Greyhound Racing New Zealand

Box Draw Review

October 2013

Confidential

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Contents

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1. Executive Summary

1.1 Objectives and Scope

Greyhound Racing New Zealand (GRNZ) has requested a review of the integrity of the process to select box draws for greyhound races.

The scope of our review was to perform the following procedures to assess the integrity of the process:

- A review of the end-to-end process to ensure appropriate controls are in place to ensure the integrity of the box draw process and to prevent or identify unauthorised changes to data.

- A review of access rights to the applications used for selecting box draws.

- Testing of results of the random number generator for unexpected trends.

- Documentation of results.

1.2 Approach

The review was conducted primarily by applying discussion, observation and review techniques with limited detailed testing being undertaken. The approach focussed on:

- understanding through discussion and observation with GRNZ management and staff and external IT services providers the box draw selection process in place;

- documenting and evaluating the controls within the process.

- Reviewing results of box draws over the past 3 years to establish any potential trends that would suggest that the box draw process is not operating effectively.

1.3 Basis and use of report

This report has been prepared in accordance with the objectives and approach set out above, and is subject to the limitations set out in Appendix 3 "Basis and Use of Report".

1.4 Overview of Findings

The table below provides a summary of the main findings resulting from our review.

Attribute	Comments
Box Draw Operational Process	- There appears to be little opportunity for the box draw prices to manipulated by GRNZ staff. - Changes that are made can be tracked in the On Track system and a report of such changes is generated. - There is however no formal review of this report. Such a review should be introduced.
Box Draw Technical Process	- The random number generator uses an algorithm to select the box draws. As such, technically, the selection is "pseudo-random" – Truly random numbers cannot be calculated using an algorithm. - The random number generator selects the greyhounds based on the record ID which is understood to be numbered in the order in which they are entered into the system (i.e. nominated). The random number generator has no record of the name of the greyhound or of the name of the trainer. - When a greyhound is selected, it is randomly allocated a box number between 1 and 8. If the lane it is given has already been allocated then the random number generates another number until a free box has been found.
Review of Box Draws by Greyhound	On the basis of the testing undertaken, no indication of adverse trends in box draws was identified.
Review of Box Draws by Trainer	On the basis of the testing undertaken, no indication of adverse trends in box draws was identified.

We have provided, in section 2, more detailed findings and analyses relating to the box draw process.

2. Box Draw Process Review

2.1 Operational Box Draw Process

A flow chart of the operational process for selecting box draws is attached as Appendix 1 to this report.

It is noted that after the box draw is made, an approximate two-day window is left for trainers to review the box draw and potentially raise any queries (e.g. for potential selection criteria errors that have been made by the greyhound racing club).

During this time it is possible for GRNZ to perform manual or system redraws. When a redraw is undertaken, the member of staff who has made the redraw, the timing of the redraw and explanation for the redraw is recorded in the On Track system.

A report can be generated from the On Track system of all processes undertaken during the box draw process and includes any manual or system redraws. There is however no formal review of this report undertaken which would identify any irregularities in the box draw process.

A review of the On Track system report should be undertaken by a member of staff independent of the box draw process to ensure no unexplained or unjustified redraws have taken place.

Any irregularities identified should be investigated and resolved.

2.2 Technical Box Draw Process

A summary of the technical box draw process has been provided by GRNZ's outsourced IT service provider.

This summary is provided in Appendix 2.

The key points to be noted in this provided by the summary are the following:

- GRNZ's On Track system applies a standard Microsoft Random Number Generator to select the box draws. The random number generator uses an algorithm to select the box draws. As such, technically, the selection is "pseudo-random" – Truly random numbers cannot be calculated using an algorithm.
- The random number generator selects the greyhounds based on the record ID which is understood to be numbered in the order in which they are entered into the system (i.e. nominated). The random number generator has no record of the name of the greyhound or of the name of the trainer.
- When a greyhound is selected, it is randomly allocated a box number between 1 and 8. If the lane it is given has already been allocated then the random number generates another number until a free box has been found.

3. Testing of Results from the GRNZ Random Number Generator (RNG)

3.1 Analysis of Random Numbers – Basis for Comparison to GRNZ RNG Numbers

An assumption to be made in the random selection of boxes is that over time it is likely that a trainer will receive an approximately even spread of box draws from 1-8. It is however unclear as to how large the population of box draws needs to be before such a trend is likely to be identifiable.

In order to provide a basis of comparison to the numbers generated by the GRNZ RNG, a review of 10,000 random numbers between 1 and 8 was selected using random.org which uses atmospheric noise to select random numbers rather than pseudo-random numbers selected using an algorithm.

The table below shows the results of box draws after 100, 500, 1,000, 5,000 and 10,000 draws:
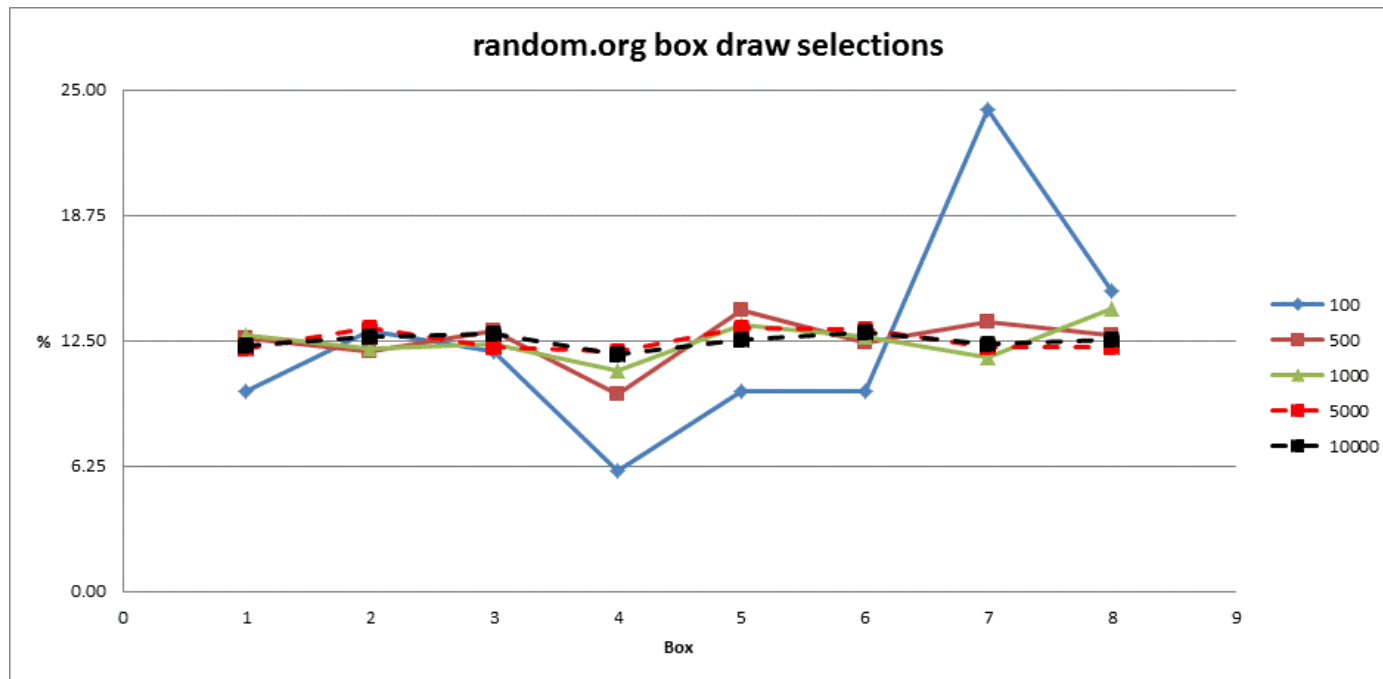
It can be seen from the analysis that after 5,000 box draws, there is almost a flat lane across each box. It is to be noted that after only 100 box draws, there is a wide range of box selections with box 4 selected only 6 times and box 7 selected 24 times. This provides an indication of the wide range of box draws that a random selection can provide.

3.2   Review of Box Draw by Greyhound

One of the complaints received by GRNZ relating to the box draw is that the same greyhound is regularly drawn in the same box.

It is to be noted that each time a greyhound enters the box draw it is with a different record ID generated by the On Track nomination system. The name of the greyhound itself is not part of the selection process.

An analysis of the greyhounds that have had more than 150 starts since 01/08/2010 is presented below, along with the first 150 random numbers generated in the analysis in in section 3.1.above.
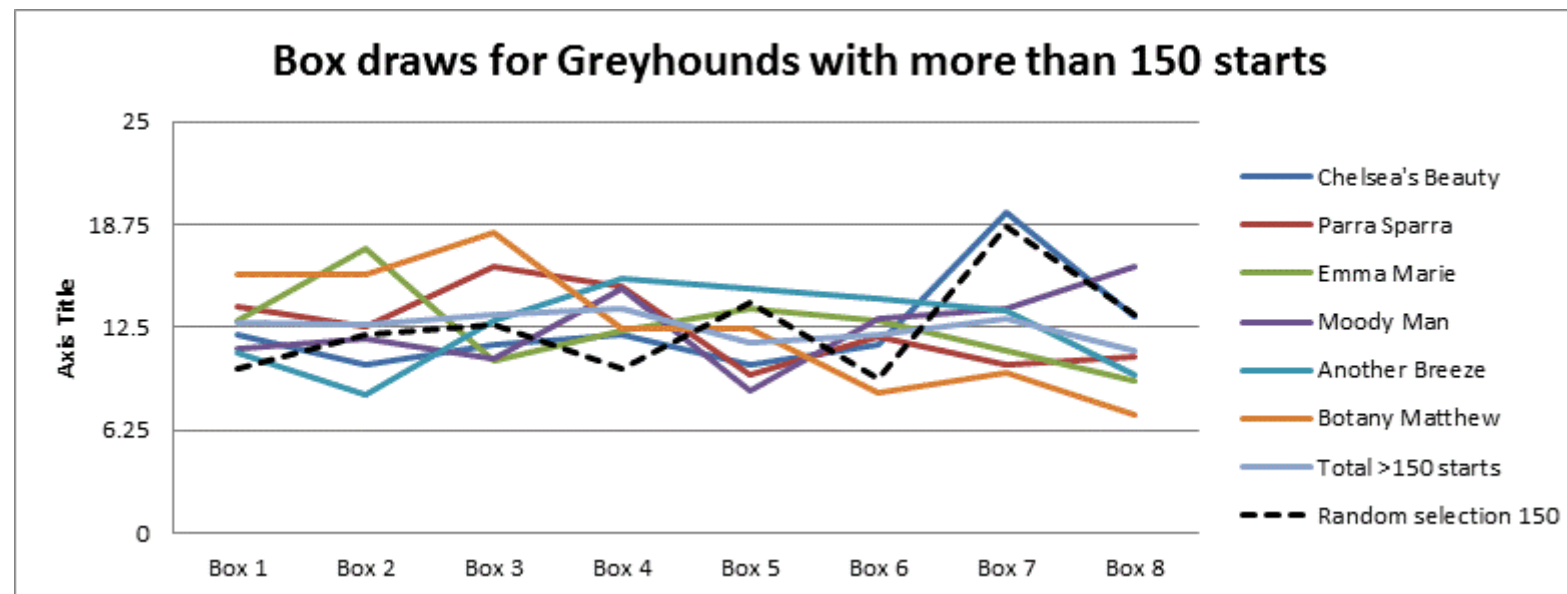
It can be seen from the results, that due to the number of starts for these greyhounds, ranging between 153 and 175, that the number of starts is too small to expect a flat line at 12.5%. The 150 random numbers generated indicate a similar variance to those greyhounds included and there is no indication from this analysis that the RNG is providing results or trends that differ from a randomly selected draw. Additionally, as indicated in the analysis in section 3.1 above, a large number of draws is required (potentially as many as 5,000) before it appears that an equal spread across all 8 boxes occurs. This is multiple times more than any greyhound will race.

Moving on to the specific concern raised by certain trainers that greyhounds regularly draw the same box twice in a row, a further analysis has been undertaken on races between 1 October 2010 and 18 September 2013 to establish if any such trends exist. During this time, 128,871 consecutive box selections of greyhounds were analysed (the analysis did not take into account the Greyhound Racing Club, simply the next race of that greyhound).

The table below indicates the probabilities of which box a greyhound is likely to draw in its next race.

		Race 2 box compared to Race 1 box							
		Box 1	Box 2	Box 3	Box 4	Box 5	Box 6	Box 7	Box 8
Race 2 box compared to Race 1 box	Box 1	0	-1	-2	-3	-4	-5	-6	-7
	Box 2	1	0	-1	-2	-3	-4	-5	-6
	Box 3	2	1	0	-1	-2	-3	-4	-5
	Box 4	3	2	1	0	-1	-2	-3	-4
	Box 5	4	3	2	1	0	-1	-2	-3
	Box 6	5	4	3	2	1	0	-1	-2
	Box 7	6	5	4	3	2	1	0	-1
	Box 8	7	6	5	4	3	2	1	0

Race 1 box marked in black

Different box to last race	Opportunities	Possibilities	Probability
7 boxes lower (e.g. box 8-box 1)	1	64	1.56%
6 boxes lower	2	64	3.13%
5 boxes lower	3	64	4.69%
4 boxes lower	4	64	6.25%
3 boxes lower	5	64	7.81%
2 boxes lower	6	64	9.38%
1 box lower	7	64	10.94%
Same box	**8**	**64**	**12.50%**
1 box higher	7	64	10.94%
2 boxes higher	6	64	9.38%
3 boxes higher	5	64	7.81%
4 boxes higher	4	64	6.25%
5 boxes higher	3	64	4.69%
6 boxes higher	2	64	3.13%
7 boxes higher	1	64	1.56%
			100.00%

The results of the 128,871 consecutive box selections can be seen in the table and graph below:

Different box to last race	% expected	Actual Number	% actual	% variance
7 boxes lower (e.g. box 8-box 1)	1.56	2,004	1.56	-0.01
6 boxes lower	3.13	4,114	3.19	0.07
5 boxes lower	4.69	6,076	4.71	0.03
4 boxes lower	6.25	8,052	6.25	0.00
3 boxes lower	7.81	9,943	7.72	-0.10
2 boxes lower	9.38	12,124	9.41	0.03
1 box lower	10.94	13,942	10.82	-0.12
Same box	12.50	16,284	12.64	0.14
1 box higher	10.94	14,058	10.91	-0.03
2 boxes higher	9.38	12,088	9.38	0.00
3 boxes higher	7.81	10,073	7.82	0.00
4 boxes higher	6.25	7,961	6.18	-0.07
5 boxes higher	4.69	6,031	4.68	-0.01
6 boxes higher	3.13	4,036	3.13	0.01
7 boxes higher	1.56	2,085	1.62	0.06
		128,871		
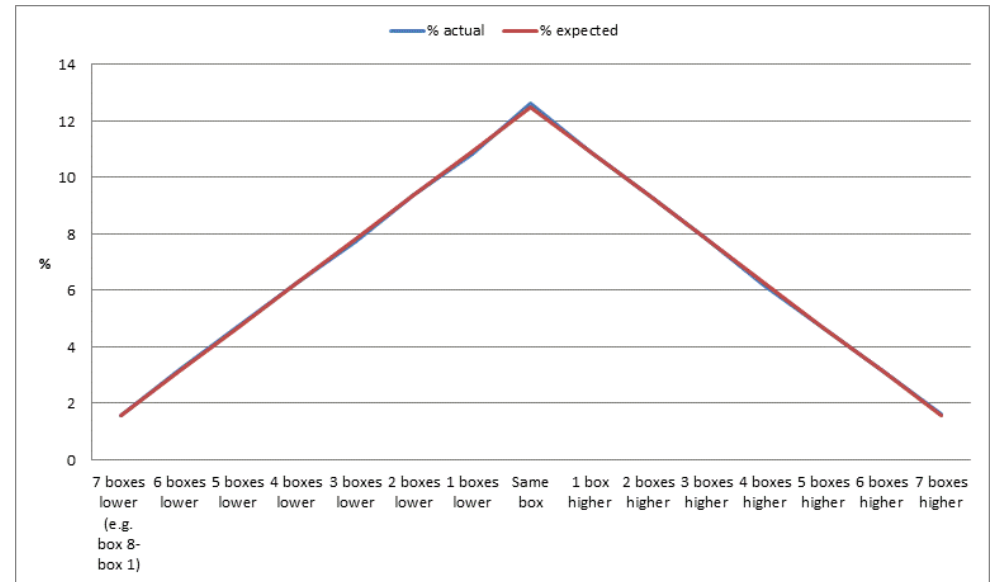
As the graph indicates, with a population of over 128,000 to test, the situations in which a greyhound is selected in the same box as its previous race, or in any other box is very close to the statistical probability. There is a 12.5% probability that a greyhound will be drawn in the same box as its previous race and an analysis of the past 3 years indicates that it has occurred in 12.64% of cases (0.14% more times than expected). In actual numbers, with 128,871 consecutive box selections, it would be expected that in 16,109 cases, the greyhound would be allocated the same box. In reality this has occurred 16,284 times, 175 more than statistically expected.

3.3   Review of Box Draw by Trainer

Two complaints received by GRNZ on the box draw relate to trainers "receiving a bad box draw" and trainers with 2 or more greyhounds in a race seemingly having those greyhounds drawn next to each other.

Two initial areas to consider are the definition of what is a "bad box draw" and the fact that the name of the trainer plays no part in the box selection process.

"Bad Box Draw"

In order to identify whether there is a good or bad box draw, an analysis of the starting boxes of all placed greyhounds (those finishing 1st, 2nd or 3rd) has been undertaken for all races between 1 August 2010 and 17 September 2013.

The following results can be seen for 15,933 races run between 1 August 2010 and 17 September 2013.
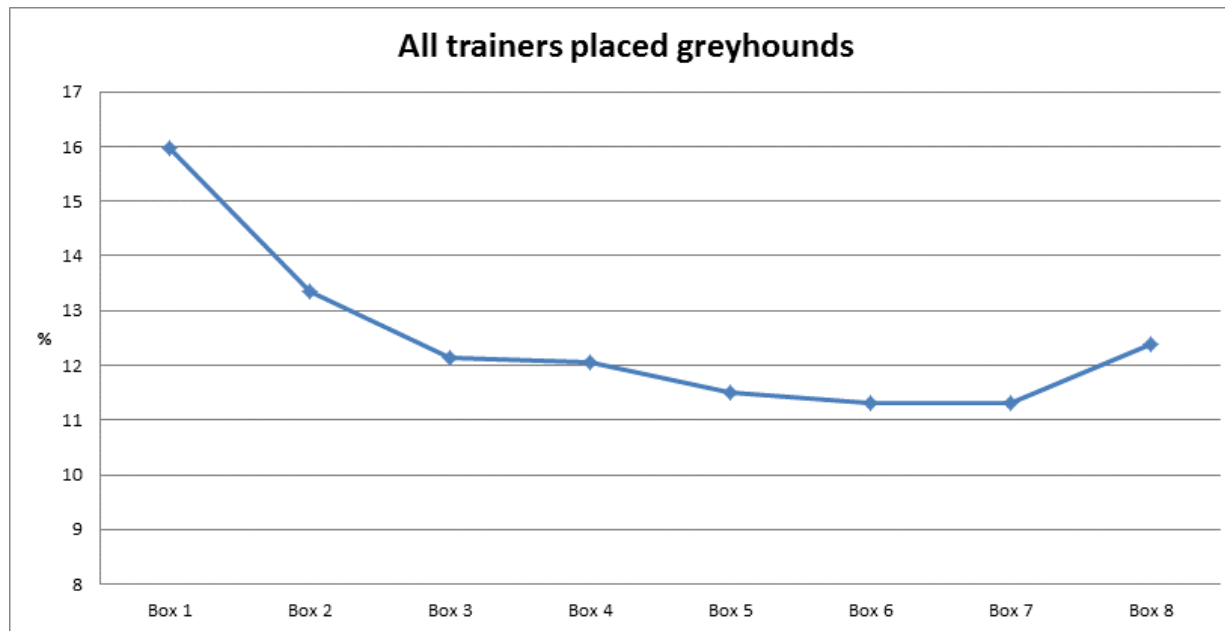
The analysis suggests that box 1 is clearly the best box to draw followed by box 2. Following that, there is between 11.3% and 12.4% rates for all the other 6 boxes.

When considering each individual racing club, the trends can change. The analysis below shows the trends for winners at races at the 3 clubs with the most races held (Auckland, Christchurch and Wanganui) in the period from 1 August 2010 to 17 September 2013. In this case the trend is less clear. Box 1 is still clearly the best box to draw but beyond that there is little to suggest that there is a "bad box draw".

Starting Boxes of Winning Greyhounds
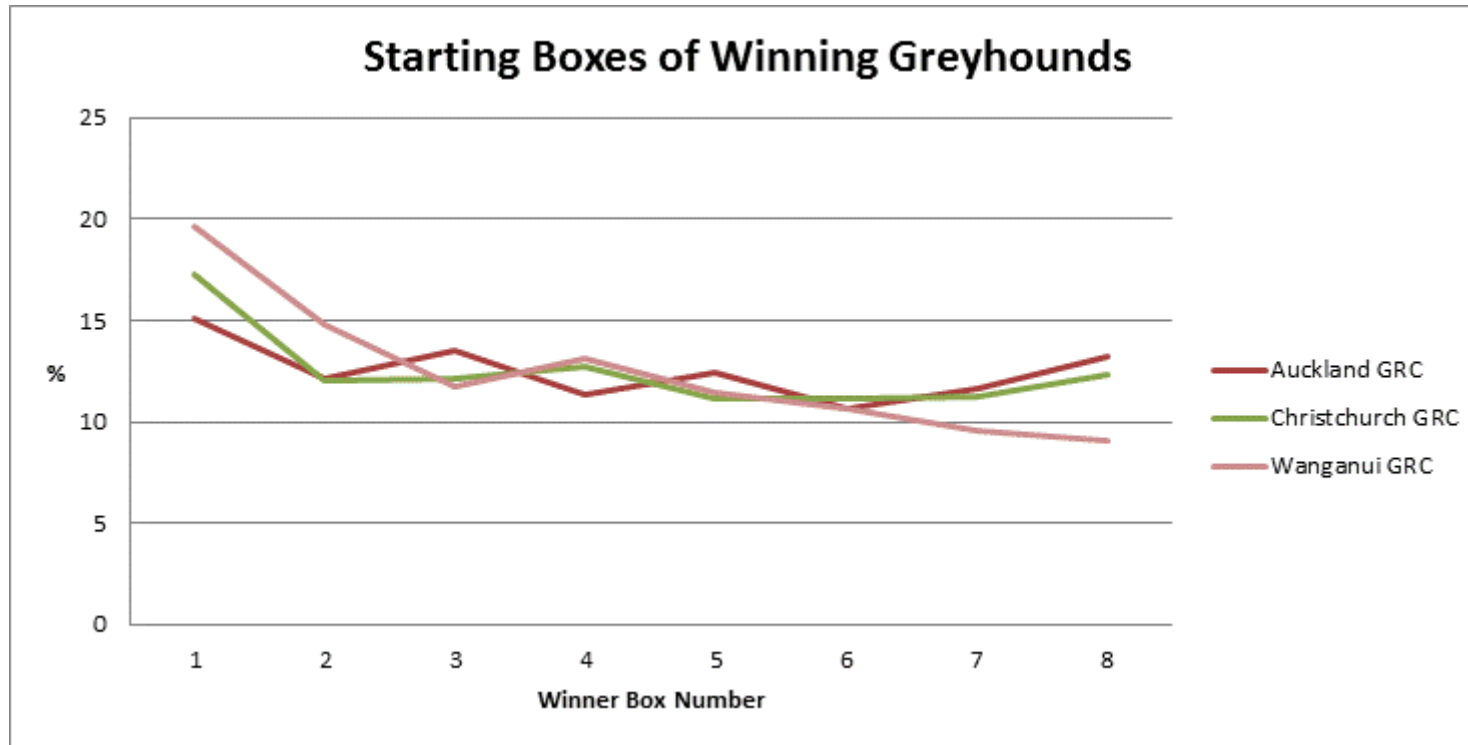
A final analysis of a selection of individual trainers has been undertaken to consider any specific trends that may have arisen at an individual trainer level.

The results of this analysis are presented below.
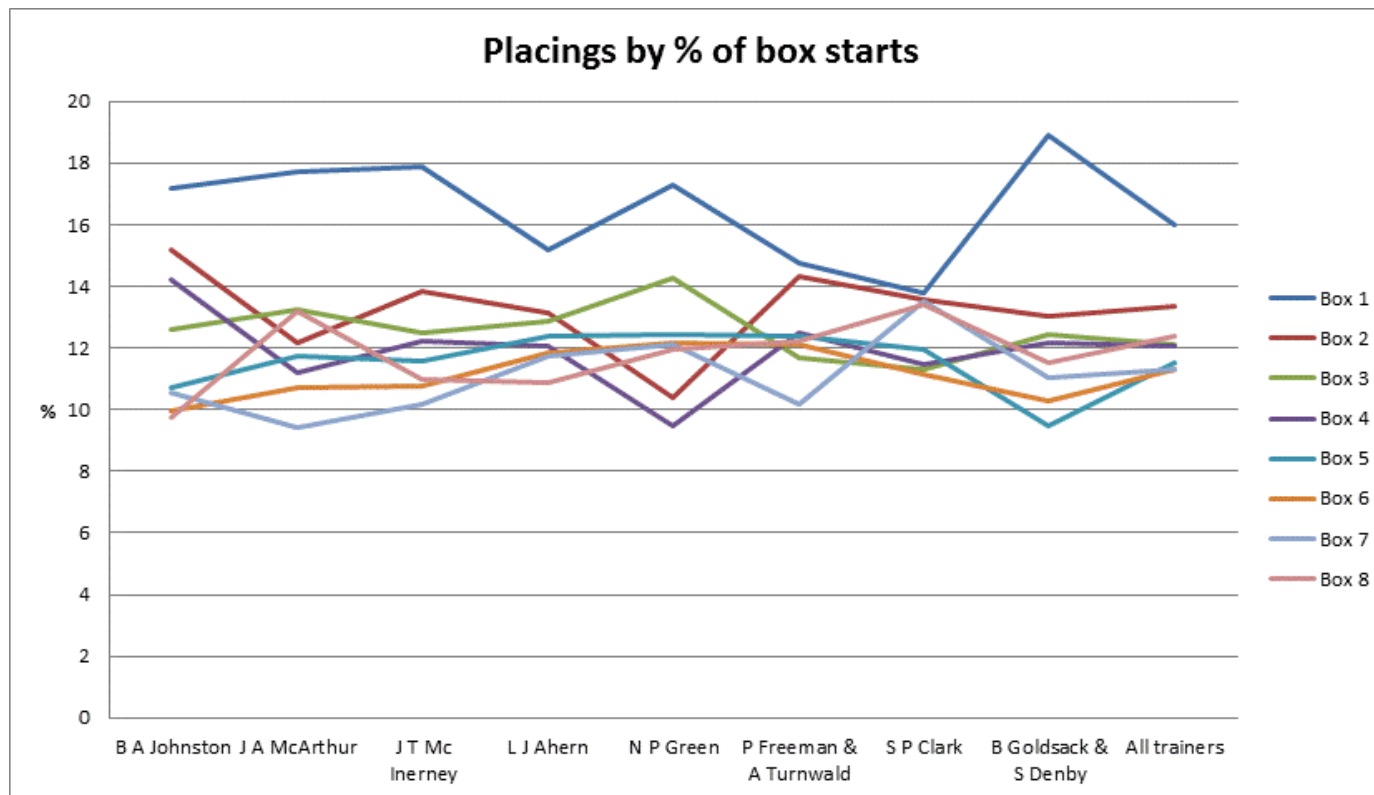
The results again highlight the similar trend that box 1 is the most successful box, possibly followed by box 2 and then little to determine between the remaining boxes.

Box Draw Selections by Trainer

The same selection of trainers as above have been reviewed to establish if any specific trends exist between trainers and the box draws during the period 1 August 2010 to 17 September 2013.

The overall results can be seen below:

Percentage of box draws by trainer

These box draws are a group of randomly selected trainers.
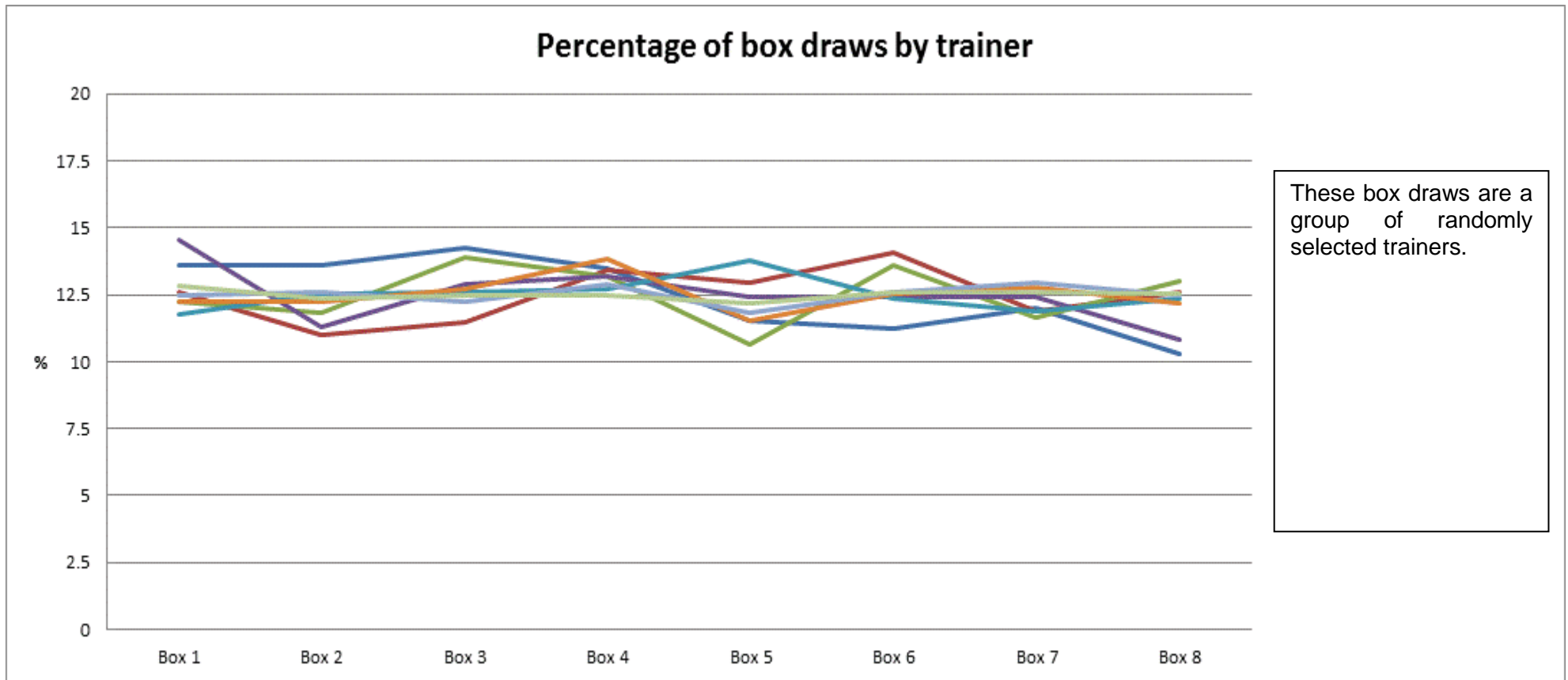
Box Draw Selections by Trainers with two greyhounds in a race

The final analysis considers concerns raised by trainers that if they have more than one greyhound in a race, those greyhounds are regularly drawn in boxes next to each other. This analysis has considered the situations where trainers have had two greyhounds in a race. With more than two greyhounds in a race, the likelihood of them being drawn next to each other increases further than in the analyses shown below.

The probability of two greyhounds being dawn next to each other in a race can be seen from the analysis below:

		Dog 2							
		Box 1	Box 2	Box 3	Box 4	Box 5	Box 6	Box 7	Box 8
	Box 1	Dog 1	1	2	3	4	5	6	7
	Box 2	1	Dog 1	1	2	3	4	5	6
	Box 3	2	1	Dog 1	1	2	3	4	5
Dog 2	Box 4	3	2	1	Dog 1	1	2	3	4
	Box 5	4	3	2	1	Dog 1	1	2	3
	Box 6	5	4	3	2	1	Dog 1	1	2
	Box 7	6	5	4	3	2	1	Dog 1	1
	Box 8	7	6	5	4	3	2	1	Dog 1

No of lanes apart	Opportunities	Total possibilities	Probability
1	14	56	= 25.00%
2	12	56	= 21.43%
3	10	56	= 17.86%
4	8	56	= 14.29%
5	6	56	= 10.71%
6	4	56	= 7.14%
7	2	56	= 3.57%

As noted, there is a 25% probability that a trainer with two greyhounds in a race will have those greyhounds drawn in boxes next to each other.

Between the period of 1 August 2010 and 17 September 2013, there were 13,685 races in which a trainer had two greyhounds in a race. The analysis of where those greyhounds were placed in the box draw can be seen below:

	Expected %	Actual %	Variance %	Expected no	Actual no	Variance no
Races where dogs next to each other	25.00	25.21	0.21	3,421	3,450	29
Races where 2 lanes apart	21.43	21.22	-0.21	2,933	2,904	-29
Races where 3 lanes apart	17.86	17.41	-0.44	2,444	2,383	-61
Races where 4 lanes apart	14.29	14.44	0.15	1,955	1,976	21
Races where 5 lanes apart	10.71	10.33	-0.38	1,466	1,414	-52
Races where 6 lanes apart	7.14	7.53	0.39	978	1,031	54
Races where 7 lanes apart	3.57	3.85	0.28	489	527	38
Total races					13,685	
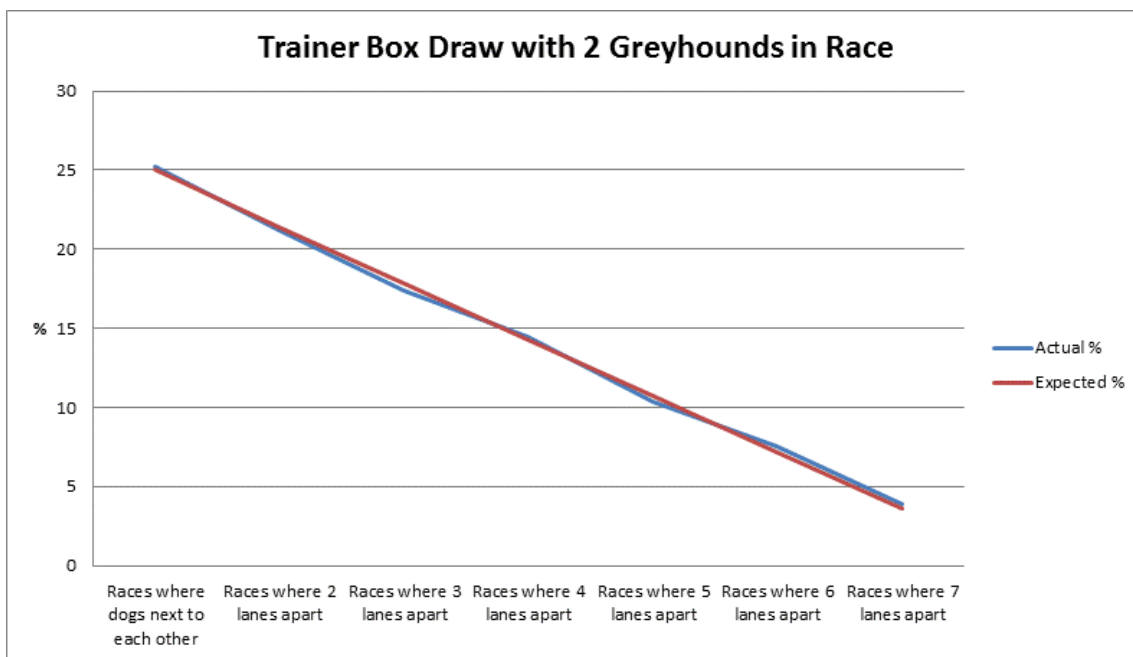
The trends can be seen to be very much in alignment with expected probabilities. It is noted that there is a 0.21% variance on the number of times a trainer has two greyhounds in a race and they are drawn next to each other. Of the 13,685 times a trainer has had two greyhounds in a race, those greyhounds have been drawn in boxes next to each other on 29 occasions more than the average probability.

4. Appendices

Appendix 1 – Operational Box Draw Process

```
┌─────────────────────────────────────────────────────────────────────┐
│              Race meeting is scheduled in Access Database            │
└─────────────────────────────────────────────────────────────────────┘
                                   │
                                   ▼
┌─────────────────────────────────────────────────────────────────────┐
│ Time of first race at meeting is entered. This automates the timings │
│ for opening and closing of nominations.                              │
│ E.g. Meeting on 04/09/2013 first race at 12.00pm. Nominations open   │
│ 27/08/13 at 12.00am and close 29/08/2013 at 12.00pm.                 │
└─────────────────────────────────────────────────────────────────────┘
                                   │
                                   ▼
┌─────────────────────────────────────────────────────────────────────┐
│ 3 methods of nomination:                                             │
│ - Online through trainer log in to GRNZ website.                     │
│ - by telephone to GRNZ                                               │
│ - by fax to GRNZ                                                      │
│ All GRNZ have ability to enter details but usually 2 staff perform   │
│ the task.                                                            │
│ Nominations are performed by choosing the meeting, then the          │
│ greyhound, then the preferred race.                                  │
└─────────────────────────────────────────────────────────────────────┘
                                   │
                                   ▼
┌─────────────────────────────────────────────────────────────────────┐
│ 15 minutes before close of nominations recheck of fax submissions is │
│ performed to ensure correctness and a check of the grade of the      │
│ greyhound. It is noted that the grade may have changed between the   │
│ opening and closing of nominations. In such cases the greyhound is   │
│ still permitted to be nominated. g of nominated                      │
│ 'Stamp Nominations' button then clicked.                             │
└─────────────────────────────────────────────────────────────────────┘
                                   │
                                   ▼
┌─────────────────────────────────────────────────────────────────────┐
│ Email is sent to clubs to inform them that field is ready for        │
│ selection to be undertaken.                                          │
└─────────────────────────────────────────────────────────────────────┘
                                   │
                                   ▼
                        ◇ Clubs follow selection ◇
                        criteria to determine type of
                        race that will be run and the field.
                                   │
                                   ▼
┌─────────────────────────────────────────────────────────────────────┐
│ Selection is performed using a drop down – in which order they       │
│ select is up to the club (e.g. alphabetical order or otherwise).     │
└─────────────────────────────────────────────────────────────────────┘
                                   │
                                   ▼
┌─────────────────────────────────────────────────────────────────────┐
│ When selection is complete an automated email is sent back to GRNZ   │
│ that the filed selection is complete.                                │
└─────────────────────────────────────────────────────────────────────┘
                                   │
                                   ▼
┌─────────────────────────────────────────────────────────────────────┐
│ Race fields are opened and 'Box Draw All Races' button is pressed.   │
└─────────────────────────────────────────────────────────────────────┘
                                   │
                                   ▼
                            ◇ Box draw is made ◇
                                   │
                                   ▼
┌─────────────────────────────────────────────────────────────────────┐
│ Box draw is held on website for up to 2 days – can be queries        │
│ regarding possible selection criteria by clubs.                      │
│ If errors identified manual or system redraw can be undertaken. Any  │
│ such cases are logged as to who did it and an explanation is         │
│ required.                                                            │
│ No formal review of exception report is undertaken.                  │
└─────────────────────────────────────────────────────────────────────┘
                                   │
                                   ▼
┌─────────────────────────────────────────────────────────────────────┐
│     After closing of draw, field is sent to clubs, TAB etc for       │
│     publication.                                                     │
└─────────────────────────────────────────────────────────────────────┘
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Appendix 2 – Technical Box Draw Process Summary

The process below is a summary description of the technical box draw process provided by the Sandfield Solution Manager.

NZGRA Box Draws

Pseudo Random Number Generator

The Race Day System application is a Microsoft Access 2007 ADP and therefore uses the Microsoft Visual Basic for Applications (VBA) pseudo Random Number Generator (RNG) function called "Rnd". This function returns a random number between 0 and 1 and we convert that decimal number to an integer between 1 and 8 inclusive.

Note that all algorithmic RNG's are "pseudo" RNG's as they use mathematical formula and algorithms to generate random numbers. They are not truly random and they do have a period of repeatability (although this period is typically an enormous number before the pattern repeats). Truly random numbers can't be calculated using an algorithm. An accepted way to obtain truly random numbers is via the use of atmospheric static and generators exist on the Internet that use such approaches (for instance www.random.org).

RNG Seeding

It is common to "seed" a random number generator before first use. We seed the RNG using the "Randomize" VBA function, called without parameters. When this function is called without parameters, the current system time is used as the seed value. It is our understanding from the Microsoft documentation on this function that the milliseconds component of the current system time is used by "Randomize". This means that even if the Randomize function was always called at the same general time of the day, we always get high variance on the number used as the seed as it is the milliseconds component (between 0.000 and 0.999).

We have also conducted testing around one reseed and reseeding between each draw. As seeding a pseudo-RNG can have a big impact on the random numbers that are generated, where and when the pseudo-RNG is seeded is vital to the overall "randomness" of the numbers generated. Therefore we only seed the pseudo-RNG when the Race Day application is opened and not before each box draw.

Box Assignment Process

In general terms, the process goes like this:

1. Get a list of the dogs to be placed into boxes (maximum of eight dogs). Note that no order is assigned to this list and the result record set that we iterate through is provided by SQL Server without any specific ordering. It is our understanding that in these situations, SQL Server will use the primary key to apply a "de facto" sort on the records and in this case it means that essentially the records are delivered in the order they were created in the system.

2. Take the first dog in the list and randomly pick a box number between 1 and 8 inclusive. If that box is available (not assigned to another dog and not to be left vacant if less than eight starters) then the dog is assigned to that box.

3. Continue to iterate through each dog in the list and randomly pick a box between 1 and 8 inclusive until a valid box is found, then assign the dog to that box.

A key point to note is that the process has no knowledge of the name of the dog or trainer and this has no bearing on the order of the dogs as they are assigned to boxes.

We have also conducted testing whereby the list of dogs is also randomised before iterating through them and randomly placing them into boxes. On large sample sizes (10,000 box draws) we could detect no discernible difference in "randomness" by first randomising the list of dogs and theory would suggest that doing so should not alter the "randomness" of the draw.

Comparisons with GRV Box Draw Code

After reviewing the GRV code (specifically their code for non-handicap races as they have specific logic to handle handicaps) we found that the same general principles were used. The following differences were noted:

1. GRV uses the Microsoft.Net pseudo-RNG function in place of the Microsoft VBA pseudo-RNG function used by NZGRA.

2. GRV randomly selects a dog then randomly selects an available box for that dog whereas the NZGRA process just randomly selects a box for each dog.

As noted above, we have conducted testing between a random dog list and an implicitly un-ordered (as provided by SQL Server) dog list and found no detectible difference in "randomness" of the box draw. However it must be pointed out that this was a subjective assessment of the resulting box draw distributions and does not constitute a detailed mathematical assessment. That said, logic would suggest that if selecting a box is "sufficiently random" then first randomly selecting a dog will not make the process "more random" or any "less fair".

Appendix 3 – Basis and Use of Report

This report is prepared on the basis of the limitations set out below:

- Our procedures were designed to provide limited assurance which recognises that absolute assurance is rarely attainable, due to such factors as the use of judgment in gathering and evaluating evidence and forming conclusions, and the use of selective testing, and because much of the evidence available for review is persuasive rather than conclusive in nature.

- Because of the inherent limitations of any internal control structure, it is possible that errors or irregularities may occur and not be detected. Our procedures were not designed to detect all weaknesses in control procedures as they were not performed continuously throughout a specified period and any tests performed were on a sample basis.

- Any projection of the evaluation of the control procedures to future periods is subject to the risk that the systems may become inadequate because of changes in conditions, or that the degree of compliance with them may deteriorate.

- The matters raised in this report are only those which came to our attention during the course of performing our procedures and are not necessarily a comprehensive statement of all the weaknesses that exist or improvements that might be made. We cannot, in practice, examine every activity and procedure, nor can we be a substitute for management's responsibility to maintain adequate controls over all levels of operations and their responsibility to prevent and detect irregularities, including fraud. Accordingly, management should not rely on our report to identify all weaknesses that may exist in the systems and procedures under examination, or potential instances of non-compliance that may exist.

- Recommendations for improvement should be assessed by management for their full commercial impact, before they are implemented.

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