

A Preliminary Examination of Irish Draught Horse Cannon Bone Measurements and Trends within the IDHSNA and Ireland Populations

Report Prepared for the Board of Directors of the IDHSNA

Prepared by,

Chris Neher

Final Report

June 5, 2012



Dear IDHSNA Members:

During the March 15, 2012 Board of Director's meeting, under agenda item 9, the Board discussed an opportunity to conduct an analysis of the relationship between height and cannon bone measurements and trends in the Irish Draught herd. Two members of the IDHSNA were willing to conduct the independent study and provide the results to the Board. The Board voted unanimously to provide the data to Chris Neher and Karen Young.

Draft versions of the report were submitted to Board of Directors in April and May of 2012 for review, questions, and comments. On June 5, 2012 the revised final report incorporating and addressing all submitted comments and suggestions was delivered to the Board of Directors.

The Board has chosen to make this final independent study available to the membership. It is attached for your review.

Thank you.

The IDHSNA Board of Directors.

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Summary Discussion

The issues of Studbook ownership, inspection authority, performance testing, and inspection criteria have been contentious and divisive, both in the past as well as the present, in Ireland, Great Britain, and here in North America. The wonderful Irish Draught Horse and Irish Draught Sporthorse inspire deep emotional responses from those who own, breed, ride and cherish them. These passionate responses are born of a desire to protect and nurture the breed we love. Unfortunately, differences of opinion on the best way to protect and nurture the breed have led to deep and painful schisms within several ID societies worldwide. These divisions have largely been over the fundamental question of which governing body should be given the authority to inspect and approve our horses, and on what criteria these approvals should be based.

This report is a first attempt to step back from the overarching decision of who should have the authority to inspect our horses, and to examine a single characteristic of the Irish Draught Horse, the cannon bone circumference, and how it has changed through the years. The aim of the report is to begin to form a base of shared understanding about our horses; to avoid the philosophical arguments of what “should be” and provide a narrow ledge of commonality by discussing “what is” and “what has been.” The hope is that this analysis, as limited as it may be, will provide a more “evidence-based” understanding of our horses to inform future discussions of Irish Draught politics and policy.

This analysis made use of readily available data on horse age, gender, breed, height, cannon size, girth, and inspection year to estimate a range of statistical measures for both Ireland purebred stallions since 1981 and for IDHSNA-inspected horses since 2008. The aim of the study was to see if an analysis of currently available data would yield statistically significant, understandable, and intuitive results. Indeed both the Ireland and IDHSNA data provided valuable information on breed characteristics, and (in the case of Ireland) trends. There are four primary findings associated with this analysis.

FINDING 1: A model of IDHSNA-inspected horses successfully explains differences in cannon bone size as a function of sex of the horse, the height of the horse, and whether the horse is a purebred or a sporthorse. All of these factors are statistically significant predictors of cannon size.

Practical Implication The encouraging results of this “off-the-shelf” modeling effort suggests that Society resources placed into a more systematic collection of data for the NA herd could provide an even richer picture of breed characteristics, and trends associated with horses registered in the IDHSNA studbook.

FINDING 2: There has been a highly statistically significant shift towards smaller cannon bone sizes within Ireland-inspected RID and Class 1 stallions over the past 30 years. This shift appears to have occurred in or around 1989, and has not reversed itself in more recent years.

Practical Implication _ Cannon size is cited in historical and current breed descriptions as an important characteristic of the ID as a foundation breed. This characteristic is generally described as a minimum cannon size for the breed. Long-term changes towards smaller cannons in approved horses could threaten this fundamental characteristic of the breed.

FINDING 3: Irish Draught stallions graded as Class 2 in Ireland since 2010 do not on average have any larger cannon bones than those graded as Class 1.

Practical Implication _ This finding shows that there does not seem to be any systematic disadvantage in the HSI inspection process for heavier boned stallions. However, it also shows that the entire pool of ID stallions brought forward for inspections in Ireland in the past 3 years has substantially less bone than those approved two to three decades ago.

FINDING 4: The purebred stallions inspected by the IDHSNA in recent years are more similar to RID stallions approved in the 1980s in Ireland than those approved in Ireland in more recent years in terms of cannon size.

Practical Implication _ Based on this analysis it appears that the selection of horses for import and breeding of purebred horses in NA has successfully retained some of the cannon bone size that appears to have been lost in Ireland in the late 1980s and early 1990s.

It is important to understand the limitations of this analysis and the findings presented above. While the statistical relationships found in this analysis are strong and robust, both factors that give us confidence in our conclusions, they are based on data measured by humans, recorded by humans, and of course analyzed by humans. There are without doubt errors in the data underlying this analysis, and while pains were taken to correct errors where found, others likely exist. The patterns in the data discussed in this report, however, are very likely not the result of any remaining data errors, but reflect patterns of historical and current trends in conformation.

Finally, an important caveat is that while we do know that bone has been lost in Ireland, and also know the general timing of that loss, it would require a much richer database and a more complex analysis to definitively ascribe a causative relationship explaining the source of that loss.

Introduction

This paper presents the preliminary results of an analysis of cannon bone measurements in both IDHSNA-registered Irish Draught horses and sporthorses, and Ireland-registered and approved ID stallions. The objective of the analysis is to determine whether existing and historical data on ID horses and sporthorses can be effectively used to examine and answer key questions regarding both current average characteristics of the breed and trends in those characteristics over time. The goal of the analysis is to begin to form a data-based understanding of characteristics within the Irish Draught breed in order to help inform both intra-society and inter-society discussions of breed characteristics and type, and the impact of inspection methodologies on those key characteristics. This analysis focuses on one key aspect of ID type—cannon bone measurement, in order to provide a preliminary picture of current and, to the extent possible, historic cannon bone measurements in North America and Ireland Irish Draught herds. This analysis is based (in the case of the IDHSNA horses) on limited data, and therefore should be seen as a starting point in formulating policy on future data collection and analysis. The results herein are intended to inform the ongoing conversation regarding purebred ID type, and potential loss of breed characteristics over time.

Cannon bone measurement is the focus of this analysis for two primary reasons:

1. It is an objective measure that is easily quantifiable. Although measuring the circumference of the cannon bone is susceptible to measurement error (as is any measurement) it is one conformation statistic that is commonly collected during the inspection process.
2. It is a characteristic of the purebred ID that is frequently cited as a key trait distinguishing the ID from lighter breeds and types. The fact that it is viewed as a key measure of the purebred ID is underlined by the fact that inspections in both NA and Ireland have long required recording of the cannon bone measurement as one of the objective physical measurements in the inspection process.

The cannon bone characteristics and measurements of the purebred Irish Draught horses have been included in the official breed standards of the IDHS in the past. In her seminal book on the breed, Fell (1991) cites the IDHS official breed standard as including “with 9 inches of clean, flat bone” under standards for Type and Character.¹ Currently, the HSI Studbook Regulations for the Irish Draught Horse in its description of Breeding Objectives and Type of Horse specifies the cannon bone to be “Approximately 23 cms (9 inches) of clean, flat bone.”² Given the significance placed on cannon bone size, both historically within the breed standard, and within

¹ Alex Fell (1991). *The Irish Draught Horse*. p. 3.

²http://www.horsesportireland.ie/_fileupload/Louise/2011/Prosposed%20Breeding%20Policy%20for%20the%20Irish%20Draught%20Horse%202010%20SC.pdf

current ongoing IDHSNA discussions of breed type, this analysis focuses on this key conformational characteristic.

The analysis and results presented here are necessarily somewhat limited in scope, and based on data readily available both in published sources and maintained databases. Therefore all results should be viewed within the full context of their statistical significance. Where appropriate, uncertainty associated and possible sources of error in the data and results are noted.

2.0 Data Sources

Three primary data sources were used for the following analysis:

1. The BOD of the IDHSNA supplied the registration database, which contained bone and height information for a subset of horses inspected in recent years.
2. Stephen Kennedy (V.P. of the IDHSNA) collected data on RID and Class 1 stallions approved in Ireland since 1981. Steve kindly made this data available for analysis. Data sources include the Horse Sport Ireland website and associated publications.³
3. Data on HSI Class 2 stallions approved since 2010 was accessed from the IDHS website, and coded into a database by Karen Young of the IDHSNA.

3.0 Methods Used

This analysis uses standard statistical and econometric methods. Both nonparametric and parametric results are reported. Nonparametric results are presented as mean (average) values of the variables in the two data sets. Additionally, parametric results from simple multivariate linear regression models explaining cannon bone size as a function of other traits and external variables are presented for the data.

The results of estimated parametric models are evaluated using standard residual analysis methods as well as inspection of the overall fit of the models and the statistical significance of the explanatory variables included in the models.

³ Data sources include <http://www.horsesportireland.ie/stallions/hsi-stallion-inspections-2011.9245.html> and <http://www.irishsporthorse.com/fileupload/publications/stalbook.pdf>. It should be noted, that a small number of stallions in the Irish publications have incomplete or no conformation statistics recorded. These horses have been excluded from the following analysis.

In interpreting the statistical significance of the following results, it is important to note that the RID and Class 1 stallion data from Ireland is not a typical “probability sample” drawn from a larger population and therefore subject to a degree of sampling uncertainty. Rather this data represents a “census” of all RID stallions inspected in Ireland since 1981. As a census, nonparametric results, such as average (or mean) values have no sampling uncertainty associated with them. The only uncertainty in the nonparametric results for the Ireland data would arise from the potential (and unknown) sources of measurement error and data entry error.

In the case of the IDHSNA data, this information is intended to be a census of all IDHSNA horses inspected since 2008. It is not intended to represent the entire NA herd in the database.

4.0 Results

The results of this analysis are presented in three sections. Section 4.1 describes the results of the analysis of the data from the IDHSNA registration database. Section 4.2 presents the results of the analysis of the Ireland RID stallion data. Section 4.3 discusses overall cannon bone measurements for HSI Class 2 stallions graded since 2010. Section 4.4 summarizes the findings associated with analysis of the Ireland data. Finally, Section 4.5 provides a preliminary discussion of comparisons between the Ireland and IDHSNA results.

4.1 Analysis of Available IDHSNA Data

The IDHSNA began a policy of recording bone and height measurements into the society’s Breeder’s Assistant Database from inspection forms with the 2008 inspections. An examination of the entire database of IDHSNA-registered horses found 144 with complete bone-height data reported. An important limitation of the IDHSNA data is that it is clear from inspecting the data so far entered that procedures and standards for entering this data are still being developed. For example, whether height is recorded in inches hands or centimeters, or what specific information to record from the inspection forms. It is fair to say that the IDHSNA data is a “work in progress,” and as such the results from this preliminary analysis should be viewed as merely indicative of the types of analysis and results that the data will support once data entry standards have been finalized, and the data has been cross-checked with inspection sheets for completeness, consistency and errors. Given the preliminary nature of this data, however, it is encouraging that the data still supports a generally robust statistical relationship between bone and height (among other variables).

Table 1 shows the basic nonparametric descriptive statistics for the horses in the IDHSNA database with complete bone and height information. It should be noted that this population is generally comprised of those horses that were inspected between 2008 and 2011, although in a few cases bone and height were entered for horses not inspected during this period. The average bone measure for all 144 horses is 8.74 inches. The Table 1 results include both purebred and sporthorses, and both mares as well as stallions and geldings.⁴

Table 1. Average Measures for IDHSNA-registered Horses with complete Bone and Height Recorded.

All IDHSNA-Registered Horses with both Bone and Height Recorded					
Variable	N	Mean	Std Dev	Minimum	Maximum
AGE⁵	144	7.32	2.74	4.00	20.00
Female	144	0.64	0.48	0	1
ID	144	0.45	0.50	0	1
Hands	144	15.99	0.63	13.75	17.75
Bone	144	8.74	0.62	7.13	10.50

Table 2 shows the information from the above table broken down by the gender and ID/IDSH status of the horses. Several intuitively consistent patterns are evident in this table. Purebred stallions/geldings have the largest average bone measure (9.21 inches).⁶ The other intuitive patterns shown are that mares on average have less bone than males, and sporthorses have less than purebreds. These results give a level of comfort with the data as they are consistent with our *a priori* expectations.

Table 3 shows an estimated parametric multivariate linear regression model that explains bone size as a function of the height of the horse, whether it is a purebred or a sporthorse, and whether it is male or female. All of these variables are statistically significant at or near the 90% level of confidence. Additionally, the included variables explain about 34% of the observed variation in the bone measurements. The Table 3 regression is based on bone measured in inches. Height is in hands, and ID and Female are both 1/0 indicator variables.

The interpretation of the estimated coefficients on the explanatory variables is as follows:

⁴ Note that the IDHSNA data includes all IDHSNA-registered horses for which measurements are recorded. This includes a small number of horses that were presented for inspection but failed to be graded as RID. Direct comparisons to RID (or Class 1) stallions in Ireland in this analysis (Figure 1, below) utilize only Passed (RID) IDHSNA stallions.

⁵ The Age variable is the horses age as of 2012. The IDHSNA database inconsistently recorded when the cannon and height measurement was taken so a based year of 2012 was used to calculate age.

⁶ The average for only purebred RID stallions is slightly smaller at 9.18 inches.

- ID—Purebred IDs in the database have on average 0.38 inches more bone than do sporthorses
- FEMALE—Mares in the database have on average 0.13 inches less bone than do stallions and geldings.
- HANDS—For every hand taller a horse is, their bone (on average) is 0.38 inches larger.

Again, the results of the estimated model are consistent with our expectations and lend further support to the stability and consistency of the IDHSNA data thus far collected.

Table 4 shows the fit diagnostics for the regression model of IDHSNA data. In general, the plots show that the model does not significantly violate normality assumptions for the model error terms.

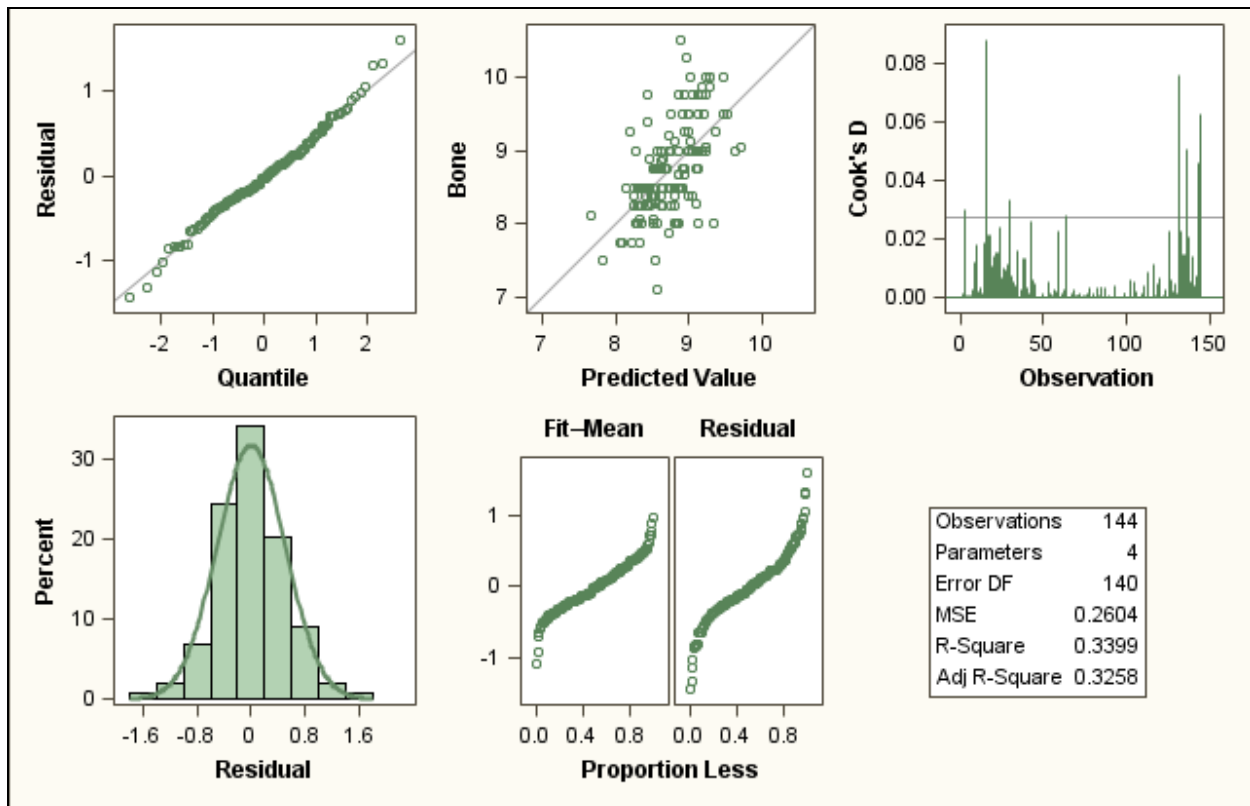
Table 2. Average Measures for IDHSNA-registered Horses with complete Bone and Height Recorded: by Gender and Breed/Type.

Sporthorse Stallion/Geldings					
Variable	N	Mean	Std Dev	Minimum	Maximum
AGE⁵	24	7.00	3.34	4.00	20.00
Height	24	16.07	0.60	14.88	17.25
Bone	24	8.65	0.69	7.13	10.50
Sporthorse Mares					
Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	55	7.67	2.69	4.00	15.00
Height	55	15.76	0.59	13.75	16.75
Bone	55	8.45	0.44	7.50	9.75
Purebred Stallion/Geldings					
Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	28	7.61	2.87	5.00	17.00
Height	28	16.36	0.62	15.38	17.75
Bone	28	9.21	0.52	8.00	10.00
Purebred Mares					
Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	37	6.78	2.26	4.00	16.00
Height	37	16.00	0.59	14.88	17.00
Bone	37	8.89	0.65	7.50	10.25

Table 3. Linear Regression of IDHSNA Data: Cannon Bone Measure is Dependent Variable

Number of Observations Read		144			
Number of Observations Used		144			
Root MSE		0.5103	R-Square		0.3399
Dependent Mean		8.743	Adj R-Sq		0.3258
Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	2.587	1.166	2.22	0.028
ID	1	0.381	0.088	4.32	<.0001
Female	1	-0.132	0.093	-1.43	0.156
hands	1	0.379	0.072	5.25	<.0001

Table 4. Fit Diagnostics for IDHSNA Data Regression.



4.2 Analysis of Ireland RID and Class 1 Stallion Data

The data on Ireland Irish Draughts consisted of inspection data for all approved RID and Class 1 stallions. The data was for the years 1981-2012. In total 154 stallions were in the database, and variables included height, bone, girth, age of horse at inspection, and year of inspection (and measurement). The Ireland stallion data was collected from stallion listings published over the years by various organizations and agencies within Ireland overseeing the stallion inspection process.⁷

In the years 1981-2012, several overseeing bodies in Ireland have been responsible for Irish Draught stallion inspections. Figure 1 shows a plot of the individual cannon bone measurements along with the average bone measures for each period during which the horses were inspected by either a different authority or under different procedures.

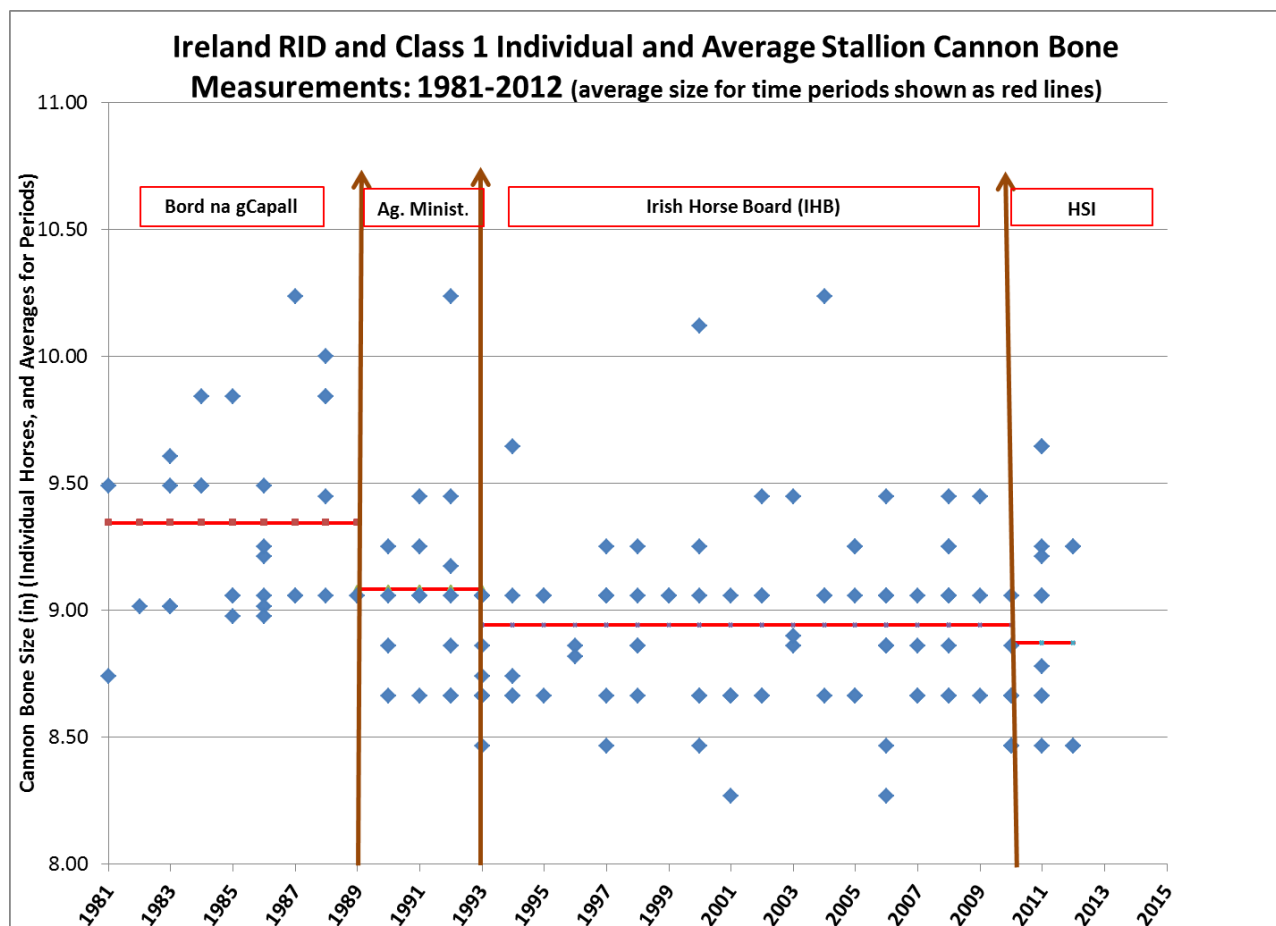


Figure 1. Individual and Average Cannon Bone Measures for Ireland RID and Class 1 Stallions: 1981-2012.

⁷ In several cases, stallions listed in two separate books were shown with different statistics. In these situations the statistics from the listing closest to the stallion's inspection date was used in the analysis.

Several results are clear from Figure 1. First, there is a significant amount of variation in cannon sizes across the entire 1981-2012 inspection period. However, it does seem that stallions approved in later years in the series have somewhat smaller cannon bone measures than those approved earlier. This result is supported by the continually declining average cannon sizes for each subsequent period of inspection under differing authorities.

Table 5 shows the simple nonparametric descriptive statistics for the Ireland RID and Class 1 stallion data. The average bone measurement for all 154 stallions in the data is 9.02 inches. Table 6 further breaks down these averages by time period (1981-1988, 1989-1992, IHB-1993-2009, and HSI-2010-2012).

Table 5. Average Measures for Ireland RID Stallions (1981-2012)

Stallions Approved (1981-2012)					
Variable	N	Mean	Std Dev	Minimum	Maximum
Bone	154	9.02	0.39	8.27	10.24
Age	154	4.68	2.64	3.00	16.00
Hands	154	16.54	0.31	15.70	17.42
Girth	154	78.98	2.80	72.04	88.58

One key question raised by the data is whether the changes in cannon size over time represent an ongoing linear trend, or one (or more) discrete shifts in the size of cannons on approved stallions at a particular point(s) in time. This is an important question in that if there is an ongoing trend towards presentation and approval of lighter stallions, this trend could be projected to continue into the future. However, if changes in the data series are actually representative of one or more discrete shifts in cannon size, then there is not necessarily cause for concern that the trend towards lighter boned stallions might continue into the future.

Table 6. Average Measures for Ireland RID Stallions by Inspection Organization and Time Period.

Stallions Approved by Bord na gCapall (1981-1988)					
Variable	N	Mean	Std Dev	Minimum	Maximum
Bone	28	9.34	0.38	8.74	10.24
Age	28	3.64	1.22	3.00	7.00
Hands	28	16.59	0.23	16.04	17.02
Girth	28	80.42	2.64	75.98	88.58
Stallions Approved by Ministry of Agriculture (1989-1992)					
Variable	N	Mean	Std Dev	Minimum	Maximum
Bone	18	9.08	0.38	8.66	10.24
Age	18	3.28	0.46	3.00	4.00
Hands	18	16.55	0.37	15.85	17.42
Girth	18	80.40	2.11	76.38	84.25
Stallions Approved During IHB Inspections and Performance Testing (1993-2009)					
Variable	N	Mean	Std Dev	Minimum	Maximum
Bone	86	8.94	0.33	8.27	10.24
Age	86	5.08	2.77	3.00	15.00
Hands	86	16.54	0.31	15.70	17.27
Girth	86	78.11	2.67	72.05	85.04
Stallions Approved During New HSI-Format Inspections (2010-2012)					
Variable	N	Mean	Std Dev	Minimum	Maximum
Bone	22	8.87	0.38	8.46	9.65
Age	22	5.68	3.53	3.00	16.00
Hands	22	16.45	0.35	15.80	17.03
Girth	22	79.08	2.85	73.23	86.61

One method of statistically testing whether there has been a “structural change”, or a fundamental discrete shift, in cannon sizes over time and when that shift may have occurred is to aggregate the data by year and apply a statistical test of significant difference at alternative possible breakpoints (or points where you suspect a change has occurred) within the data. A commonly used statistical test for structural breaks is the Chow test.⁸

⁸ In the Chow test (G.C. Chow, 1960):

RSSR = the sum of squared residuals from a linear regression in which β_1 and β_2 are assumed to be the same

SSR₁ = the sum of squared residuals from a linear regression of sample 1

SSR₂ = the sum of squared residuals from a linear regression of sample 2

β has dimension k, and there are n observations in total

Then the F statistic is: $((RSSR - SSR_1 - SSR_2)/k) / ((SSR_1 + SSR_2)/(n - 2k))$.

Table 7 shows the average, maximum and minimum bone measurements by year. It also shows the number of stallions passed in each year.

The annual data from the table was modeled using a SAS AUTOREG time series regression procedure along with a Chow statistical test applied to a broad range of alternative breakpoints (years).

Table 7. Ireland Stallion Cannon Bone Measures by Year: Average, Minimum, and Maximum.

Year	Average of Bone	Min of Bone	Max of Bone	Number of horses
1981	9.11	8.74	9.49	2
1982	9.02	9.02	9.02	1
1983	9.28	9.02	9.61	4
1984	9.61	9.49	9.84	3
1985	9.23	8.98	9.84	4
1986	9.17	8.98	9.49	6
1987	9.45	9.06	10.24	3
1988	9.64	9.06	10.00	5
1989	9.06	9.06	9.06	1
1990	8.96	8.66	9.25	4
1991	9.09	8.66	9.45	6
1992	9.16	8.66	10.24	7
1993	8.83	8.46	9.06	10
1994	8.95	8.66	9.65	5
1995	8.92	8.66	9.06	3
1996	8.84	8.82	8.86	2
1997	8.92	8.46	9.25	6
1998	8.94	8.66	9.25	5
1999	9.06	9.06	9.06	2
2000	9.04	8.46	10.12	6
2001	8.66	8.27	9.06	5
2002	8.98	8.66	9.45	5
2003	9.07	8.86	9.45	3
2004	9.25	8.66	10.24	4
2005	8.98	8.66	9.25	5
2006	8.88	8.27	9.45	9
2007	8.81	8.66	9.06	4
2008	9.03	8.66	9.45	9
2009	9.06	8.66	9.45	3
2010	8.66	8.46	9.06	8
2011	9.04	8.46	9.65	10
2012	8.86	8.46	9.25	4

Figure 2 shows a plot of the statistical significance of the Chow test statistics for the tested breakpoint years 1983 through 2000. The data points in RED are breakpoints in the time series where the years before and after the breakpoints are statistically different at the 90% level of confidence. The two years with the most significant Chow statistics were 1989 and 1990 (both significant at the 98% or better level of confidence). The breakpoint at 1989, however, provides

the best evidence for a structural change in the data from the period before 1989 to the period 1989 and after.

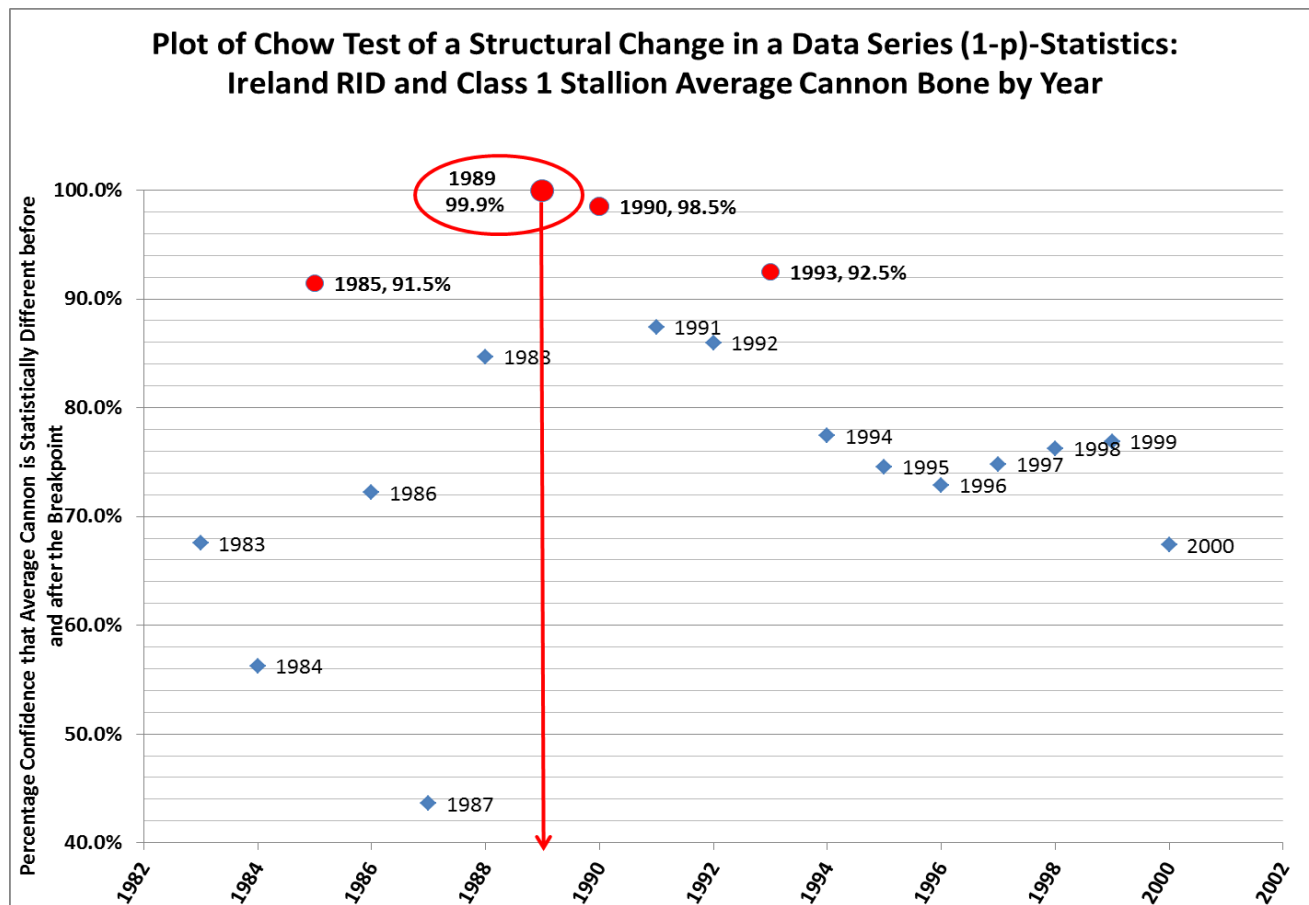


Figure 2. Plot of Statistical Significance of Chow Tests of Structural Change in a Data Series (1-p Statistics).

The results presented in Figure 1 and Figure 2 suggest that there was, at the least, a shift in cannon bone sizes from the pre-1989 period to later inspections. One possible explanation for this sudden decrease on bone in approved stallions may have been due to a systematic change in the way the cannon bone was measured at inspections. No record of such a systematic change in measurement technique was found in this analysis. However, the data was analyzed statistically to see if there was any support for the case of a change in measurement technique leading to lower cannon measurements.

Figure 3 and Table 8 below show a plot of average, minimum, and maximum bone by year, along with fitted linear trends for each series. Figure 3 is a simple plot of the annual data shown in Table 7. There are two results shown in the figure and table that strongly suggest there has been no systematic change in measurement procedure that resulted in smaller sizes after 1989.

1. There are several post-1990 horses with cannons as big, or bigger, than the two largest cannons measured in the pre-1989 period. If there were a systematic decrease in the bone sizes post-1989, it would be statistically improbable (although not impossible) that these large bone measures would be observed after the measurement change.
2. The passage of time explains fully 42% of the observed variation in MINIMUM bone measures for each year, while it only explains 3.7% of the variation in MAXIMUM bone measures. Moreover, the estimated trend in MAXIMUM bone by year is not statistically significant, while that for MINIMUM bone is highly statistically significant. (see regression results below)

The most straightforward interpretation of this data and analysis is that in the post-1988 period the minimum cannon bone size passed in inspection has decreased significantly. However, over the same time period there is no statistically significant decrease in the maximum bone measurement passed in inspection. If there were a “systematic” change in measurement then one would expect (all else being equal) that we would see a very similar pattern in the MINIMUM, MAXIMUM, and AVERAGE bone by year over the period.

One interpretation that is consistent with this data is that after the Ireland Agriculture Department took over inspections in 1989, inspectors became more willing to pass stallions with less bone. Perhaps these horses passed because they were the ones who did the “best” in the performance testing. This passing of lighter horses by definition brought down the AVERAGE bone of passed stallions as well. However, the inspectors continued to pass occasional very heavily-boned horses as well. They became more willing to pass lighter stallions while at the same time were not specifically disallowing all large bone stallions. This result is inconsistent with the hypothesis that something changed in the way the cannon bone was measured. The results of this analysis are consistent with the finding that the statistical correlation between average cannon bone size of approved horses in Ireland and inspection group and procedures used is an appropriate interpretation of the data.

Table 8. Linear Trend Models of Alternative Annual Cannon Bone Measures in Ireland Approved ID Stallions.

Parameter/Statistic	Measurement		
	Average Cannon Bone	Minimum Cannon Bone	Maximum Cannon Bone
Intercept	9.26***	9.03***	9.59***
Trend Variable (T-statistic)	-0.013*** (3.54)	-0.018*** (4.67)	-0.008 (1.08)
R-square Statistic ¹	0.294	0.421	.037
Sample size	32		

¹ The R-Square statistic shows the proportion of the observed variation in the cannon bone measure that is explained by the model.

*** indicates that the estimated coefficient is statistically significant at the 99% level of confidence

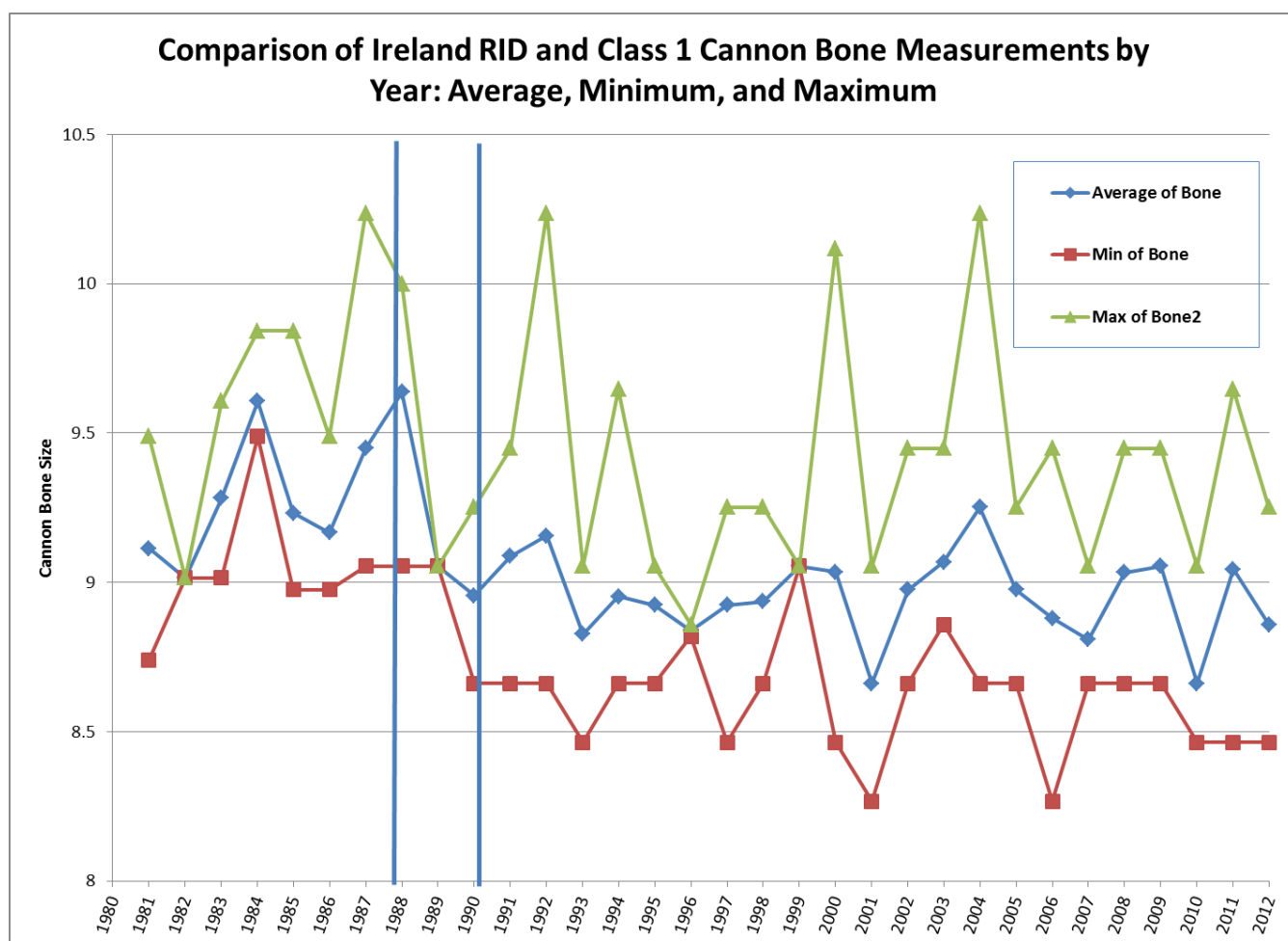


Figure 3. Trends in Average, Minimum and Maximum Bone Measurements in Ireland, by Year.

Given the evidence for a structural change in the size of cannon bones of approved stallions in Ireland from before 1989 to 1989 and after, it is logical to include an indicator variable for the pre-1989 period and 1989-on in any regression model of Ireland cannon bone sizes. For the sake of completeness, a model of cannon sizes was estimated using the individual horse data, and the following explanatory variables.

1. AG is an indicator variable which takes a value of 1 in the inspection years 1989-1992 when the Ministry of Agriculture was overseeing inspections of ID stallions in Ireland.
2. IHB is an indicator variable which takes a value of 1 in inspection years when the Irish Horse Board was conducting the RID inspections along with performance testing.(1993-2009)

3. HSI is an indicator variable which takes a value of 1 in years when Horse Sport Ireland was conducting Class 1 Irish Draught inspections (2010-2012).
4. HANDS is a continuous variable for the height of the stallion in hands at its inspection.
5. GIRTH is a continuous variable for the girth of the stallion in hands at its inspection.

Table 9 shows the estimated linear regression model for the Ireland data of RID stallions. For this regression, bone is in inches, height in hands, girth in inches, and AG, HSI and IHB are 1/0 indicator variables.

The estimated model in Table 9 explains about 30% of the variation in bone size and all explanatory variables are statistically significant at the 95% level of confidence or greater.

The interpretation of the estimated coefficients on the explanatory variables is as follows:

- HANDS—for every hand taller a stallion is, its bone is on average 0.21 inches larger
- GIRTH—for every inch of girth larger a stallion is, its bone is on average 0.028 inches larger.
- AG—during the AG inspection years approved RID stallions had on average 0.252 inches less bone than in the 1981-1988 inspection years.
- IHB—during the IHB inspection years approved RID stallions had on average 0.31 inches less bone than in the 1981-1988 inspection years.
- HSI—during the HSI inspection years (2010 - 2012) approved stallions had 0.40 inches less bone than those approved during the 1981-1988 period.

The results for HANDS and GIRTH are consistent with our *a priori* expectations that a taller larger horse would on average have more bone. The results for the AG variable (and by extension the variables for IHB and HSI) are consistent with the results of the Chow test of structural change discussed above.

Table 9. Linear Regression of Ireland Data: Cannon Bone Measure is Dependent Variable

Number of Observations Read			154		
Number of Observations Used			154		
Root MSE		0.3328	R-Square	0.2954	
Dependent Mean		9.02	Adj R-Sq	0.2716	
Coeff Var		3.69			
Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	3.02	1.46	2.07	0.04
AG	1	-0.252	0.10	-2.50	0.01
IHB	1	-0.311	0.077	-4.06	0.00
HSI	1	-0.397	0.096	-4.13	0.00
Hands	1	0.210	0.101	2.11	0.04
Girth	1	0.035	0.012	3.00	0.00

4.3 Analysis of Horse Sport Ireland Class 2 Stallion Data

Appendix D shows the list of HSI Class 2 approved ID stallions inspected since 2010. One concern that has been voiced regarding the current HSI inspection system is that it may favor lighter, sportier, more athletic ID stallions over somewhat heavier, “more traditional” ID stallions in the inspection process. A comparison was made between the average cannon bone size of HSI Class 1 and HSI Class 2 stallions to see if Class 2 cannon bones were significantly different from those of the Class 1 approved stallions. Figure 4 shows this comparison graphically.

For the 2010-2012 inspection years, there is little difference between the average cannon bone size for those ID stallions placed in Class 2 and those who are awarded Class 1 status. At this point, the Class 2 stallions even have a slightly smaller average cannon bone size than do the Class 1 approved ID stallions.

On the one hand it is somewhat comforting that evidence to date does not support the conclusion that HSI-administered inspections are systematically leading to lighter boned stallions being approved for Class 1 status while relegating heavier boned horses to Class 2. On the other hand, the data shows that all Class 1 and Class 2 stallions presented for inspection in 2010-2012 are statistically significantly lighter than ID stallions passed as RID in earlier periods.

4.4 What does the Ireland Data Tell Us and Not Tell Us?

It is important to not overstate what can be deduced from the Ireland ID stallion data. The preceding analysis clearly showed two key results from the parametric regression models:

- Irish Draught stallions approved prior to 1989 had on average larger cannon bones than those approved in the period from 1989-2012. Figure 1, Figure 2 and the associated report text points clearly to a sudden, long-lasting shift towards smaller cannon sizes in approved ID stallions in Ireland beginning in 1989 or 1990. This shift towards smaller cannons did not reverse in subsequent years. Since changes in genetics are a generally gradual process, the dramatic decline in bone size evident in the data is most likely explained by a factor or factors other than fundamental genetic change in the breed from one year to the next. Possible explanations are 1) a willingness on the part of inspectors to pass lighter boned horses in 1989 and later years, 2) lighter horses being chosen to be presented for inspection in 1989 and later years, or 3) a combination of these or other unknown factors.
- When the shift in cannon bone size between the pre-1989 period and the following period was controlled for, no additional statistically significant parametric trend in cannon bone size was evident.
- In addition to the parametric regression models of the Ireland data, this analysis also computed simple average values for the data (Table 6). The data shows that the average cannon bone size of approved ID stallions was highest in the pre-1989 period, and lowest in the current HSI period. Since these average values represent a census of all inspected ID stallions in Ireland, there is no uncertainty as to whether the average from one period is statistically different from the average from another.⁹ The non-parametric average cannon bone values for Ireland ID stallions are compared in Figure 4.
- The data on cannon bone size over time for Ireland RIDs and Class 1 stallions, reveals unambiguously what HAS happened in the past. However, the trends in the data are not robust, nor statistically significant enough to allow for the prediction of trends in cannon bone sizes in future years. This is an issue that could be revisited in several years when more HSI stallion data is available.

⁹ Uncertainty and associated confidence intervals would be appropriate in the case of a randomly drawn sample of stallions from a larger population, to account for the possibility that the sample drawn was not truly representative of the entire population. In the case of the Ireland stallion data, there is no sampling error as the data includes all approved stallions. However, even if the data WERE ASSUMED to be a sample (rather than a census) in which a small percentage (say 10%) of the stallions were randomly missed in collecting the data, all of the Table 6 average cannon sizes would still be statistically different from one another at the 95% level of confidence (after employing the appropriate “finite population correction factor”).

4.5 Comparison of Ireland and IDHSNA Stallions

In an effort to place IDHSNA RID stallions and their bone measures in the context of the Irish stallions Figure 4 shows a bar graph of IDHSNA purebred stallion/gelding bone and RID stallion bone in Ireland by time period.

The figure shows that the IDHSNA herd is currently most similar to the 1981-1992 stallions approved in Ireland. Additionally, the figure graphically shows the changes in average cannon bone measures in Ireland over time.

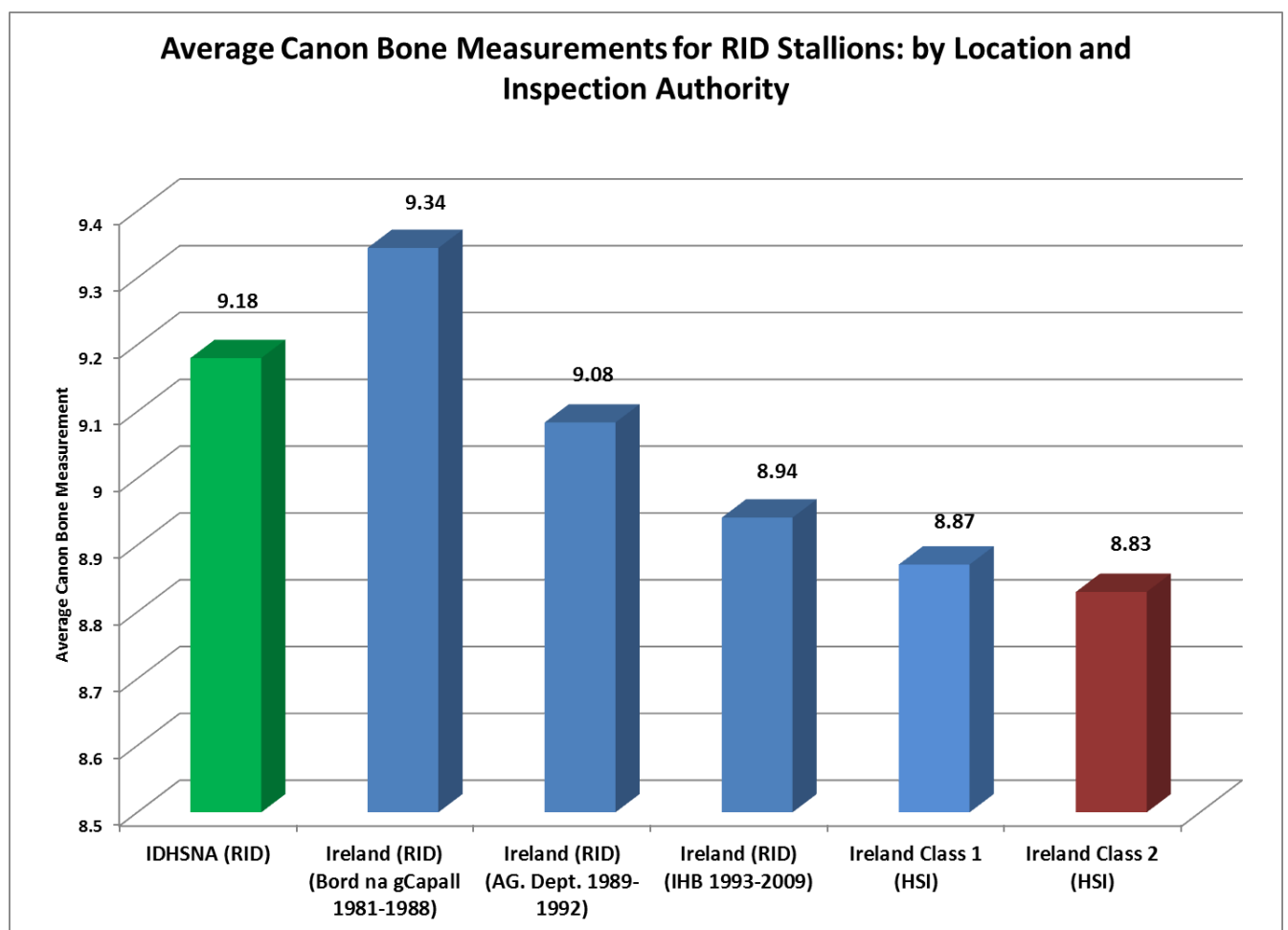


Figure 4. Comparison of IDHSNA and Ireland RID stallion Average Bone.¹⁰

¹⁰ Note: The average of all IDHSNA stallions and purebred geldings brought forward for inspection is 9.21 inches.

5.0 Conclusions, Limitations, and Further Research

Two key results of this analysis are:

1. Both the NA and IRE data support robust, consistent, and highly statistically significant models of cannon bone measurement as a function of other conformational and institutional explanatory variables. While the estimated models only explain between one-quarter and one-third of the observed variation in cannon size across horses, this is accomplished with a small number of off-the-shelf variables. These results are very encouraging, and suggest that construction of more complete, and complex models may be used to effectively explain key conformational traits of the Irish Draught breed.
2. The long-term data on RID and Class 1 and Class 2 stallions from Ireland raises significant questions as to the reasons for the apparent loss of cannon bone in approved ID stallions over time. Additional research on this topic might include examining data from inspected, but not passed stallions prior to 2010. This additional data might cast some light on apparent trends in ID stallion approval in Ireland.

As noted previously, the data used in this analysis is limited in certain respects. Measurements are taken by people under different circumstances, and by individuals of different levels of training. There is an unavoidable level of measurement error in such numbers. Additionally, the IDHSNA data is for only a subset of NA horses having been inspected in 2008-2011, and data entry standards for even this period are still being developed. Undoubtedly, estimates and models for the IDHSNA herd could be improved by gathering more and better (more consistent) data on key variables. The data is also limited in that variables included in the analysis only include those that were readily available, such as height, girth, age, etc. Undoubtedly, models including a wider range of explanatory variables such as paternal or maternal lines, could (at least theoretically) improve the overall explanatory power of both the NA and IRE data.

Given the somewhat constrained nature of the data used however, it is quite surprising that the models estimated from that data are consistent and quite robust in their statistical significance. None of the estimated parameters for the explanatory variables (in models for either data set) were counter to expectations.

None of the results in this analysis are intended to be definitive, but rather to inform the overall discussions within the IDHSNA on issues of breed type, and inspection structure and affiliation.

ACKNOWLEDGMENTS:

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APPENDIX A: Ireland Stallion Inspection Data 1981-2012

Obs	Stallion	year	Bone	Hands	Girth
1	Ballinrobe Boy	1981	8.74	16.54	77.17
2	Kildalton King	1981	9.49	16.73	77.95
3	The Conqueror	1982	9.02	16.63	83.07
4	Corrandulla Star	1983	9.61	17.03	80.31
5	Powerswood Purple	1983	9.02	16.04	77.95
6	Prospect Pride	1983	9.02	16.54	77.95
7	Sillot Hill	1983	9.49	16.63	81.50
8	Copper King	1984	9.49	16.73	81.89
9	Flagmount King	1984	9.84	16.73	81.10
10	Jack Of Diamonds	1984	9.49	16.83	84.65
11	Carrabawn View	1985	9.06	16.54	81.10
12	Glidawn Diamond	1985	9.06	16.63	81.10
13	Golden Warrior	1985	8.98	16.83	75.98
14	Rakish Paddy	1985	9.84	16.63	79.92
15	Blue Rajah	1986	9.06	16.14	79.92
16	Brown Lad Lara	1986	9.49	16.24	81.89
17	Diamond King	1986	9.21	16.73	81.89
18	Diamond Rock	1986	9.25	16.24	81.89
19	Duleek Hero	1986	9.02	16.73	83.07
20	Holycross	1986	8.98	16.54	81.10
21	Rne Shore	1987	9.06	16.44	78.74
22	Silver Glider	1987	9.06	16.63	76.77
23	Townrath Pride	1987	10.24	16.54	78.74
24	Coolehane Flight	1988	9.06	16.93	88.58
25	Cream Of Diamonds	1988	10.00	16.54	78.74
26	Home Rule	1988	9.84	16.54	79.92
27	King Henry	1988	9.45	16.83	81.10
28	Naldo	1988	9.84	16.44	77.95
29	Elm Hill	1989	9.06	16.34	79.53
30	Annaghdown Star	1990	9.06	16.83	81.50
31	Blue Champion	1990	9.25	16.04	79.53
32	Crannagh Hero	1990	8.66	16.34	79.13
33	Red Hackle	1990	8.86	16.44	80.71
34	Cork Arthur	1991	9.06	16.44	80.71
35	Gold Link	1991	9.06	16.34	78.74
36	Golden Trump	1991	9.45	16.73	83.07
37	Mourne Mountain Star	1991	8.66	16.93	83.46

Obs	Stallion	year	Bone	Hands	Girth
38	Springpark Jack The Lad	1991	9.25	17.03	83.86
39	Suma's Murphy's Law	1991	9.06	16.34	78.35
40	Agherlow	1992	8.86	16.83	79.92
41	Ard Grandpa	1992	9.45	17.42	78.74
42	Corran Ginger	1992	9.06	16.73	80.31
43	Creggan Emperor	1992	8.66	16.44	79.13
44	Dunkerrin Grey Mist	1992	8.66	15.85	76.38
45	Ri An Domhan	1992	9.17	16.44	79.92
46	Sammys Pride	1992	10.24	16.44	84.25
47	Classic Vision	1993	9.06	16.73	78.35
48	Crosstown Dancer	1993	9.06	16.73	82.28
49	Diamond Clover	1993	8.66	16.73	82.68
50	Ginger Holly	1993	8.86	16.83	84.65
51	Grosvenor Lad	1993	8.66	16.54	80.31
52	Mountain Pearl	1993	8.66	16.83	76.77
53	The Bard	1993	9.06	15.94	75.98
54	Welcome Diamond	1993	8.46	16.54	74.41
55	Woodland Boy	1993	9.06	16.44	81.89
56	Wyzer Diamond	1993	8.74	16.44	76.38
57	Ben Calverstown	1994	9.65	16.63	81.89
58	Fast Silver	1994	8.66	16.44	77.56
59	Its The Quiet Man	1994	9.06	16.83	81.89
60	Roeview Pride	1994	8.74	16.14	77.17
61	Westmeath Lad	1994	8.66	16.34	78.74
62	Castana	1995	8.66	16.44	78.35
63	Celtic Gold	1995	9.06	16.34	77.56
64	Kensons King William	1995	9.06	16.54	74.41
65	Coille Mor Hill	1996	8.86	16.73	76.77
66	Huntingfield Rebeel	1996	8.82	16.63	76.38
67	Coopers Hill	1997	9.25	17.13	82.28
68	Herrero	1997	9.06	16.93	77.56
69	O'learys Irish Diamond	1997	9.06	16.44	79.53
70	Parkmore Pride	1997	8.46	16.54	79.53
71	Rockrimmon Silver Diamond	1997	9.06	16.73	78.35
72	The Pride Of Gloster	1997	8.66	15.94	78.35
73	Crosstown Pride	1998	9.06	16.54	78.74
74	Drumri	1998	8.86	16.44	78.74
75	Finns Clover Inn	1998	8.86	16.34	77.17
76	Grange Bouncer	1998	8.66	16.54	79.92
77	Mount Diamond Flag	1998	9.25	16.73	81.50

Obs	Stallion	year	Bone	Hands	Girth
78	Star Kingdom	1999	9.06	17.22	82.28
79	Welcome Flagmount	1999	9.06	16.14	74.41
80	All The Diamonds	2000	8.46	16.54	74.80
81	Clonakilty Hero	2000	8.66	16.73	75.98
82	Coolcronan Wood	2000	9.06	16.54	75.20
83	KEC Double Diamond	2000	10.12	16.49	75.98
84	Supreme Ginger	2000	8.66	16.63	75.59
85	The King Of Hearts	2000	9.25	16.44	77.56
86	Comet	2001	8.27	15.94	76.38
87	Gentle Diamond	2001	9.06	16.24	78.74
88	KEC Bluejay Diamond	2001	8.66	16.04	75.59
89	Mackney Clover	2001	8.66	16.14	77.95
90	Sir Rivie	2001	8.66	16.54	76.38
91	Gurraun Zidane	2002	9.06	16.34	76.77
92	Inver Steel	2002	9.06	16.83	79.13
93	Penmerryls Rhythm And Blues	2002	8.66	15.94	76.77
94	Rosheen Yeats	2002	8.66	16.24	76.38
95	Sir Stormy Breeze	2002	9.45	16.68	81.89
96	Clonleigh Dancer	2003	8.86	16.09	77.17
97	Gurraun Golden Eye	2003	8.90	16.73	78.74
98	Huntingfield Heathcliff	2003	9.45	17.03	77.56
99	Bridgeford Stockbroker	2004	10.24	17.13	84.65
100	Diamond Design	2004	9.06	16.83	79.53
101	Rockrimmon Robusticus	2004	9.06	16.29	77.56
102	Westfield Bobby	2004	8.66	16.83	78.35
103	Carrickrock Close Shave	2005	9.25	16.24	76.77
104	Gortfree Hero	2005	9.06	17.27	78.74
105	Heigh Ho Silver	2005	9.25	16.93	78.74
106	Knockillaree Glenlara	2005	8.66	16.73	77.56
107	Shenandoah Prince Holly	2005	8.66	16.54	76.77
108	Cappa Cochise	2006	9.06	16.54	75.98
109	Creevagh Grey Rebel	2006	9.06	16.24	72.05
110	Heigh Ho Dubh	2006	8.86	16.44	77.17
111	KEC Diamond Millinium	2006	8.46	16.88	77.17
112	Luke Skywalker	2006	8.86	16.78	77.95
113	Mountain Diamond	2006	9.06	16.49	78.74
114	Moylough Bouncer	2006	8.86	16.88	80.31
115	Oh Carol's Rebel	2006	9.45	16.54	77.95

Obs	Stallion	year	Bone	Hands	Girth
116	Young Carrabawn	2006	8.27	16.39	75.20
117	Echo King	2007	9.06	16.49	77.17
118	Gleneven Rebel	2007	8.66	16.39	74.41
119	Offaly Clover	2007	8.86	16.34	75.59
120	Rebel Mountain	2007	8.66	16.34	74.80
121	Ally's Bridge	2008	9.25	16.58	82.28
122	Clew Bay Bouncer	2008	9.06	16.58	80.31
123	Grandpas Diamond	2008	9.45	17.08	85.04
124	Kilcotton Cross	2008	9.06	17.03	77.56
125	Laurelview Dancer	2008	8.86	16.73	78.35
126	Paddys Wood	2008	8.66	16.34	74.80
127	Rebel Flagmount	2008	9.25	16.04	76.38
128	Windgap Blue	2008	8.66	16.54	82.28
129	Castle Crest	2008	9.06	16.73	76.38
130	Cappa Cassanova	2009	9.45	16.58	80.31
131	Gold Dancer	2009	8.66	15.70	72.05
132	Prescotts Diamond	2009	9.06	16.54	81.10
133	Bally Vesta Silver Diamond	2010	8.86	16.04	78.35
134	Fintan Himself	2010	8.66	16.24	79.53
135	Huntingfield Ruler	2010	8.66	15.85	74.80
136	Killinick Bouncer	2010	8.46	16.44	75.98
137	King Alton	2010	9.06	16.58	81.50
138	Leighlin Emperor	2010	8.66	16.73	79.92
139	The Swarty Hero	2010	8.46	16.14	77.95
140	Welcome Emperor	2010	8.46	16.34	81.50
141	Ballineen It's William	2011	9.25	16.73	79.53
142	Carrabawn Cross	2011	8.78	16.34	77.56
143	Carrickcottage Star	2011	9.65	17.03	81.89
144	Crystal Crest	2011	8.66	16.54	78.35
145	Dunbeggan Grey Mist	2011	9.06	16.14	81.10
146	Eastern Hero	2011	8.46	16.44	75.59
147	Huntingfield Sunny C	2011	9.06	16.24	77.95
148	King of Mourne	2011	8.66	16.93	81.50
149	Scrapman	2011	9.21	17.03	79.13
150	Tors Gentleman Farmer	2011	9.65	16.54	86.61
151	Eponastables Ubih	2012	8.46	15.80	73.23
152	Gortfree Casanova	2012	8.46	16.24	78.74
153	Insfree the Holy	2012	9.25	16.68	80.71
154	Kiltealy Silver	2012	9.25	16.88	78.35

APPENDIX B: IDHSNA Registration Database Information on Bone and Height¹¹

Sex/Status	Class	Date Of Birth	FEMALE	RID	Hands	Bone (in)
Stallion	IDSH	4/15/2008	0	0	14.88	7.75
Stallion	RID	4/1/2004	0	1	16.50	9.06
Stallion	RID	6/18/2007	0	1	16.63	10.00
Stallion	RID	6/8/2004	0	1	16.50	10.00
Stallion	RID	5/22/2006	0	1	16.25	9.75
Stallion	RID	5/26/1998	0	1	17.25	9.50
Stallion	RID	4/18/2006	0	1	15.38	9.13
Stallion	RID	5/10/1999	0	1	16.25	9.00
Stallion	RID	5/4/2005	0	1	15.88	9.00
Stallion	RID	5/19/2005	0	1	15.75	8.75
Stallion	RID	5/31/2005	0	1	15.69	8.50
Stallion	RID	5/21/2003	0	1	15.56	8.50
Stallion	RIDSH	3/13/2006	0	0	17.25	8.00
Mare	ID-foal	7/4/2008	1	0	16.25	8.86
Mare	ID-Foal	5/23/2005	1	0	15.75	9.75
Mare	ID-foal	6/14/1999	1	0	16.25	8.50
Mare	ID-foal	6/5/2006	1	0	13.75	8.13
Mare	IDSH	5/21/2007	1	0	15.50	8.07
Mare	IDSH	5/10/2007	1	0	15.31	8.00
Mare	RID	3/1/2004	1	1	16.88	9.06
Mare	RID	3/4/2006	1	1	15.88	8.66
Mare	RID	7/27/2006	1	1	15.06	8.27
Mare	RID	4/24/2005	1	1	16.50	8.27
Mare	RID	5/6/2006	1	1	14.88	8.27
Mare	RID	3/22/2004	1	1	15.50	7.87
Mare	RID	4/26/1998	1	1	16.13	10.25
Mare	RID	7/24/2005	1	1	16.31	10.00
Mare	RID	4/1/2006	1	1	17.00	10.00
Mare	RID	4/19/2004	1	1	16.69	9.88
Mare	RID	6/5/2004	1	1	16.69	9.75
Mare	RID	5/11/2006	1	1	16.38	9.75
Mare	RID	4/24/1996	1	1	16.25	9.50
Mare	RID	7/3/2006	1	1	16.56	9.50
Mare	RID	4/9/2005	1	1	16.75	9.50

¹¹ Horse name is not provided as all information in the IDHSNA registration database is not yet publicly available.

Sex/Status	Class	Date Of Birth	FEMALE	RID	Hands	Bone (in)
Mare	RID	5/5/2007	1	1	16.25	9.25
Mare	RID	4/21/2007	1	1	16.31	9.13
Mare	RID	2/16/2006	1	1	16.25	9.00
Mare	RID	5/8/2006	1	1	16.50	9.00
Mare	RID	4/10/2005	1	1	15.50	9.00
Mare	RID	5/24/2004	1	1	16.50	9.00
Mare	RID	5/5/2007	1	1	15.88	9.00
Mare	RID	5/7/2006	1	1	16.00	8.75
Mare	RID	5/13/2007	1	1	15.38	8.75
Mare	RID	4/23/2007	1	1	15.06	8.75
Mare	RID	5/26/2006	1	1	16.50	8.75
Mare	RID	3/13/2008	1	1	15.44	8.75
Mare	RID	5/13/2005	1	1	16.56	8.75
Mare	RID	4/1/2005	1	1	15.19	8.75
Mare	RID	4/12/2007	1	1	16.00	8.50
Mare	RID	4/5/2005	1	1	15.50	8.50
Mare	RID	4/22/2005	1	1	15.30	8.50
Mare	RID	5/3/2007	1	1	15.75	8.38
Mare	RID	4/10/2004	1	1	16.25	8.38
Mare	RID	3/16/2006	1	1	15.75	8.00
Mare	RID	4/2/2006	1	1	15.75	8.00
Mare	RID	4/1/2006	1	1	15.00	7.50
Mare	RIDSH	9/9/2006	1	0	16.00	8.07
Mare	RIDSH	4/27/2004	1	0	15.75	9.38
Mare	RIDSH	3/28/2002	1	0	15.13	9.25
Mare	RIDSH	4/7/2003	1	0	16.50	9.20
Mare	RIDSH	5/6/2008	1	0	16.63	9.00
Mare	RIDSH	5/22/2004	1	0	16.25	9.00
Mare	RIDSH	5/6/1997	1	0	16.25	9.00
Mare	RIDSH	5/8/2005	1	0	16.63	9.00
Mare	RIDSH	6/3/2000	1	0	15.84	8.88
Mare	RIDSH	5/29/2004	1	0	16.31	8.88
Mare	RIDSH	5/2/2006	1	0	16.00	8.75
Mare	RIDSH	6/21/2007	1	0	15.94	8.75
Mare	RIDSH	1/3/2001	1	0	16.25	8.75
Mare	RIDSH	3/26/2006	1	0	16.25	8.75
Mare	RIDSH	5/12/2006	1	0	15.00	8.50
Mare	RIDSH	7/30/2000	1	0	16.75	8.50
Mare	RIDSH	4/21/2006	1	0	15.44	8.50
Mare	RIDSH	5/19/2005	1	0	16.00	8.50

Sex/Status	Class	Date Of Birth	FEMALE	RID	Hands	Bone (in)
Mare	RIDSH	4/21/2005	1	0	15.50	8.50
Mare	RIDSH	7/24/1997	1	0	15.75	8.50
Mare	RIDSH	6/24/2006	1	0	16.00	8.50
Mare	RIDSH	3/30/2005	1	0	15.56	8.50
Mare	RIDSH	6/14/2007	1	0	15.63	8.50
Mare	RIDSH	4/15/2006	1	0	15.25	8.50
Mare	RIDSH	5/7/2007	1	0	15.50	8.50
Mare	RIDSH	5/28/2004	1	0	15.75	8.50
Mare	RIDSH	6/20/1999	1	0	15.88	8.38
Mare	RIDSH	5/13/2001	1	0	15.25	8.38
Mare	RIDSH	4/19/2005	1	0	16.25	8.38
Mare	RIDSH	4/25/2001	1	0	15.69	8.38
Mare	RIDSH	4/26/2007	1	0	15.56	8.25
Mare	RIDSH	6/30/2006	1	0	15.38	8.25
Mare	RIDSH	5/1/2005	1	0	16.75	8.25
Mare	RIDSH	5/1/2003	1	0	15.81	8.25
Mare	RIDSH	4/4/2002	1	0	16.56	8.25
Mare	RIDSH	4/22/2006	1	0	15.81	8.25
Mare	RIDSH	3/16/2002	1	0	15.25	8.25
Mare	RIDSH	5/15/2001	1	0	15.75	8.25
Mare	RIDSH	3/21/2006	1	0	16.25	8.25
Mare	RIDSH	3/15/2006	1	0	15.50	8.25
Mare	RIDSH	5/6/2007	1	0	15.94	8.00
Mare	RIDSH	6/11/2007	1	0	16.13	8.00
Mare	RIDSH	6/17/2005	1	0	15.56	8.00
Mare	RIDSH	7/4/2005	1	0	16.00	8.00
Mare	RIDSH	3/6/2005	1	0	15.38	8.00
Mare	RIDSH	5/19/2005	1	0	15.50	7.75
Mare	RIDSH	5/1/2004	1	0	14.75	7.75
Mare	RIDSH	6/15/2005	1	0	14.88	7.75
Mare	RIDSH	5/24/2006	1	0	14.13	7.50
Gelding	IDSH	4/20/2007	0	0	16.75	8.66
Gelding	IDSH	6/5/2008	0	0	15.69	8.75
Gelding	IDSH	5/1/2004	0	0	16.44	8.00
Gelding	RID	4/6/2006	0	1	17.75	9.06
Gelding	RID	4/1/2005	0	1	16.00	8.39
Gelding	RID	6/24/2006	0	1	17.13	10.00
Gelding	RID	2/24/2001	0	1	16.63	9.88
Gelding	RID	3/21/2003	0	1	16.50	9.75
Gelding	RID	5/20/1995	0	1	15.50	9.75

Sex/Status	Class	Date Of Birth	FEMALE	RID	Hands	Bone (in)
Gelding	RID	4/2/2007	0	1	15.88	9.50
Gelding	RID	4/6/2007	0	1	17.13	9.50
Gelding	RID	4/30/2006	0	1	15.63	9.50
Gelding	RID	6/15/2006	0	1	16.81	9.25
Gelding	RID	4/28/2006	0	1	16.50	9.00
Gelding	RID	5/20/2005	0	1	16.25	9.00
Gelding	RID	3/13/2005	0	1	16.00	9.00
Gelding	RID	4/13/2006	0	1	16.38	9.00
Gelding	RID	6/16/2006	0	1	16.13	9.00
Gelding	RID	4/7/2006	0	1	16.75	8.00
Gelding	RIDSH	5/31/2002	0	0	16.50	8.66
Gelding	RIDSH	7/1/2001	0	0	16.63	10.50
Gelding	RIDSH	9/5/1992	0	0	16.75	9.75
Gelding	RIDSH	5/5/2006	0	0	16.25	9.50
Gelding	RIDSH	5/1/2003	0	0	16.75	9.25
Gelding	RIDSH	5/17/2005	0	0	15.75	9.00
Gelding	RIDSH	5/1/2006	0	0	16.25	9.00
Gelding	RIDSH	4/22/2006	0	0	15.00	9.00
Gelding	RIDSH	6/29/2004	0	0	15.94	8.88
Gelding	RIDSH	5/26/2004	0	0	15.75	8.75
Gelding	RIDSH	8/4/2006	0	0	15.50	8.50
Gelding	RIDSH	4/29/2006	0	0	15.50	8.50
Gelding	RIDSH	6/8/2005	0	0	16.50	8.50
Gelding	RIDSH	6/23/2008	0	0	15.38	8.50
Gelding	RIDSH	4/4/2007	0	0	16.25	8.50
Gelding	RIDSH	5/24/2008	0	0	15.69	8.38
Gelding	RIDSH	5/30/2007	0	0	16.00	8.25
Gelding	RIDSH	4/9/2006	0	0	16.50	8.00
Gelding	RIDSH	6/12/2005	0	0	15.75	7.13

APPENDIX C: Ireland HSI Class 2 Stallion List

Stallion	Bone (in)	Height	Girth (in)	Year of Birth
TARA CLOVER	9.06	17.22	87.01	1990
PURPLE ARCH	8.46	16.44	84.25	1991
DIAMOND CRACKER	9.84	17.27	83.46	1994
DEVILS PUNCHBOWL	9.65	17.32	83.07	2004
DUNGIMMON STAR KING	9.06	17.13	83.07	2001
BALLYBRACK DIAMOND	8.86	17.03	82.68	1997
SERVANT OF POWER	9.65	17.22	82.68	2003
BAWN VIEW STAR	9.06	16.54	82.28	2003
CASTLEGAR REBEL	8.74	16.54	82.28	2008
CEIDE PRINCE	9.45	17.22	82.28	2008
SKIPPING GRANGE	9.65	17.57	82.28	2004
WOODLANDS PRIDE	9.06	16.54	82.28	2005
BALLYGLASS PROUD BOY	9.06	16.73	81.89	2008
CASTLEMLY BOY	9.06	17.22	81.89	2005
KILNAGRALTA FAILTE FLAGMOUNT	9.06	16.44	81.89	2001
CAPPA ADMIRAL	9.45	16.78	81.50	2007
CAPPONELLAN VISION	9.25	16.73	81.50	2003
MASTER RIVIE	8.46	15.94	81.50	2005
ROCKHILL CLOVER	9.25	16.93	81.50	1992
THE LADYS MAN	8.86	16.54	81.50	2008
WESTMEATH ROCKY	8.94	16.93	81.50	2004
ARTHURS GOLD	10.24	16.24	81.10	1992
KING ALFRED	9.25	17.03	81.10	1991
TIGER HILL	8.82	16.44	81.10	2004
WILLOWS PRIDE	8.66	16.54	81.10	1990
CARRABAWN GINGER	8.86	16.83	80.71	2003
DRUMBILLA STAR	8.78	16.78	80.71	2007
GLENANAREEN PRINCE	9.25	16.98	80.71	1996
GORT EMPEROR	9.25	16.44	80.71	2006
LONGWOOD SILVER DOLLAR	8.66	16.09	80.71	2005
PURPLE HERO	8.86	16.04	80.71	2001
RIVIES SON	8.86	16.73	80.71	2004
WRS SUN RICH	8.94	16.83	80.71	1997
ALLEN ROCK	8.66	16.49	80.31	1989
BELLAMONT	8.66	16.93	80.31	2003
BELLEWS MATE	8.66	16.34	80.31	2005
CARRABAWN OG	9.65	16.83	80.31	2002
CRANNAGH KINGDOM	8.78	16.04	80.31	2008
CUSHLEAKE CLOVER	8.90	16.93	80.31	1997
PURPLE MATE	9.06	16.24	80.31	2002
ROSS DANCER	8.66	16.44	80.31	2000
STAR SUPREME	9.06	16.54	80.31	1999
SUNNYROSS REBEL	9.65	16.44	80.31	2007

Stallion	Bone (in)	Height	Girth (in)	Year of Birth
WARDTOWN MACHA	8.82	16.54	80.31	2006
YOUNG GEORGE	9.06	16.54	80.31	1990
BELCLARE CROSS	8.86	16.68	79.92	2000
BENLOWCROSS	8.94	17.13	79.92	2008
CLONEEN CLOVER	9.25	17.08	79.92	1991
DUNSANDLE DIAMOND	9.25	16.88	79.92	2006
OUGHBOY	8.86	16.34	79.92	1993
PRIORY REBEL	9.09	16.49	79.92	2008
WALTERSTOWN GREY	8.46	16.24	79.92	1992
YOUNG COOLEHANE	9.25	16.54	79.92	2004
CARRAIG DONOVAN	8.86	16.44	79.53	2005
CLOONDALAGAN DANCER	9.25	16.39	79.53	2006
DON CARLOS THE REBEL	9.25	16.88	79.53	2006
DRUMLANE BARNEY	9.45	16.44	79.53	2001
LEIGHLIN PRINCE	8.66	16.58	79.53	2008
MOSSFORT CHAMPION	9.25	16.83	79.53	2002
BALLYGARRETT CROSS	8.86	16.83	79.13	2006
CAHERDUFF NAVIGATOR	8.66	16.68	79.13	2003
COOLOO CREST	8.66	16.34	79.13	2004
FRANKS FANCY	9.06	16.44	79.13	1992
GREY LAUGHTON	8.27	16.24	79.13	1988
KILMOVEE PURPLE REIGN	9.06	16.19	79.13	2006
ATLANTIC WATT	8.27	16.34	78.74	2001
BELLINE TYNAGH GOLD	8.66	16.73	78.74	1992
CLONLEIGH SILVER MIST	8.86	16.58	78.74	2001
FRAOCHAN	8.66	16.19	78.74	2005
GLENARANEEN KING	9.84	16.39	78.74	1994
KEALDEARRA KINGDOM	8.46	16.09	78.74	2005
LASSBAN CEDAR VIEW	8.54	15.94	78.74	2000
LOUGHRY LAD	8.50	16.19	78.74	1990
MARISHES MIGHTY QUINN	8.66	16.44	78.74	2006
POWERWOODS GLADIATOR	9.06	16.73	78.74	1997
SANDYS LIGHT	9.25	16.73	78.74	1999
SEACREST BLUE	8.86	16.39	78.74	2005
THE GEEZER	8.86	16.14	78.74	2005
WELCOME DAWN	8.86	16.88	78.74	2001
ANRINNIN SILVER DRAGON	8.86	16.14	78.35	2008
CAHERLEA KING	8.66	16.34	78.35	2000
CLOVER SKIPPY	8.46	16.73	78.35	1995
GLID UIBHALL	8.66	16.44	78.35	2001
GORTLEA CLOVER	9.06	15.90	78.35	1993
GRANIT HERO	8.27	16.14	78.35	2005
LASSBAN CARRABAWN PRINCE	8.27	15.85	78.35	2003
LISATARA TOM	8.78	16.68	78.35	2005
MANOR PEARL	9.06	16.63	78.35	1998
MIZEN GOLD	9.06	16.34	78.35	2003
THE FOUR ALLS	8.46	16.58	78.35	2001

Stallion	Bone (in)	Height	Girth (in)	Year of Birth
ALIS HERO	8.46	16.63	77.95	1998
CONNACHT DIAMOND	8.27	16.73	77.95	1992
COOLCAUM HILL	9.25	17.52	77.95	1994
DANCING BOY	9.06	16.83	77.95	1993
FANCY DAN	8.86	16.54	77.95	2000
KEC DIAMOND DYNASTY	9.06	16.73	77.95	1999
KILCARNEY KING	9.06	16.39	77.95	1999
KNOCKALOUGH DIAMOND	9.06	16.73	77.95	2005
LISLAP BENEDICT	8.90	16.68	77.95	2005
MACKNEY HILL	9.45	16.49	77.95	1997
MANOR WELCOME	8.46	15.65	77.95	2005
ROS REBEL	8.27	15.85	77.95	1999
THE DASHING BLACK	8.27	16.34	77.95	2007
TRUMP HERO	8.86	16.04	77.95	2006
CALLANAGH GOLD	9.06	16.44	77.56	1992
GLOSTERS CLOVERS DREAM	8.66	16.24	77.56	1999
GORTFREE CASANOVA	8.46	16.14	77.56	2007
IRISH MIST TWO	8.46	16.54	77.56	1991
MILLHOLLOW REAL MAC COY	9.13	16.73	77.56	2006
MOYAN GINGER DIAMOND	8.66	16.63	77.56	1997
TULLYS TANGAWIZI	8.66	16.58	77.56	2006
CARROWEENEY HERO	9.25	16.24	77.17	2004
LOOBRHU GINGER WOOD	8.66	16.34	77.17	1999
MOYANS GLENSIDE REBEL	8.66	16.44	77.17	1992
PORTHALL LEO	8.66	15.94	77.17	1997
PURPLE LAD	8.46	15.70	77.17	2000
TRENDY GLIDER	8.66	16.34	77.17	2003
TULLYCOMMON BOY	9.45	16.04	77.17	1990
COILLE MOR HILL THE SECOND	8.86	16.34	76.77	2001
COOLOO HUNTINGFIELD	8.86	16.34	76.77	2005
LISSYCREMIN CLASSIC IBANE	8.66	16.34	76.77	2004
MURNACBEG CLOVER	9.06	15.94	76.77	1994
THE RED LAD	8.66	15.90	76.77	2003
YOUNG ZIDANE	8.74	16.04	76.77	2007
ARDGLEN BOY	8.66	16.09	76.38	1993
CARLTON HILL	8.66	16.54	76.38	1996
CLOONEEN SEA KING	8.66	16.68	76.38	2004
DRISHANE DIAMOND	8.54	16.34	76.38	2005
DUNKERRIN LEADER	8.86	16.68	76.38	2001
KNOCKAWUDDY BOY	8.86	16.54	76.38	2007
LUGDUFF SILVER	8.46	16.14	76.38	2006
NURNEY ALL DIAMOND STAR	8.66	16.04	76.38	2004
REBEL BALLAD	8.66	16.93	76.38	2005
TERENURE LAD	8.46	16.29	76.38	1998
THE KINGS SON	8.66	16.24	76.38	1997
DIAMOND MINE	8.27	16.24	75.98	1992
ESKER REBEL	9.06	16.04	75.98	2006

Stallion	Bone (in)	Height	Girth (in)	Year of Birth
FUERTY SILVER	9.06	15.75	75.98	2008
KILLONAN HERO	8.66	15.70	75.98	2006
LOCK KEY	8.66	16.63	75.98	2000
NOTTINGHAM FOREST	8.46	16.39	75.98	2000
PADDYS PRINCE	9.06	16.39	75.98	1998
SHANBALLY REBEL	8.86	15.85	75.98	2008
TREANLAUR ROCKY	8.86	16.49	75.98	2006
BRACKENS BEN	9.06	16.63	75.59	2004
CARRICKVIEW DIAMOND	8.66	15.85	75.59	2004
DEL AMITRI	8.66	16.73	75.59	1997
FLAGMOUNT CLOVER DIAMOND	8.46	16.19	75.59	1996
GLANNTANA	8.46	16.29	75.59	2005
MACS MERRY STAR	9.06	15.94	75.59	2004
MR GINGER BEN	9.06	15.75	75.59	2002
BREEDA MOUNTAIN	8.66	15.94	75.20	2007
CROSSBOYNE GOLDEN WONDER	8.46	15.80	75.20	1998
DIREEN KINGDOM	8.27	15.90	75.20	2003
KILDAULTON COPPER	8.07	15.85	75.20	2000
KILLEA HILL VIEW	8.66	15.99	75.20	2001
MATTYMOUNT DIAMOND	8.66	16.04	75.20	2006
MURPHYS MAN	9.06	16.73	75.20	1993
PHILIPSTOWN BOBBY	8.46	16.14	75.20	2004
RINEEN CLOVER	8.58	16.04	75.20	1993
BALLYHOURA BREEZE	8.66	16.39	74.80	1995
BALLYLANDERS VISION	8.74	16.39	74.80	2004
COOLGREEN ELM	8.66	15.65	74.80	2003
COOLVIN LEGACY	8.27	15.55	74.80	2008
HAYESTOWN WARRIOR	8.46	16.09	74.80	2005
WELCOME CREST	8.66	16.14	74.80	2004
KILLINICK TRUMP	8.66	16.49	74.41	2005
KING OF RINROE	8.46	15.75	74.41	2004
BALLYMOYLE DAKOTA	8.66	16.14	74.02	2004
LARKHILL SAFFRON	7.87	16.14	74.02	2008
RAKISH RI	8.27	16.63	74.02	2002
LAS VEGAS DIAMOND	8.66	16.14	73.62	1995
MOLLYS BOY	8.66	15.65	73.62	2003
SWILLY LAD	9.06	16.83	73.62	2002
BALLYELL MARCHESI REBEL MAN	8.66	16.04	73.23	2003
GALWAY STAR	8.50	15.55	72.83	1990
DERG SHOWTIME	8.07	16.04	71.26	2006
WELCOME ZIDANE	8.07	16.04	71.26	2006
GLOVE ELM	8.86	16.44	40.16	2007