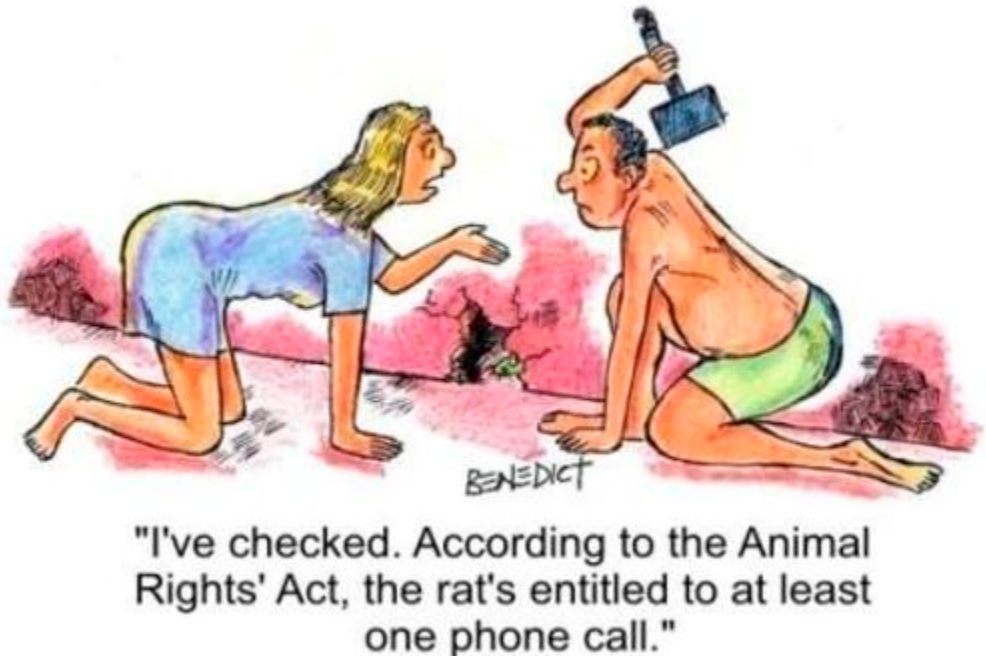
Treatment of Embedded Residual Rat Populations within a Managed Area Grid System Ark in the Park Waitakere Ranges, Auckland



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2012

Treatment of Embedded Residual Rat Populations within a Managed Area Grid System at Ark in the Park Waitakere Ranges, Auckland

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1. Abstract

Through the course of two previous studies undertaken by Martineau (2010) and McGregor (2011) the presence of residual embedded rat populations was identified between irregularly spaced baitlines. These baitlines sit within the L and F block sections of Ark in the Park, Waitakere Ranges Auckland. Research was undertaken to see if the embedded rat populations could be removed using standard baiting practices. The study included six lines of which two were control lines. Standard baiting practices were successful in three of the four targeted lines. The failure of the method to work on two of the other lines is reviewed within as well as possible alternate solutions and further issues surrounding irregularly spaced baitlines.

2. Introduction

As an isolated archipelago altered by human invasion and manipulation New Zealand's original biota has long been distorted from its original state. Considerable quantities of New Zealand species are extinct and large proportions of the remainder are endangered to some extent (Towns & Daugherty, 1994). Due to this New Zealand has always acted at the forefront of the field of conservation. In sight of our past mistakes we can consider it some consolation that we are leaders in the fields of pest control and island reserve establishment offshore and onshore (Towns & Broome, 2003) (Saunders & Norton, 2001). The success of New Zealand Department of Conservation (DOC) island pest eradication programmes led DOC to initiate six mainland island projects between 1995 and 1996 (Suanders, 2004). Following on from their success Forest and Bird in partnership with Auckland Regional Council created the Ark in the Park mainland island community project in 2003. Relying

largely on volunteer power as of October 2011 Ark in the Park has reached a size of 2300 hectares (Maxwell, 2012) (see Figure 11 in the Appendix).

Located within the Waitakere river catchment in the Waitakere Ranges Ark in the Park is an open sanctuary relying on continuous pest control to maintain invasive mammalian pest species at manageable numbers. Ark in the Park runs an active reintroduction programme returning locally extinct species to the Waitakere Ranges. Among the successful reintroductions are native bird species such as the North Island Robin (*Petroica longipes*), Hihi or Stitchbird (*Notiomystis cincta*) and North Island Kokako (*Callaeas cinereus*). However this program is only viable when combined with proper management of the invasive pests among them the Ship (*Rattus rattus*) and Norway (*Rattus norvegicus*) rats (Innes, et al., 1999). Through intensive and integrated pest management Ark in the Park aims and succeeds at maintaining these species at overall low levels (below 5% rat tracking indices) during the birds breeding season from September through to February. Compared with the unmanaged areas outside the Ark where high levels of rats can be found (70-80% rat tracking indices) (Bellingham, et al., 2009). Ark in the Park maintains the low numbers through extensive baiting with Brodifacoum 'Pest off' (delivered in cereal form). By utilising a grid system approach, the park is ordered into areas to maximise efficiency. Those areas are then crossed by parallel running bait lines set 100m apart with a baitstation laid down every 50 metres along each line. With this approach each bait station is within at least 100 metres of the next. The purpose being that the average home range of the rat species is considered to be between 0.5 ha and 1.5 ha dependant on if they are male or female (Hooker & Innes, 1995) . With this methodology Ark in the Park has met with relative success with many reintroduced species re-establishing themselves. However it had been suggested that certain bird populations were not growing at the rate expected. A report by Adrien Martineau (2010) brought to attention areas of higher rat activity within the Ark. To follow up on his research Elizabeth McGregor (2011) undertook a follow up study in to identify the issue. From this the presence of residual embedded rat populations between irregularly spaced baitlines was identified. To follow up on McGregor's study this research project was suggested by Forest and Bird. The purpose to identify if the removal of embedded rat populations was possible using standard practices (bait lines and occasional

trapping) and to further review the reasons for the presence of a residual embedded rat population within Ark in the Park and alternate methods of removal.

2.1 Study Areas

The six lines being studied are all located within the central and northern part of Ark in the Park. The Ark itself is within the Waitakere river catchment found in the northern part of the Waitakere Ranges. The majority of Ark in the Park is a mix of original forest cover and regenerating forest of Broadleafs and Podocarps (McGregor, 2011). Of the six lines four are located within the areas with embedded rat populations and the other two are control lines for comparison. Three of the lines are located within L block bordering the Lower Kauri track and Whatiri track. L block sits at the northern end of the Ark bordering on a paddock with a fringe of gorse (*Ulex europaeus*) separating them. The L block lines are called L1.5, Lea and Lf/Lg (control line) seen below from right to left (Figure 1). The other three lines are located within F block bordering the Fenceline tracks and the Robinson Ridge track. F block sits in the centre of the park surrounded on three sides by native rainforest, the fourth edge borders on the Waitakere Dam and reservoir. The F block lines are called F3/F4 (control line), F9.5 and F14.5 (also labelled F14a) seen below from top to bottom (Figure 1).

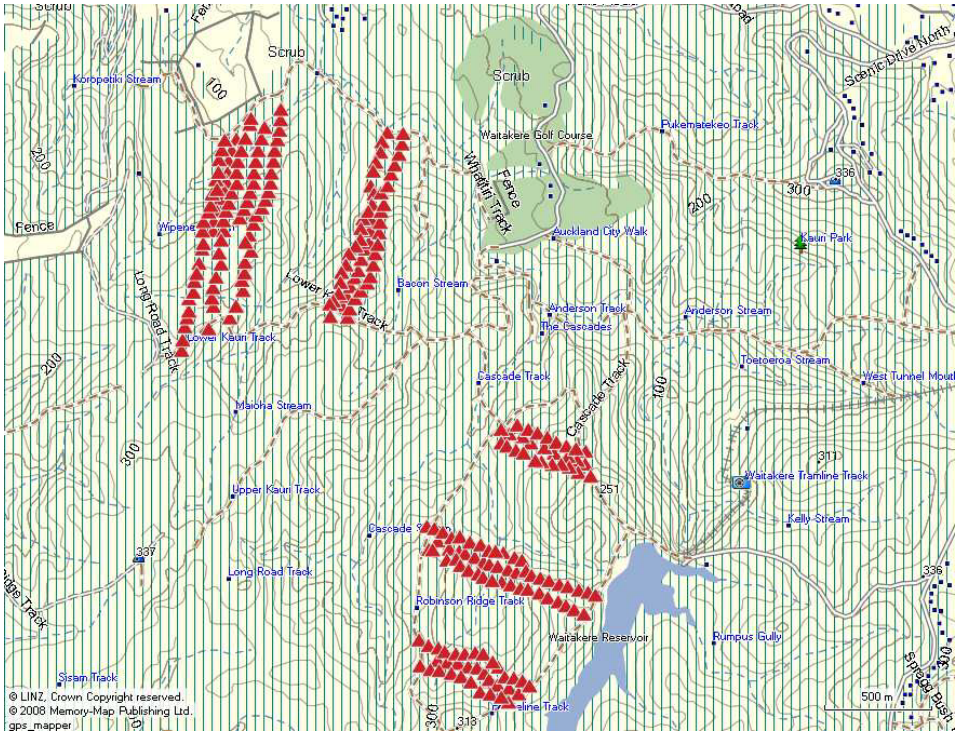


Figure 1: *All Lines (top L block, bottom F block) irregularly spaced and controls, Ark in the Park, Cascades Kauri Park, Waitakere, Auckland (Source McGregor 2011).*

3. Methods

3.1 Mapping

After the six locations in Fig. 1 were monitored in the McGregor (2011) study and the presence of embedded rat populations was proven, the construction of new baitlines was initiated. Ark in the Park has gathered GPS locations on nearly all its baitlines and baitstations including the irregularly spaced baitlines. With this data entered into Mapsource the new lines listed above were virtually constructed within the program. The control lines (F3/F4 & Lf/Lg) consisting of only monitoring tunnels remained from the McGregor study. First the halfway points were found between the two neighbouring irregularly spaced lines. Initially this was done using the standard practice of Ark in the Park. A specific bearing relates to each block within Ark in the Park in the case of L block the lines are run along a bearing of approximately 20˚ north. Therefore a person should be able to run a perpendicular line through all parallel baitstations at a bearing of roughly 110˚. The topography of the field tends to disagree and the reality is that the baitlines, specifically the irregularly spaced baitlines do not follow these bearings very well, which led partly to the original problem. An alternate simpler strategy was consequently implemented. The number of baitstations in each neighbouring irregular baitline was totalled and compared for the highest equal amount. Of that amount the most representative stations of the baitline paths were chosen and the halfway point was found between each and marked with a point. From there these points were simply joined. Alternating marks were placed every 25 metres along this new baitline representing the baitstations and monitoring stations (Figure 2). This was undertaken for all four sets of the irregularly spaced baitlines.

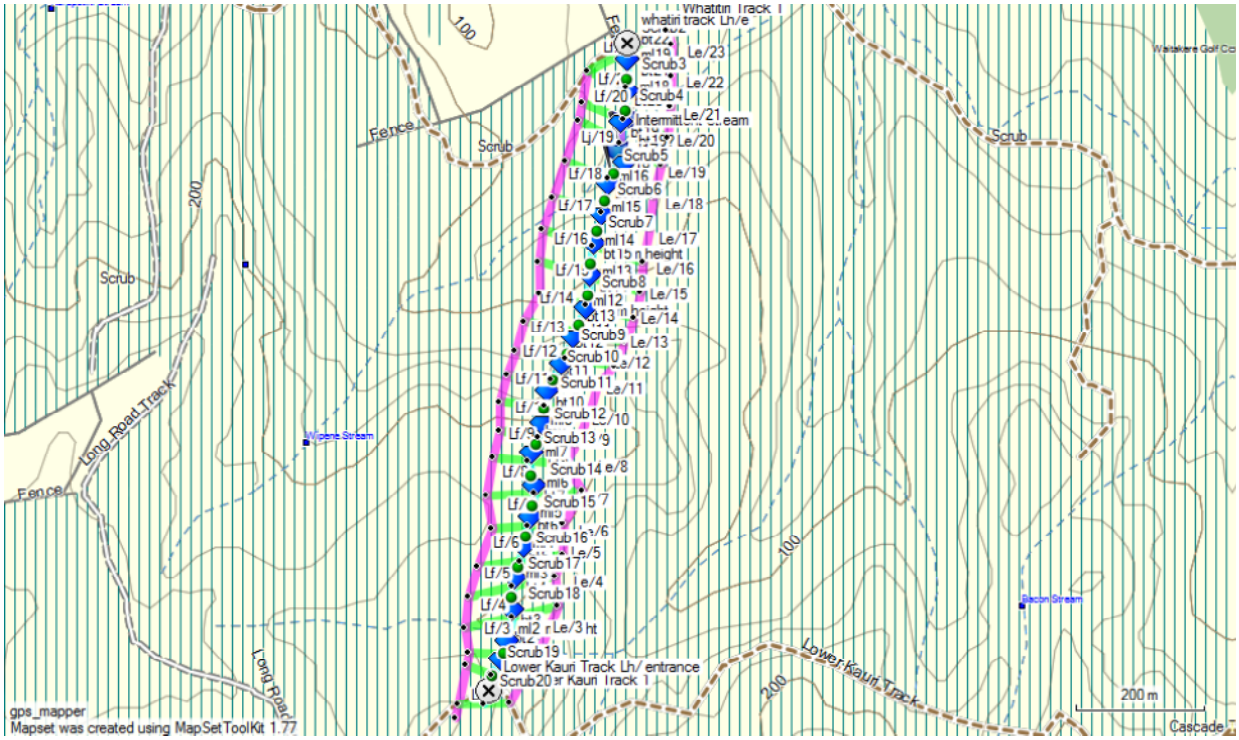


Figure 2: *Mapsource image depicting methodology for the construction of baitline Lea.*

Standard practice for monitoring suggests that monitoring lines should always lay parallel to a baitline never on top or parallel to one as it will warp the data. In the case of this project this is not an issue as the purpose of the monitoring is to see if rat presence can be decreased to below five percent rat tracking indices achievable through this method. However any follow up study may have to change the positions of the monitoring tunnels.

3.2 Baitline Construction

The GPS locations of the new baitlines were taken of Mapsource and placed onto a GPS (Garmin GPSMAP 60CSx). The lines were constructed in two stages of two man teams. The leader follows the GPS coordinates from baitstation marker to monitoring station marker and so on. This is done using the compass bearing given by the GPS followed with the use of a compass. By focusing on the furthest visible point on that bearing and following it then readjusting the course once again a person can travel from maker to marker. As the person led he/she tagged the path with tape thereby marking the baitline. The second person follows and clears a path through the bush with as little damage to the forest as possible. In the second stage the baitstations and monitoring stations were placed. Only ten monitoring stations were placed on each line within the section with the largest gaps to remove

extraneous effort and limit spending. The supporting theory behind this is simply that if the method can remove the pests from the largest area it can remove pests from the smallest area. Originally the baitstations were to be placed at the locations identified by the GPS however the Maps cannot take into account topography hence distances between baitstations may increase. The method that was used is more time costly and much more representative. A leading person walked out along the line holding the leading end of a 25 metre length of rope (used to represent the distance between bait and monitoring stations) the second person held the other end and remained in position. When the rope grew taut it marked the location of a new baitstation or possible monitoring station. As the lines lay within the Waitakere River catchment area all baitstations installed had to be lain down 20 metres outside of any major stream according to Watercare regulations. Because of this adjustments had to be made throughout the course of baitline construction and as a result certain baitstations lie closer together then others. At each of these points a GPS location would be taken for later comparison to the original virtual line. The baitstations were attached to the nearest suitable tree to each location, a standard hammers length of the ground with a stick connecting it to the ground providing an access bridge for mice. Each station location was also marked with a triangle with the stations name on it. This process is repeated along the length of the line and results in the construction of a finished baitline. The result in all cases using the second technique was a baitline with one or two more baitstations but one that functioned properly by covering all areas. It is better to be conservative and overlap then it is to create a gap. (Later adjustments can be made to lines to provide easier access ropes etc if needed) (See the appendix for finished baitlines and virtual baitline comparisons)

3.3 Baiting

The original baiting of the project lines were undertaken in December by members of the research. All other baiting was done as part of the standard baiting cycle of Ark in the Park. Below is given the general dates of baiting within L and F block as part of the regular cycle. These baitings include the irregularly spaced baitlines and the new baitlines in April 2012. Based on the data you can see that the months coincide in 2011 and 2012. This means in regards to baiting the monitoring of this research was done under the same conditions as that of McGregor.

L Block: Oct 2010, April 2011, August 2011, Nov 2011, April 2012

F Block: Sept-Oct 2010, May 2011, Aug-Sept 2011, December 2011, April 2012

Baiting was done following the standard practices of Ark in the Park a single sealed bag of second generation anti coagulant Brodifacoum was placed in each baitstation with a tear in it to allow access.

3.4 Monitoring

Monitoring was undertaken once every four or five weeks following the initial monitoring when possible (weather and intervening activities within and outside the Ark permitting) following the standard practices of Ark in the Park. Black tracking tunnels were used in conjunction with trakka (tracking) cards (white cardboard cards with ink in the middle). The cards of all six monitoring lines were placed out in the field overnight at the same time to prevent bias (peanut butter on the edges of the middle of the card acting as bait) and then collected the next day to have their data collected and recorded. All rat and mouse footprints identifiable were recorded as presence. On one monitoring occasion the cards from the three F block lines were left out over a five day period instead of overnight due to inability to collect them after a single night. Near the end of the monitoring period all the cards were left out for a month long period to see if after six plus months of baiting the results would differ from the overnight monitoring. This was undertaken by not collecting the cards after an overnight period only recording the data separately in the field and leaving the cards there till the next monitoring a month later. The line F14.5 was constructed earlier than the others to test if the methodology worked. This resulted in two extra monitorings for that line. All the lines went through a rest period of at least two weeks after construction to allow the animals to familiarise themselves with the altered environment. After this the initial overnight monitoring of all lines occurred followed by overnight monitoring six times for the L lines and Five times for the F block lines (due to the five day monitoring). (Note: one monitoring tunnel was removed for the duration of the study due to the presence of a wasp nest nearby tunnel M6 see table 2 in the appendix)

3.5 Trapping

During the initial phases of the research project we were approached and asked to supply a number of rat tails to another researcher. This project was approached as we working with larger densities of rats it allowed us to more easily supply them. Seven double entrance trap tunnels were placed at approximately the same location as seven of the monitoring stations (within five metres of each one) along the Lea baitline with two mark six Fenn traps in each. After the initial trapping the traps were integrated as part of the study. The traps were set three times over the course of the study.

3.6 Data Analysis

All recorded monitoring data was entered into an excel spreadsheet. The data grouped based on period of monitoring either overnight, five days or a month and by rat or mouse presence. Results were also separated by monitoring date to allow comparison with the 2011 McGregor data. All data concerning the monitoring results is presented as percentages representing the tracking indices. To remove bias during comparison the monitoring that started in December was continued throughout the same months as the McGregor (2011) study February through to June. However McGregor undertook her study every three weeks resulting in data for eight monitorings compared with the respective five (L block) and four (F block) for this project over the same time period. To allow for comparison the five and four data sets from the McGregor monitorings that were closest to those in this study in terms of date out of the 8 data sets were taken for comparison. This is possible as there were no changing variables during the McGregor monitorings aside from seasonal change which also occurred within the data sets of this research. Thus if the dates match using a subset of data for comparison is acceptable.

Table 1: *Chosen dates for comparison subset*

	chosen dates for the comparison subsets (Lea example)				
De Koning	25/01/2012	23/02/2012	29/03/2012	09/5/2012	13/06/2012
McGregor	10/02/2011	4/03/2011	2/04/2011	13/05/2011	4/06/2011

The results were presented in line graphs for visual comparison of the trend in monitoring results between the McGregor study and this study (Figure 3). Two tailed T-tests comparing the mean monitoring result (%) of the chosen subset of each line of the two studies was also

undertaken. Line graphs were also constructed showing the changing mice tracking indices for each line throughout the study and changing mice tracking indices compared with rat tracking indices (Figure 4 & 5). Bar graphs were made showing the rat tracking and mice tracking indices for each line during the five day monitoring and month long monitoring (Figure 6 & 7). The trapping results were collated in excel and placed in a table.

4. Results

4.1 Rat tracking index result comparison and trends

The comparative monitoring covers the period February to June. The first monitoring of this period occurs 3 months after the initial baiting of all baitlines. Different trends were clearly recorded by McGregor compared with this study (Figure 3). McGregor recorded higher and rising rat indices along the F block lines F14.5 and F9.5. The control line F3/F4 produced similar results in both studies. Comparatively this study found very little evidence of rat presence after the initiation of baiting on the lines F14.5 and F9.5. Similarly McGregor recorded higher rat indices along the L block lines Lea and the control line Lf/Lg then this baiting supported study. Both studies recorded similar results for the line L1.5. the T-test result from comparing the De Koning and McGregor mean rat tracking indices for the line F14.5 was found to be insignificant (P-value = 0.3559). However the same T-test run with all the monitoring data from both studies for F14.5 provides a different outcome. By ignoring the date of each monitoring as an influencing variable the result is considered very significant (P-value = 0.0276). For the comparison of the other five lines between the two studies the result for F9.5 is considered significant (P-value = 0.055), for control line F3/F4 insignificant (0.3559), Lea extremely significant (P-value = 0.0007), L1.5 insignificant (P-value = 0.3559) and for the control line Lf/Lg insignificant (P-value = 0.1824).

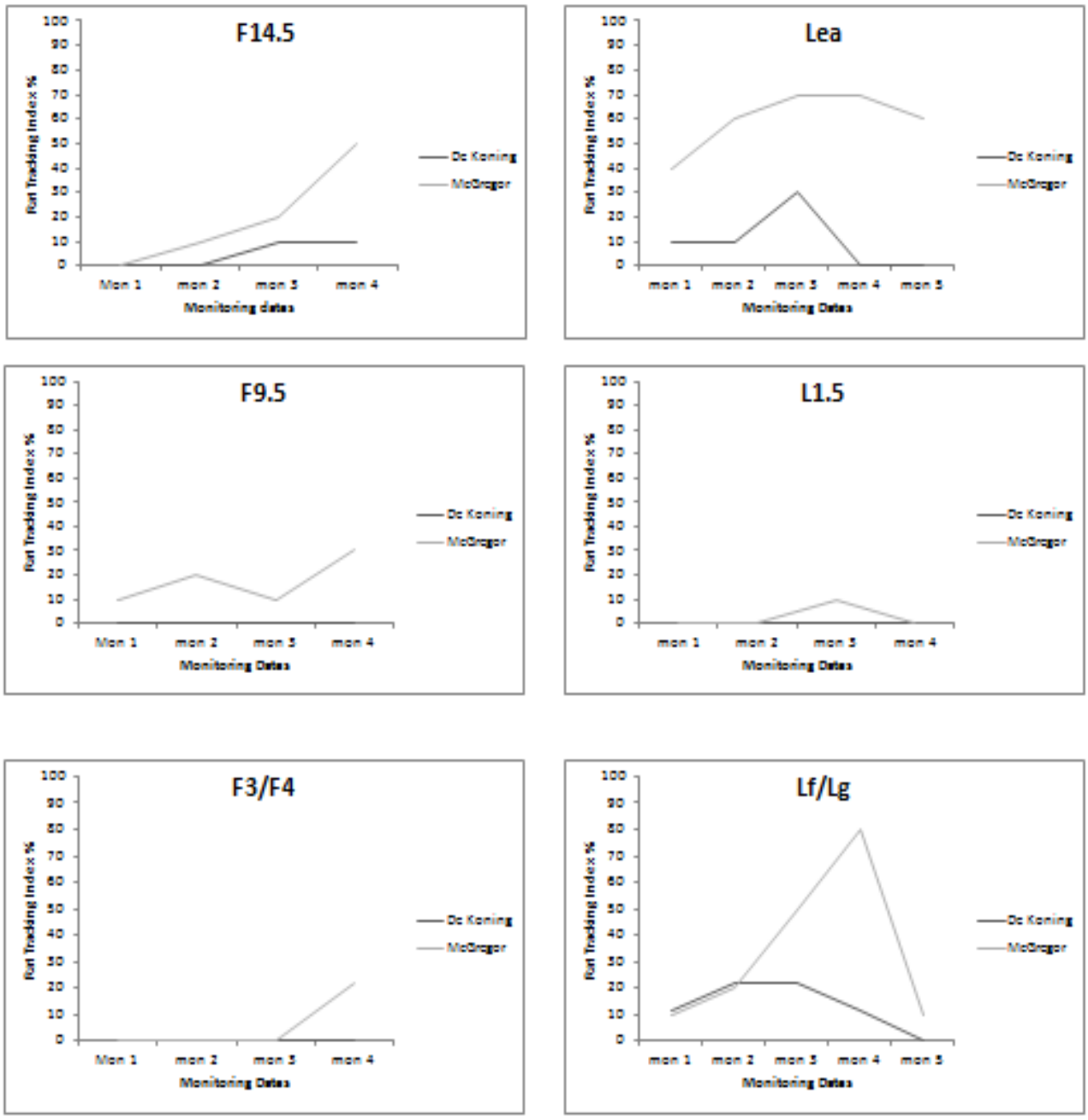


Figure 3: *Comparison of trend in recorded rat tracking indices (%) between McGregor and de Koning (February to June 2012, Ark in the Park, Waitakere) (McGregor 2011).*

4.2 Mice and rat tracking index comparison

The graphs depict mice presence during the monitoring (figure 4). In F block the only rat presence was recorded during the latter part of the monitoring. L block monitoring shows an increase in mice presence for the lines Lea and Lf/Lg over the course of the monitoring. Line L1.5 recorded no mouse presence over the course of the study. When the monitoring

data is compared with the same monitoring data for rat presence no visible trend can be identified in F block. L block can be interpreted as having an increase in mouse presence as rat presence falls according to the graph depicting the tracking indices (Figure 5).

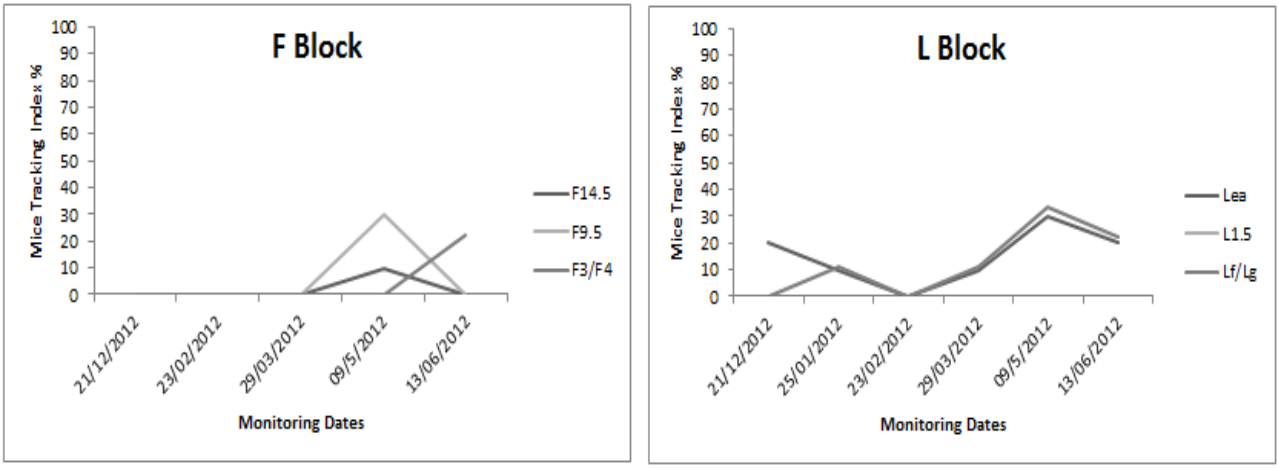


Figure 4: *Trends in mice tracking indices (%), December 2011 to July 2012.*

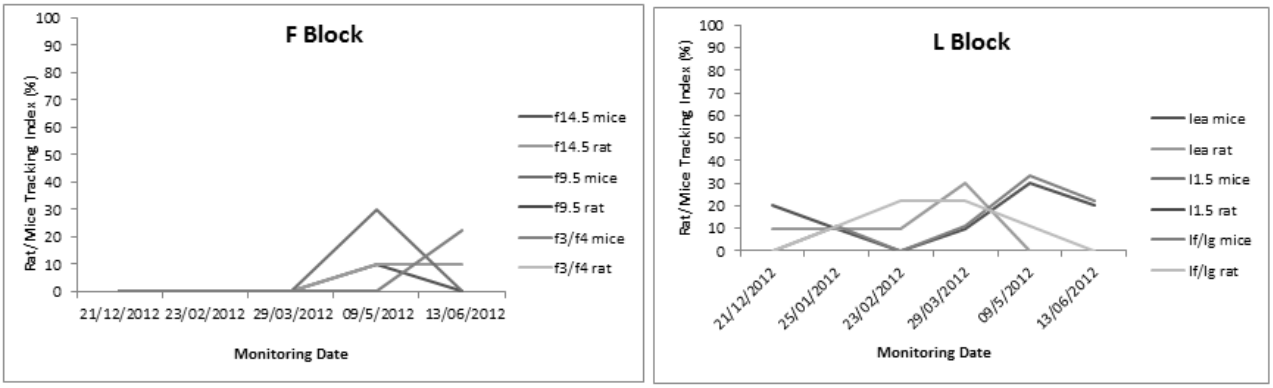


Figure 5: *Trends in mice tracking indices compared with trends in rat tracking indices (%), December 2011 to July 2012.*

4.3 Result of different monitoring time period

The mice and rat tracking indices recorded when the monitoring cards are left out for a five day period is variable according to the data and graphs (Figure 6)**.**F9.5 recorded three mice over the period of five overnight monitorings and five mice and a rat over a single 5 day monitoring. F14.5 recorded one mouse and two rats over the period of five overnight monitorings and two mice over a single 5 day monitoring. When the monitoring cards were left out for just over a month (41 days) all lines recorded higher presence for both rats and mice (Figure 7). In the case of Lea and Lf/Lg the Rat tracking indices were 100%. However

that percentage is out of the total number of cards returned not the full complement (number in brackets indicates amount of cards returned after the month).

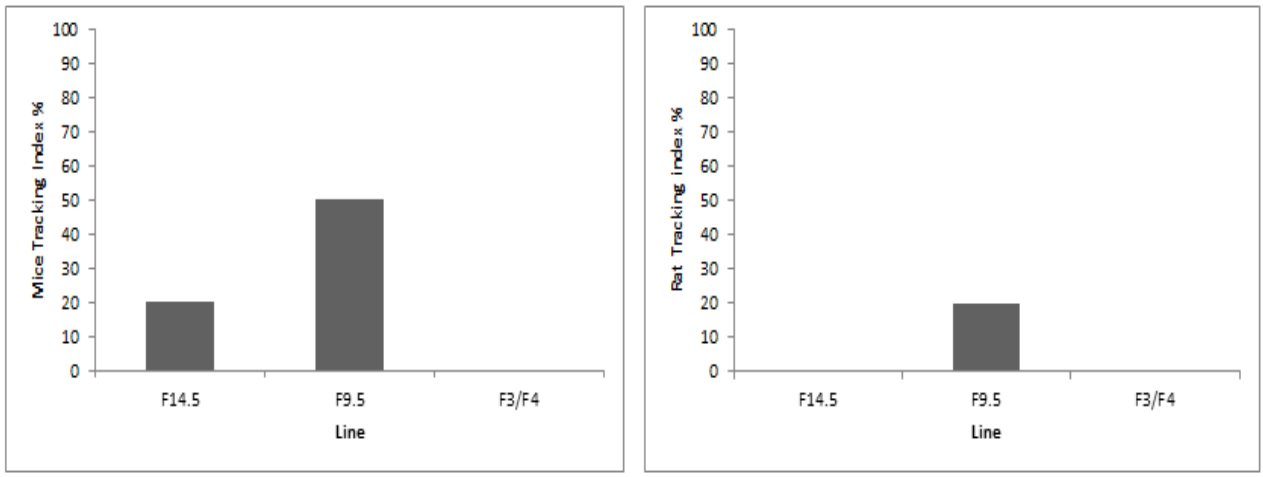


Figure 6: *Mice and rat tracking index (%) results from a 5 day monitoring (25/01/2012).*

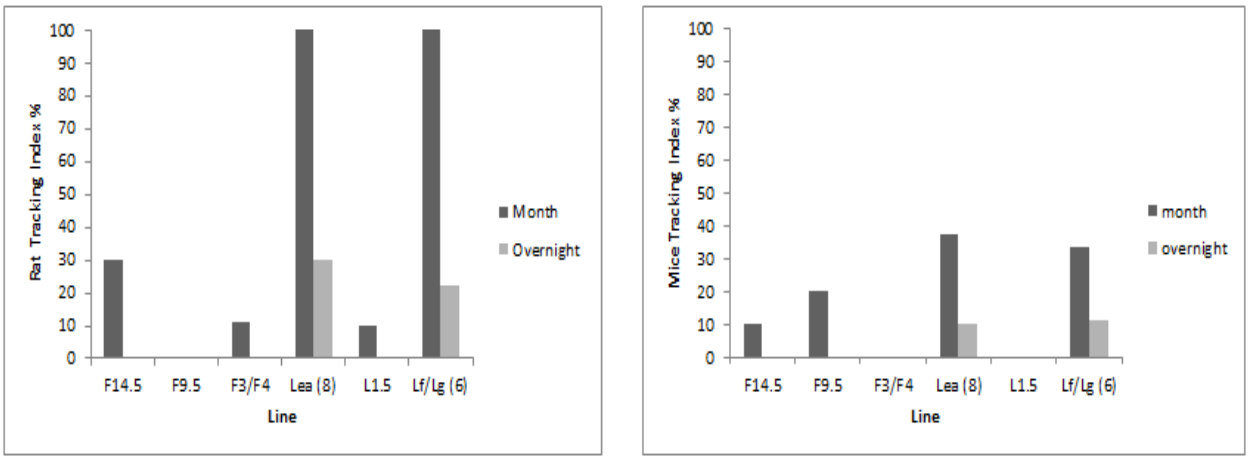
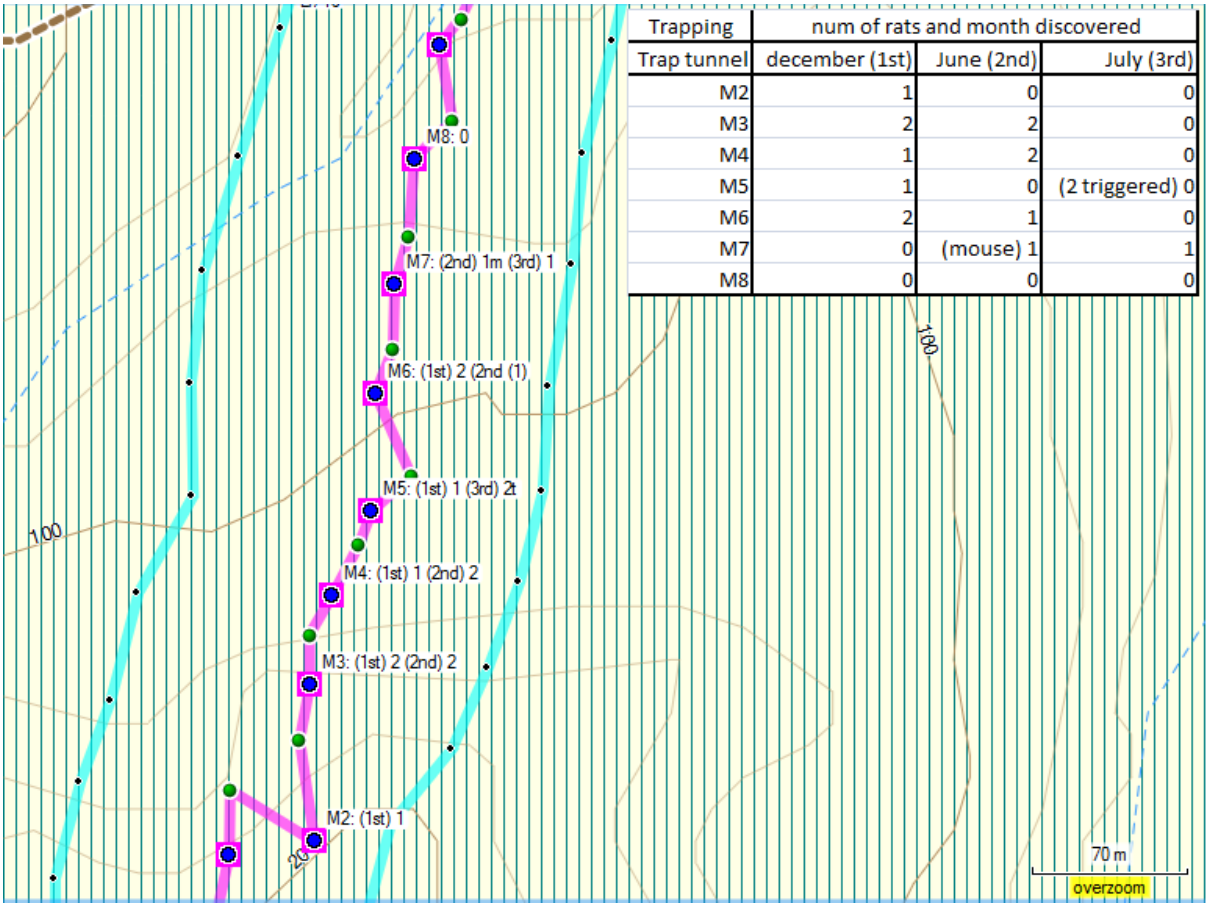


Figure 7: *Mice and rat tracking index (%) results from a one month (41 day) monitoring (29/03/2012 – 09/05/2012). (Number in brackets (-) indicates how many trakka cards were retrieved)*

4.4 Trapping

Over the period of December to July 2012 14 mark 6 Fenn taps were set three times and caught a total of thirteen rats and one mouse with two traps triggered but empty. There is no immediate trend visible between location and number of rats trapped.



Trapping	num of rats and month discovered		
Trap tunnel	december (1st)	June (2nd)	July (3rd)
M2	1	0	0
M3	2	2	0
M4	1	2	0
M5	1	0	(2 triggered) 0
M6	2	1	0
M7	0	(mouse) 1	1
M8	0	0	0

Figure 8: *Location of traps and trapping results for the period of December to July 2012, Line Lea, Ark in the Park, Waitakere (traps set 3 times)*

5. Discussion

Comparison of the rat indices recorded by McGregor (2011) and de Koning support this project as a relative success. The goal of Ark in the Park is to have rat tracking indices below the 5% level. The control lines F3/F4 and Lf/Lg of this study are the representatives of this standard within the study. F3/F4 characterizes these standards successfully. The L block control line Lf/Lg conversely presents high rat tracking indices relative to the levels that are expected from a regularly spaced baitline within the Ark and can be considered far from successful. The prior study undertaken by McGregor (2011) highlighted issues regarding the results from Lf/Lg. The three lines F14.5, F9.5 andL1.5 can be considered a success when compared with the rat indices recorded on the F3/F4 control line. The three lines have met the requirements in regards to the removal of residual embedded rat populations using standard baiting practice. Comparatively Lea and Lf/Lg cannot be considered a success by

these same standards. Model baiting practices failed in removing embedded rat populations within certain irregularly spaced baitlines and not others. This would suggest that there is more to the issue than just making certain the rat has the opportunity to interact with the bait stations.

5.1 Home range size and embedded rat populations

Among Ship and Norway rats the major pest for the Ark is most probably the ship rat. During the period 2003-2010 861 rats were trapped with only one being a Norway rat (Colgan, 2010). Norway rats (*Rattus norvegicus*) are therefore either less likely to be caught by the Fenn traps implemented during that period or the majority of rats present within Ark in the Park are of the species ship rat (*Rattus rattus)*. The home range of ship rats has been suggested for males to lie between 1.0 and 1.50 ha and 0.3 to 0.5 ha for females in New Zealand rainforests (Hooker & Innes, 1995) (Dowding & Murphy, 1994). Annual home ranges however do not follow a circular path (Dowding & Murphy, 1994) and topography and specifically features of the landscape can be highly influential on home range size in any specific direction. A pilot study in a Beech forest of Fiordland recorded rat home range sizes of much greater size (7 – 11 ha) (Pryde, Dilks, & Fraser, 2005). Within a single area home range study for ship rats in New South Wales range size varied for males depending on amount of forest vegetation (Cox, Dickman, & Cox, 2000). The effect of this on the microhabitat scale could be suggested as a highly influential factor on inability to remove residual rat populations. An issue that is possibly only enhanced in mainland islands as bird populations thrive and further remove the need for residual rat populations to travel for food.

5.2 Leaking lines and identification via mapping

Consider variable home ranges for ship rats as a factor influencing baiting capabilities. Using the program QGIS L block is depicted below (Figure: 10) with 50 metre radius buffers attached to each baitstation. The red depicts the new baitlines L1.5 and Lea laid in over the gaps. From comparison it becomes clear that the gaps were on a much smaller scale for the three successful lines compared with Lea. Secondly note the proximity of the Lf/Lg line to Lea and the small holes within Lf/Lg. It is possible that Lea acted as a source population for Lf/Lg explaining the lines failure as a control line and the high rat tracking indices recorded

there. The leaking of rats into Lf/Lg was further compounded by the small holes in that line. It could be possible but unlikely that the whole area acts as one large embedded rat population linked by small habitat corridors in between the bait stations. The mapping of baitstation GPS co ordinates with 50 metre radius buffers attached in geographic Information systems (GIS) is a viable way to identify irregularly spaced baitlines and probable embedded rat populations within a protected area. The suggested radius could be bigger though as F3/F4 is depicted below with very small gaps but with low rat tracking indices conversely this could be due to the close proximity of three different walking tracks. If the mapping method is used It is important to note the accuracy of the GPS being implemented. The Garmin GPS used by Ark in the Park have an accuracy of +5m to +10m on a clear day.

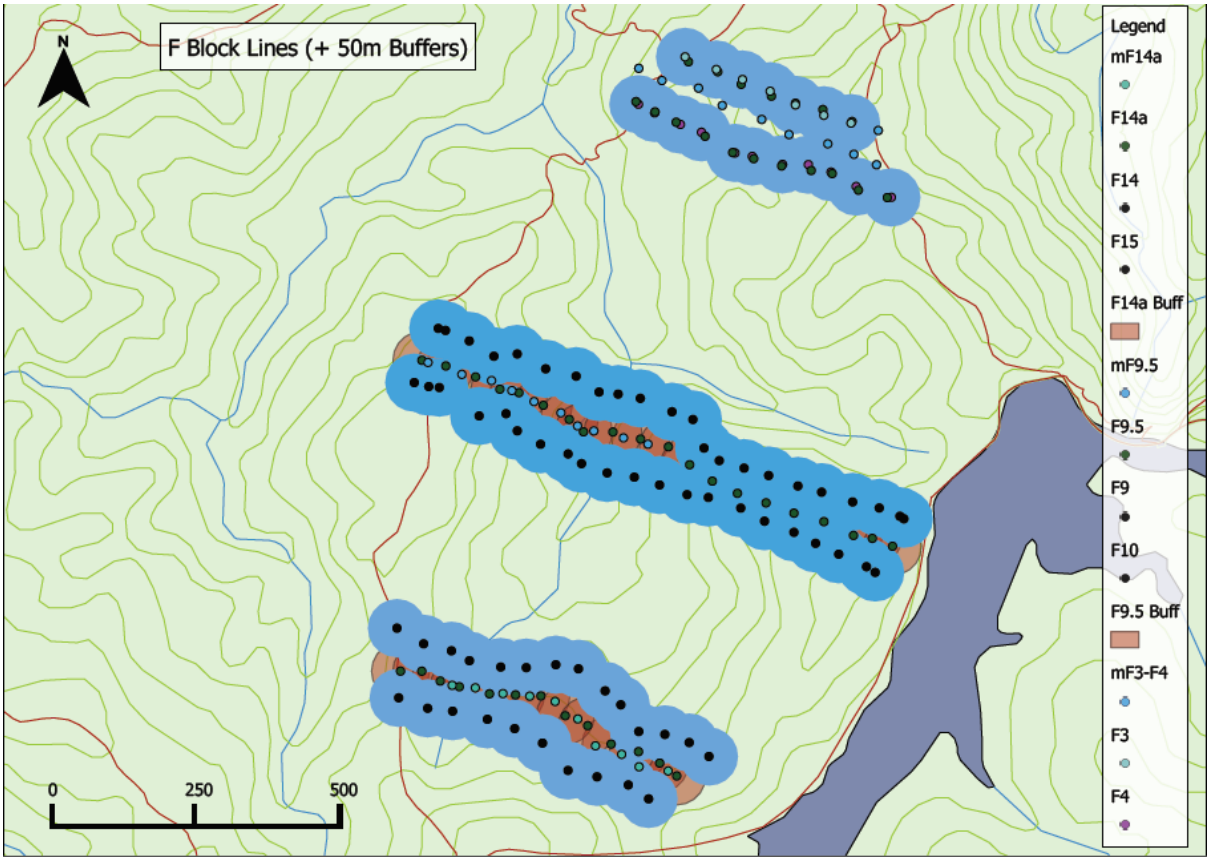


Figure 9: *QGIS map depicting F block lines and bait stations with 50 metre radius buffers, Ark in the Park, Waitakere.*

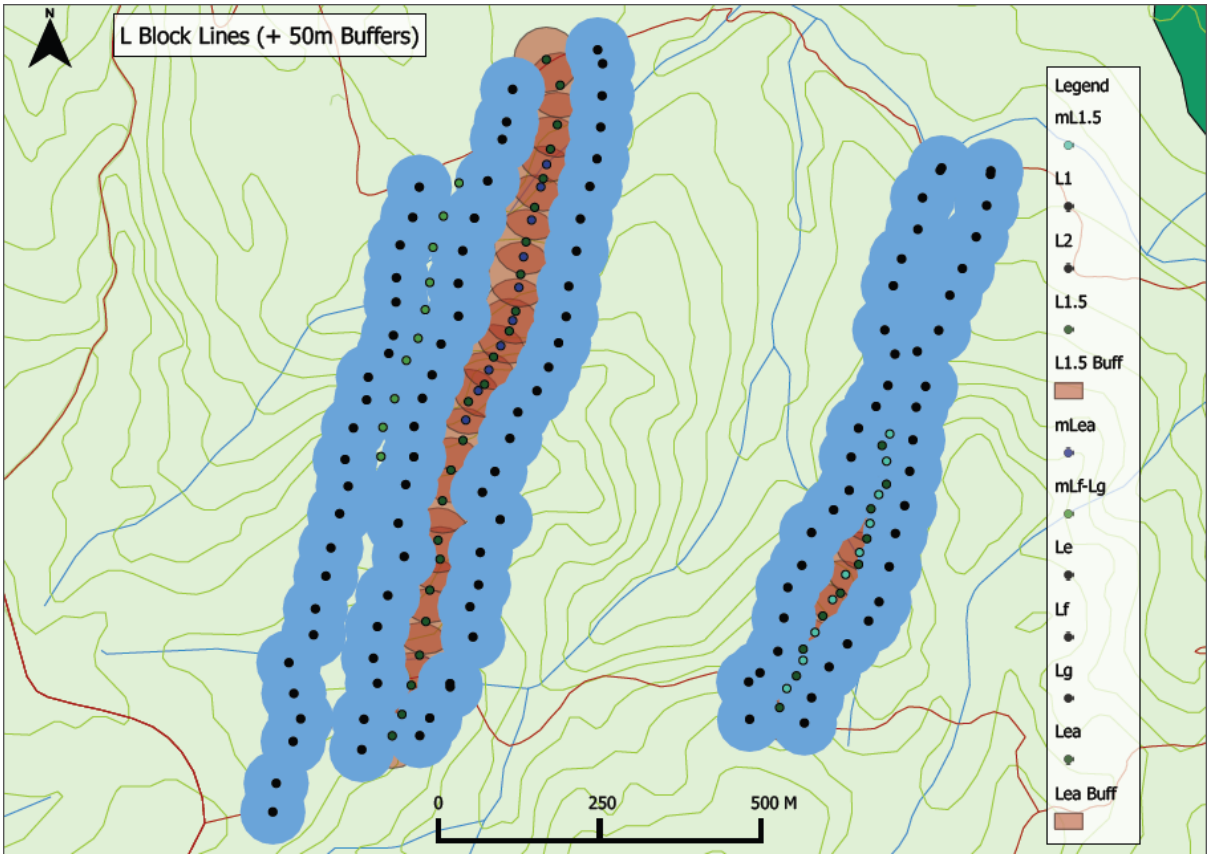


Figure 10: *QGIS map depicting L block lines and bait stations with 50 metre radius buffers, Ark in the Park, Waitakere.*

5.3 Cause and solution

The mix of variable home ranges among ship rats (Innes & Skipworth, 1983), a larger than average baitline hole and "leaking" or "proximity" baitlines have created the situation where standard baiting practices are unable to remove the embedded rat population. The rats may have become bait shy (Dubock & Kaukeinen, 1978) due to prolonged but limited exposure to the brodifacoum though it is unlikely with Brodifacoum (Hadler & Buckle, 1992). Alternately they have begun to develop resistance to second generation anticoagulants as occurred with the first (Hadler & Buckle, 1992). Resistance is unlikely though as a few more interim generations are expected before such an event occurs. In comparison trapping of Lea has remained consistent though rats can become trap shy (Innes & Skipworth, 1983) this has not been the case yet it seems. The best solution consequently is to implement a major trapping action in the area using the zippin methodology or similar to remove the current rat population. Once removed any new immigrants to the area will have no

resistance to the bait and regular baiting will be able to maintain that section below five percent rat tracking indices.

5.4 Further issues and conclusion

Throughout the study monitoring with three different lengths was undertaken. The standard period of Ark in the Park monitoring is overnight. The reduced chance of contagion is the immediate advantage where a single rat tracks over multiple cards suggesting a group where there is actually an individual (Innes, et al., 1995). Also the data is more readily comparable to other data sets using the same methodology. In comparison monitoring with longer periods of a month or more carries the disadvantage of contagion in full. Through this same aspect it carries the advantage that fewer rats are missed when the population being monitored reaches small numbers. In the case of Ark in the Parks Lea line only eight out of ten cards were found after a month of monitoring. The cards were most probably taken by the rat, behaviour that could be confirmed with a well positioned camera. Out of those eight all of them showed rat tracks suggesting the presence of more rats then can be confirmed by overnight monitoring equally home range size for those rats could be much larger than expected. The five day monitoring in the same way showed higher rat tracking indices than the overnight monitoring. The standard practice of the Ark is to use overnight monitoring yet at low levels they may not record all the rats present. The use of longer monitoring periods at that stage of the baiting may be a viable secondary confirmation of success. To avoid contagion as much as possible periods of three days or a week could be implemented instead of a month. It should be noted that when the rats were removed to the extent they were in L block predator prey relationships changed. A visible trend depicting the increase in mice numbers could be seen within Ark in the Park and was to be expected (Martineau, 2010).

Ark in the Park is a well founded project with an abundance of ecosystem and conservation situations to study. It is hoped that a few of the ideas and conclusions made within this report may aid in the removal of pests furthering the reintroduction of endemic birds into the Waitakere Ranges. The large part of what is clear is that the construction of baitlines requires a structured and systematic approach that takes into account all variables a feat that will become easier as GIS improves. Though it may be slower in the future setting up

correct baitlines and being preventative is a much more cost effective approach in the long run then future problem solving. Being on the conservative side is always best and one baitstation more is always better than one baitstation less.

Acknowledgements

Andy Warneford you brought me this project, acted as my supervisor throughout and always had an insight for me to mull over, thank you for it all. I would like to thank Maj De Poorter for giving me this opportunity and entrusting me with this project. Laurence Béchet I cannot express how much I appreciated all your help in the field, throughout the mapping, the advice you gave and the lessons you taught me about organizing groups of people just pure thanks. To all my awesome volunteers throughout the length of the project cheers and thanks to you all, specifically Chris and Bruce your help throughout undoubtedly helped to make this possible. Finally thanks to the unknowns that led to me arriving at the conclusion of this amazing opportunity and lesson.

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Appendix

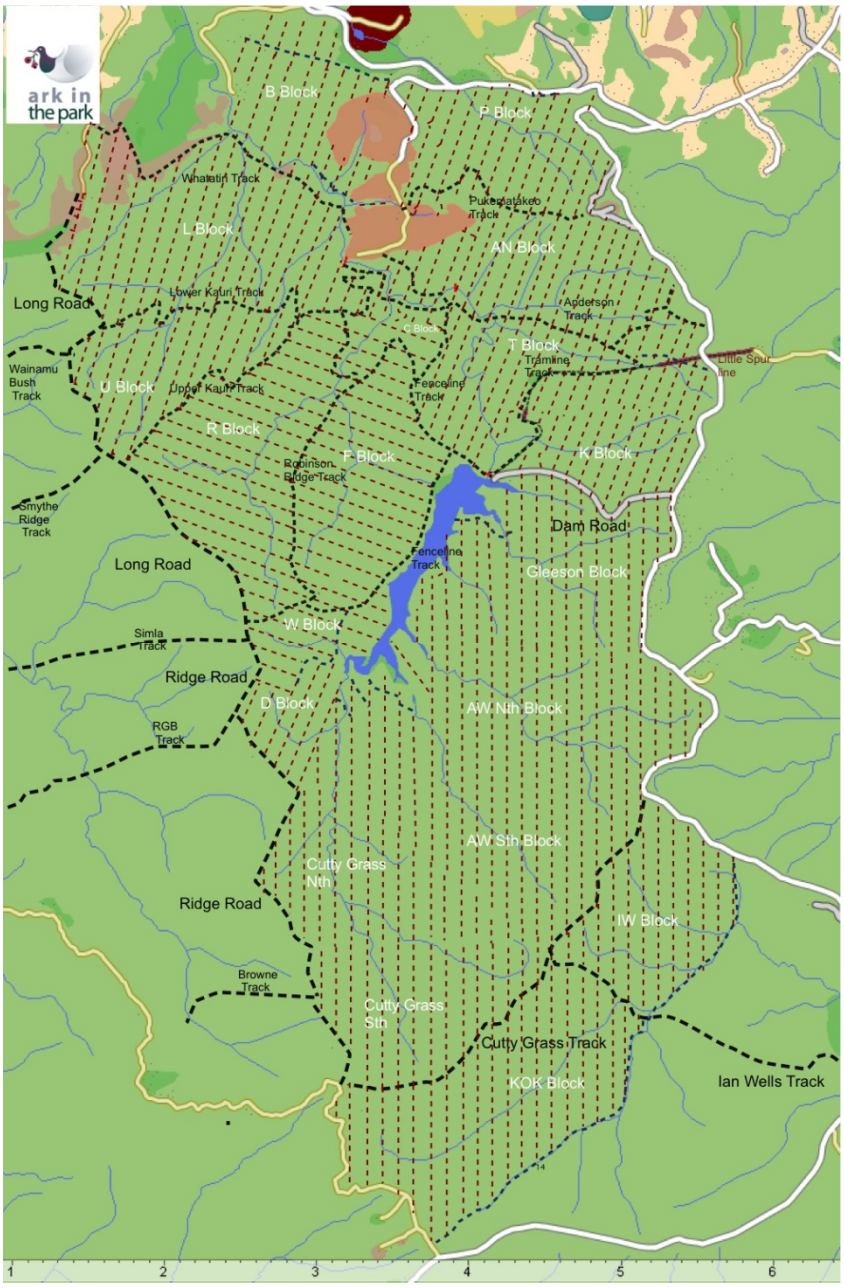

Figure 11: *Map of Ark in the Park Cascades Kauri, Waitakere Ranges, Auckland.*

Table 2: *Overnight rat/mice monitoring data (2011-2012).*

Embedded Rat Pop Study Monitoring Results

F Block	Date:	8/11/2011	20/11/2011	21/12/2012	25/01/2012	23/02/2012	29/03/2012	09/5/2012	13/06/2012
F14.5	1	0	0	0	-	0	0	0	0
	2	0	0	0	-	0	0	0	0
	3	0	0	0	-	0	0	0	0
	4	0	0	0	-	0	0	0	0
	5	0	0	0	-	0	0	0	0
	6	0	0	0	-	0	0	0	1
	7	0	0	0	-	0	0	1	0
	8	0	0	0	-	0	0	(mice) 1	0
	9	0	0	0	-	0	0	0	0
ERP	10	0	0	0	-	0	0	0	0
F9.5	1	-	-	0	-	0	0	0	0
	2	-	-	0	-	0	0	0	0
	3	-	-	0	-	0	0	0	0
	4	-	-	0	-	0	0	(mice) 1	0
	5	-	-	0	-	0	0	0	0
	6	-	-	0	-	0	0	0	0
	7	-	-	0	-	0	0	0	0
	8	-	-	0	-	0	0	0	0
	9	-	-	0	-	0	0	(mice) 1	0
ERP	10	-	-	0	-	0	0	(mice) 1	0
F3	1	-	-	0	-	0	0	0	0
	2	-	-	0	-	0	-	0	0
	3	-	-	0	-	0	0	0	0
	4	-	-	0	-	0	0	0	0
	5	-	-	0	-	0	0	0	0
	6	-	-	0	-	0	0	0	(mice) 1
	7	-	-	0	-	0	-	0	(mice) 1
	8	-	-	0	-	0	0	0	0
	9	-	-	0	-	0	0	0	0
CTRL									

L Block	Date:	8/11/2011	20/11/2011	21/12/2012	25/01/2012	23/02/2012	29/03/2012	09/5/2012	13/06/2012
Lea	1	-	-	0	0	0	1	0	0
	2	-	-	0	0	0	0	0	0
	3	-	-	(mice) 1	(mice) 1	0	(rats/mice) 1	(mice) 1	(mice) 1
	4	-	-	0	0	0	0	0	0
	5	-	-	(rats/mice) 1	0	0	0	(mice) 1	(mice) 1
	6	-	-	0	0	0	1	0	0
	7	-	-	0	0	0	0	0	0
	8	-	-	0	0	0	0	(mice) 1	0
	9	-	-	0	1	0	0	0	0
ERP	10	-	-	0	0	1	0	0	0
L1.5	1	-	-	0	0	0	0	-	0
	2	-	-	0	0	0	0	-	0
	3	-	-	0	0	0	0	-	0
	4	-	-	0	0	0	0	-	0
	5	-	-	0	0	0	0	-	0
	6	-	-	0	0	0	0	-	0
	7	-	-	0	0	0	0	-	0
	8	-	-	0	0	0	0	-	0
	9	-	-	0	0	0	0	-	0
ERP	10	-	-	0	0	0	0	-	0
Lf/Lg	1	-	-	0	0	0	0	0	0
	2	-	-	0	0	0	1	0	0
	3	-	-	0	0	1	0	0	0
	4	-	-	0	0	1	1	0	(mice)1
	5	-	-	0	1	0	0	(rats/mice) 1	0
	6	-	-	0	-	-	-	-	-
	7	-	-	0	(mice) 1	0	0	(mice)1	0
	8	-	-	0	0	0	(mice)1	(mice)1	(mice)1
	9	-	-	0	0	0	0	0	0
CTRL	10	-	-	0	0	0	0	0	0

Table 3: *Five day and month long rat/mice monitoring data (2012).*

ERP study 5 Day Monitoring				ERP study inter period (month) Monitoring					
F Block	tunnel	25/01/2012		F Block	tunnel	29/03/2012	L Block	tunnel	29/03/2012
F14.5	1	0		F14.5	1	(mice) 1	Lea	1	1
	2	0			2	0		2	1
	3	0			3	1		3	-
	4	0			4	0		4	1
	5	0			5	0		5	-
	6	0			6	0		6	(rats/mice) 1
	7	0			7	0		7	(rats/mice) 1
	8	(mice) 1			8	0		8	1
	9	0			9	1		9	1
ERP	10	(mice) 1		ERP	10	1	ERP	10	-
F9.5	1	0		F9.5	1	0	L1.5	1	-
	2	0			2	0		2	0
	3	(mice) 1			3	(mice) 1		3	0
	4	(mice) 1			4	0		4	0
	5	(mice) 1			5	0		5	0
	6	0			6	(mice) 1		6	0
	7	1			7	0		7	1
	8	(mice/rats) 1			8	0		8	0
	9	(mice) 1			9	0		9	0
ERP	10	0		ERP	10	0	ERP	10	0
F3	1	0		F3	1	0	Lf/Lg	1	0
	2	0			2	0		2	-
	3	0			3	0		3	-
	4	0			4	1		4	1
	5	0			5	0		5	(rats/mice) 1
	6	0			6	0		6	-
	7	0			7	0		7	1
	8	0			8	0		8	-
	9	0			9	0		9	-
CTRL				CTRL			CTRL	10	1

Table 4: *Amount of bait taken from each baitstation on line Lea (24/04/2012).*

Baitstation	State of Bait (24/04/2012)
Lea1	Bait not eaten and Bag nibbled
Lea2	Bait not eaten and Bag nibbled
Lea3	Bag nibbled and more than ½ gone
Lea4	Bag nibbled and less than ½ gone
Lea5	Bait not eaten and Bag nibbled
Lea6	Bait not eaten and Bag nibbled
Lea7	Bait not eaten and Bag nibbled
LeA 8	Bait not eaten and Bag nibbled
LeA 9	bag nibbled and Bag nibbled
LeA10	Bag nibbled and Bag nibbled
Lea11	Bait not eaten and Bag nibbled
Lea12	Bait not eaten and Bag nibbled
Lea13	Bait not eaten and less than half
LeA 14	Bag nibbled and more than ½ gone
LeA15	more than ½ and more than ½
LeA16	all gone and all gone
LeA19	bag nibbled and more than half
LeA20	Bait not eaten and Bag nibbled
LeA21	more than half and all gone
LeA22	Bait not eaten and Bag nibbled
LeA23	Bait not eaten and Bag nibbled

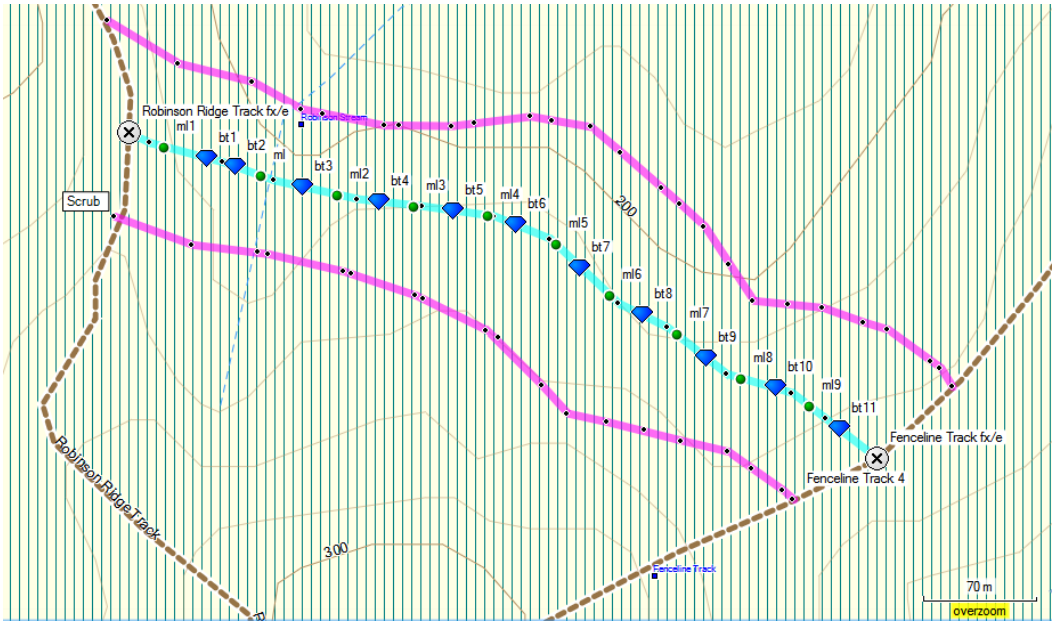

Figure 12: *Mapsource image depicting line F14.5 (no comparison map).*

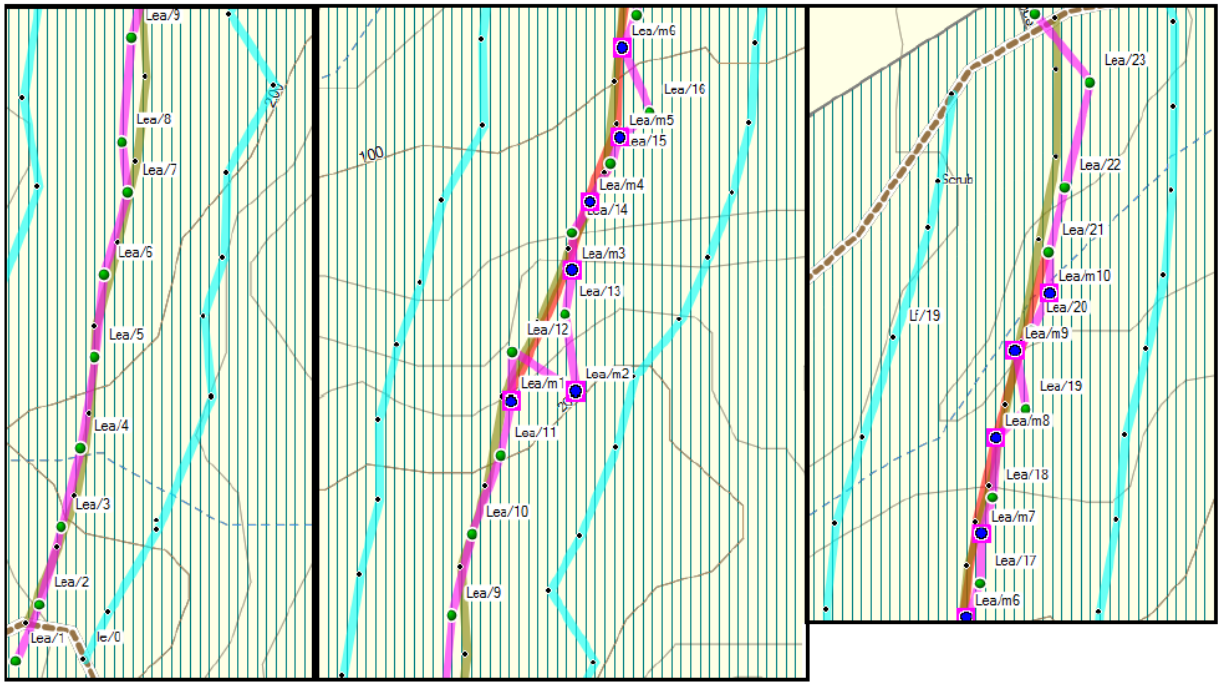

Figure 13: *Mapsource images depicting Line Lea comparison, virtual line overlaid by field line.*

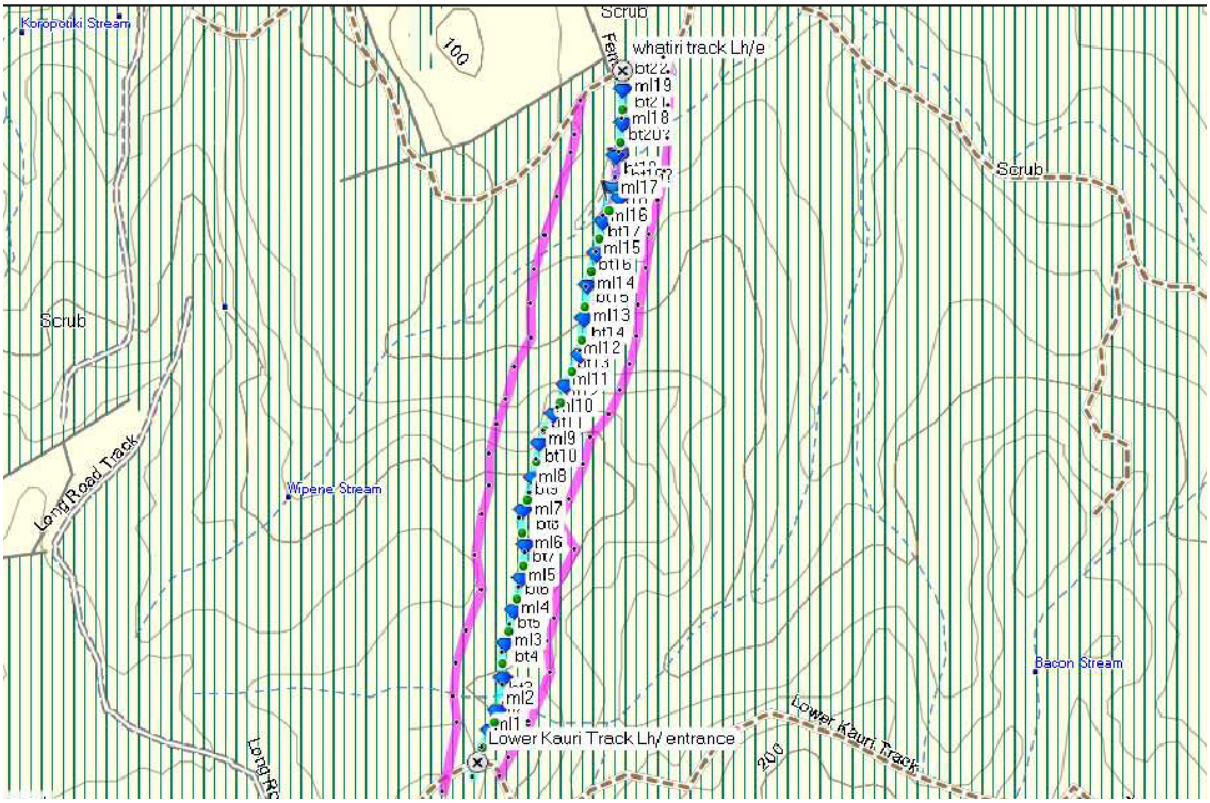

Figure 14: *Mapsource image depicting Line Lea.*

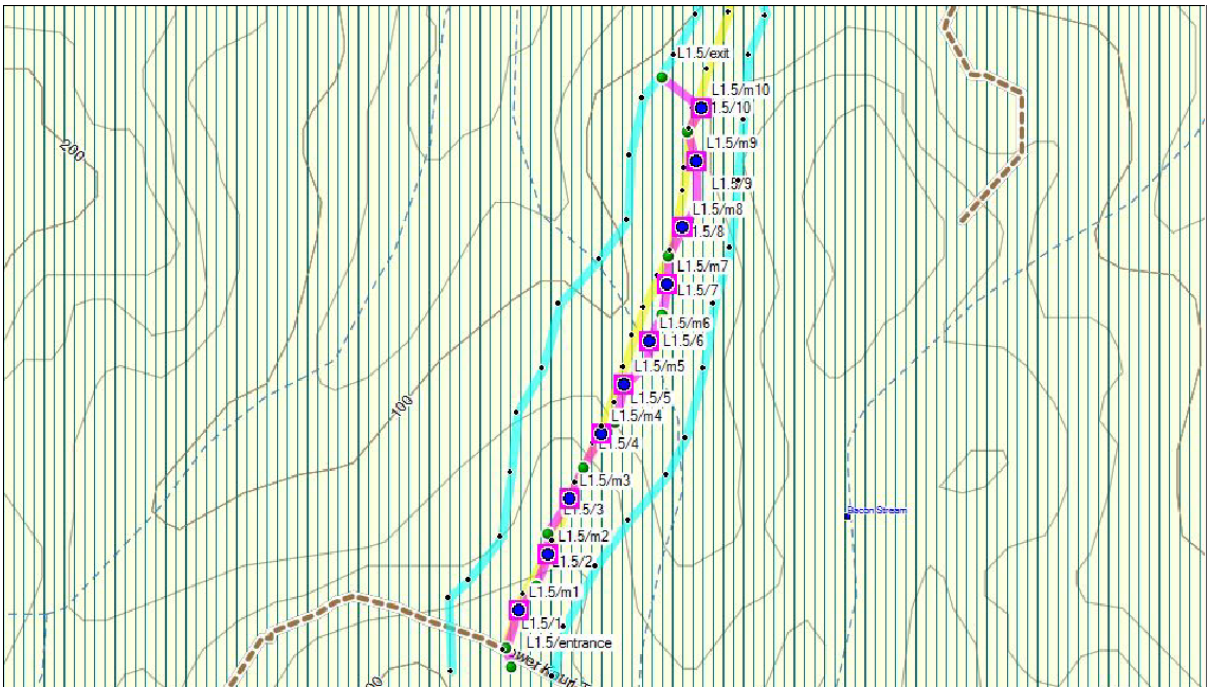

Figure 15: *Mapsource images depicting Line L1.5 comparison, virtual line overlaid by field line.*

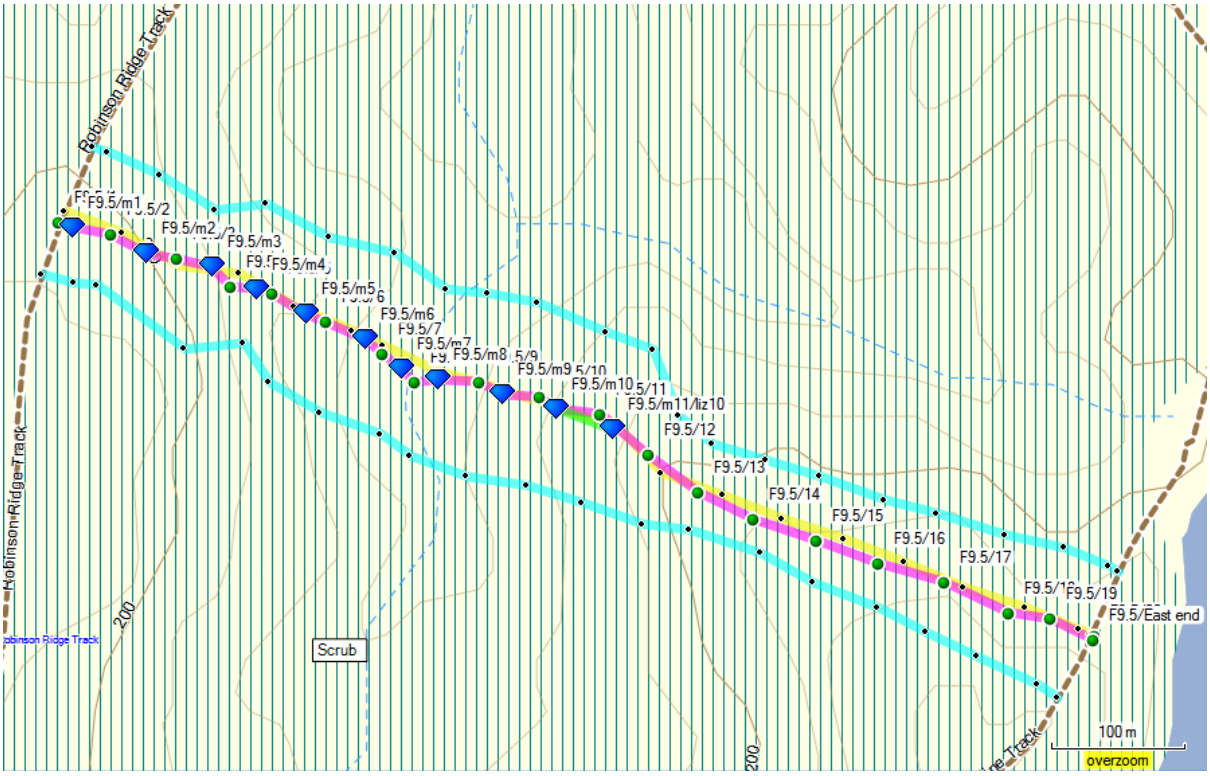

Figure 16: *Mapsource image depicting Line F9.5.*

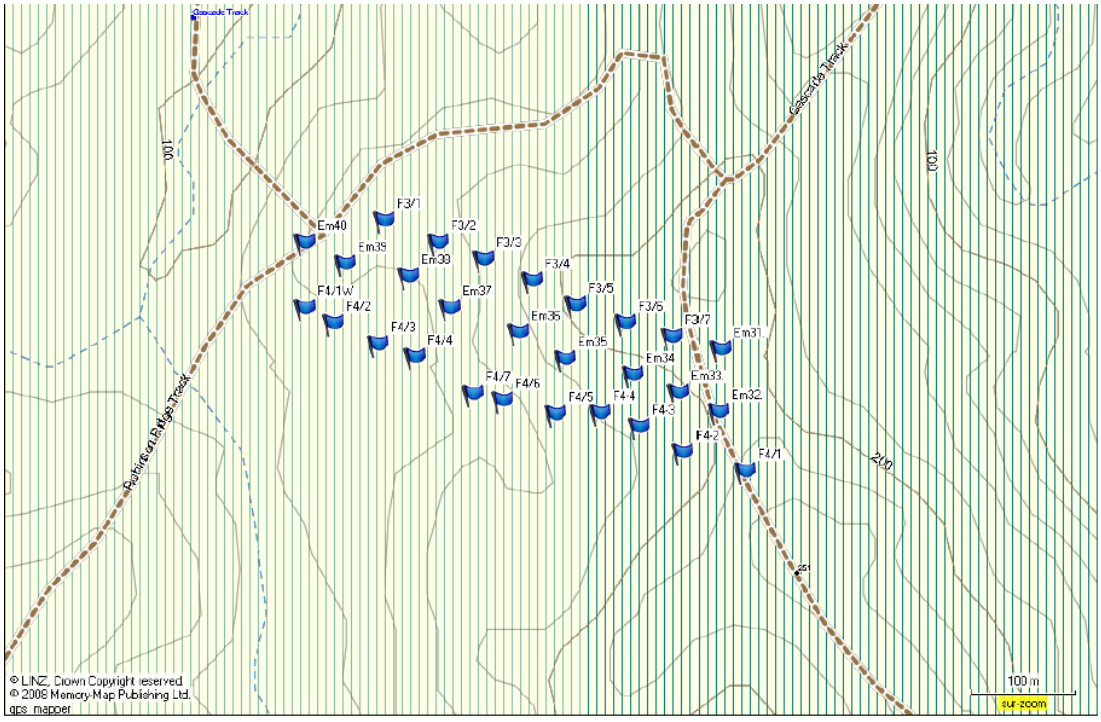

Figure 17: *Mapsource image depicting Line F3/F4 (Source McGregor).*

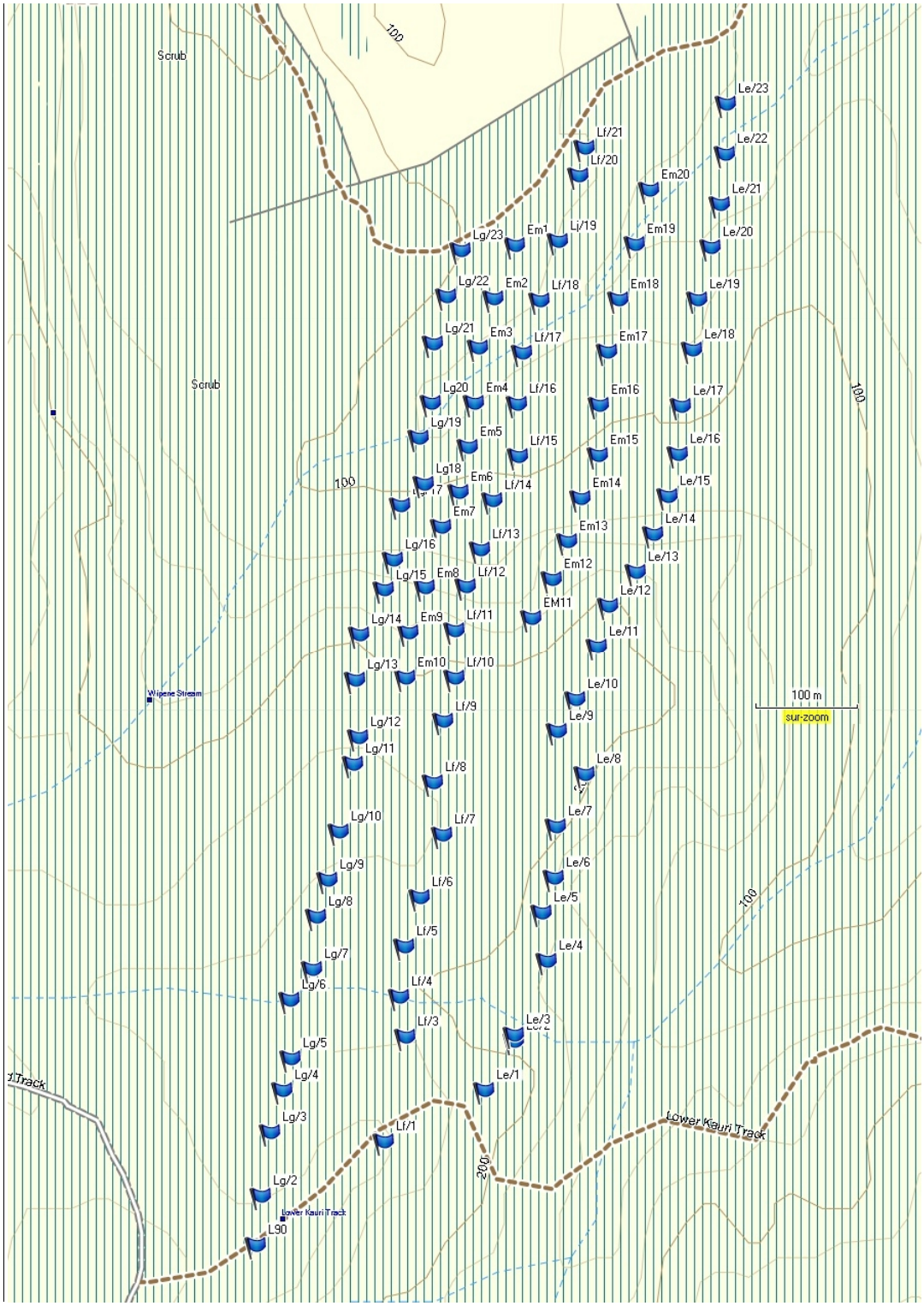

Figure 18: *Mapsource image depicting Lines Lea, Lf/Lg and surrounding lines (Source McGregor).*