0
	14-Mar				1							2			3
	15-Mar	■	■	■	■	■	■	■	■	■	■	■	■	■	0
	16-Mar														0
	17-Mar				1								1		2
Average passes per night		0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.1	0.2	0.0	0.8



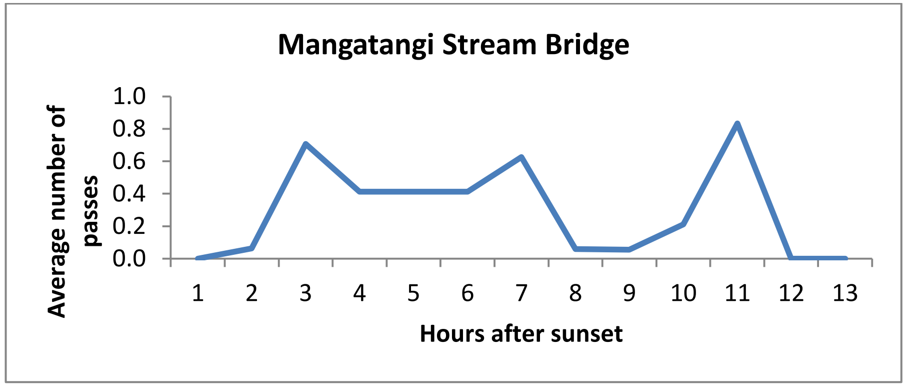
Long tailed bat activity at Mangatangi Stream Bridge, 2015



Mangatangi Stream Bridge

- 🟦 <10
- 🟩 10-19
- 🟨 20-29
- 🟧 30-39
- 🟧 40-49
- 🟥 50+
- ⬛ Recording Paused

Hours after sunset		1	2	3	4	5	6	7	8	9	10	11	12	13	
Time	date	1900	2000	2100	2200	2300	0	0100	0200	0300	0400	0500	0600	0700	Total
	16-Feb	####		2				1	■			1	■	■	3
	17-Feb	■	■	■	■	■	■	■	■	■	■	■	■	■	0
	18-Feb	■	■	■	■	■	■	■	■	■	■	■	■	■	0
	19-Feb	■													0
	20-Feb	■				1		1				6			8
	21-Feb	■					4	4			2			■	10
	22-Feb	■									2				2
	23-Feb		■			1	1					1			3
	24-Feb			1	3	1		1				3			9
	25-Feb			3	2		1					1			7
	26-Feb	■		3	1	2	1							■	7
	27-Feb		■	■	■	■	■	■				1		■	1
	28-Feb	■		2		2						1		■	5
	29-Feb		■	■	■	■	■	■	■	■		■	■	■	0
	1-Mar		1	1	1			3	1	1		1			9
	2-Mar							■							0
	3-Mar														0
	4-Mar														0
	5-Mar														0
	6-Mar														0
	7-Mar														0
Average passes per night		0.0	0.1	0.7	0.4	0.4	0.4	0.6	0.1	0.1	0.2	0.8	0.0	0.0	64



Long tailed bat activity at Mangatangi Stream Bridge, 2016