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A QUANTITATIVE GENETIC ANALYSIS OF THE ANCESTRY OF NEIL TRASK LINE BRED HEREFORD CATTLE

A Thesis

by

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ABSTRACT

Diverse expression of any given trait within a breed is required to protect the breed from the unwanted consequences of selective breeding. Within the cattle industry, the fluid state of selective breeding trends, and consumer demand, creates a need for intermediate/moderate type cattle within individual breeds. These cattle have the ability to stabilize a given breed and bring it back from the extreme ends of the popular selection trends. This allows cattle breeders to change the genetics of their cattle, with relative speed, and meet consumer demands. Also, it protects individual breeds from harmful genetic mutations. This is evident in the increase in demand for intermediate cattle herds, like the Trask cattle, during the time period when most of the prominent Hereford breeders had carriers of snorter dwarfism in their herds. For this reason, it is important to preserve intermediate cattle lines like the Trask cattle, which have not conformed to popular cattle breeding trends. The genetic influence of various groups of ancestors on Trask bred bulls in current/recent herds was assessed using Wright's Relationship Coefficient (R_{xy}), and the inbreeding coefficient (F_x). Mean inbreeding coefficients of a group of 26 representative bulls from Trask bloodlines were compared to the mean inbreeding coefficient of all cattle in the available pedigree. Mean relatedness of the same 26 bulls with 1) a group of 15 prominent ancestors in the Hereford and Polled Hereford breeds, 2) a group of 30 ancestors that had the most descendants in the pedigree, and 3) a group of 19 prominent Trask line ancestors, was compared to the entire pedigree mean relatedness with the same groups. These comparisons were tested by 1) approximating a beta distribution representing the distribution of relatedness or inbreeding coefficients and testing the mean against that

approximated distribution, and 2) employing resampling methods to generate a bootstrapped distribution and compare means to those distributions. These two analysis methods produced slightly different results; the beta *P*-values resulted in a failure to reject the H_0, and the bootstrap resulted in the rejection of the H_0. This difference highlighted the beta distribution method's inability to account for the variation that occurs among samples drawn from a given population. The bootstrap resampling method was able to account for this variation because it draws numerous random samples to use in the calculation of the empirical *P*-values.

Results provide a scientific assessment on the genetic influence of the Trask pedigree ancestors on the Trask bred bulls in recent/current herds. Testing against approximated beta (β) distributions may have resulted in type II errors (failure to reject the null hypothesis when it is in fact false). Mean relationship coefficients for the ancestors show the Trask herd ancestors had the closest relationship with the Trask bulls (mean R_{xy} = 0.208), followed by the top 30 ancestors (mean R_{xy} = 0.150), and then the key breed ancestors (mean R_{xy} = 0.132). The Trask herd ancestor group not only had the closest relationship to the Trask bulls, they also had the smallest relationship coefficient (mean R_{xy} = 0.072) with the Trask pedigree as a whole. This may indicate that the genetic distance that accumulated between the Trask cattle and the rest of the Hereford breed is due to isolation and inbreeding associated with linebreeding. The mean F_x values showed the sample of 26 Trask bulls (F_x = 0.130) was more inbred than the animals in the Trask pedigree (F_x = 0.056).

DEDICATION

To my family who taught me to strive to be a better person today than yesterday

To all those who supported and believed in me

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Contributors

This work was supervised by a thesis committee consisting of Dr. Penny Riggs [Committee Chair], Dr. James Sanders [Committee Co-Chair], Dr. Andy Herring, and Dr. David Riley; all from the Department of Animal Science.

All work for the thesis was completed by Matthew Simmons, under the advisement of Dr. James Sanders of the Department of Animal Science, and Dr. David Riley of the Department of Animal Science. Dr. Sanders advised on all topics relating to the Trask cattle pedigree, and the selection of cattle to be included in this project. Dr. Riley advised on all topics related to data collection and analysis. Most importantly, he advised on the writing of computer code for quantitative genetic calculations.

Stacey Sanders and the American Hereford Association provided the extensive Trask cattle pedigree file used in this project.

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INTRODUCTION

In the early 1900s Polled Hereford cattle became a recognized cattle breed, and with that came the breed's own set of prominent breeders and prominent cattle herds (American Hereford Association, 2009). Due to the fluid state of popular selective breeding trends, a need exists for stabilizing forces within individual breeds. In other words, breeders who create and follow their own selective breeding program to produce a more intermediate/moderate cattle type, regarding a given trait can serve as a stabilizing force among cattle producers. Such producers do not follow the cattle breeding fads. On occasions when the prominent cattle lines become too extreme, both genotypically and phenotypically, the cattle lines which have not gone to the extremes are instrumental for the improvement of their breed. They give a breed the ability to genetically bring its performance traits back to a more intermediate type with relative ease. If a particular line of cattle does not carry a certain harmful mutation, it may provide a source of breeding animals that can help in the elimination of harmful recessive genes. This was certainly the case regarding the Trask cattle, during a period when much of the breed was trying to eliminate carriers for snorter dwarfism. Neil Trask was one of these breeders who served as a stabilizing force. His Trask cattle line and others like it, became very important to both polled and horned Hereford cattle breeders, during times when they were in need of a stabilizing force (Dr. J. O. Sanders personal communication, 2018). Through providing this stabilizing force, he became one of the prominent Polled Hereford breeders (American Polled Hereford Association, 1975; Dr. J. O. Sanders personal communication, 2018).

Neil Trask bought his first cattle in 1931, and after approximately sixty-five years of operating his ranch, the Trask cattle were sold to pay legal expenses. With that, the Trask Ranch reached its end, in 1997 (Trask, 1958; James W. Wright personal communication, 2017). A handful of breeders have attempted to revive the Trask cattle line to continue its legacy (Hayden, 2014; Dr. J. O. Sanders personal communication, 2014; Dr. S. Meadows personal communication, 2017). To that end, several recently and/or currently living Trask bred bulls (Trask bulls), which are all descendants of the Trask ranch herd, are available. This project is a study of the ancestry of the Trask line of cattle and is intended to measure the genetic relationships between a sample (n = 26) of the Trask bulls and their ancestors. This is a unique cattle line within the Hereford breed that was developed under pasture conditions for production on forage in the southern United States.

OBJECTIVES

The purpose of this study is to assess the genetic influence of various ancestors on Trask bred bulls in recent/current herds, evaluate the relationships among the Trask bulls, and compare the level of inbreeding for each of the Trask bulls to the average degree of inbreeding of the Trask pedigree. For the sample of (n = 26) Trask bulls, the objective is to provide an index/table of the level of relatedness to the other Trask bulls, level of relatedness to the 30 most influential ancestors in the Trask pedigree (most progeny), level of relatedness to the Neil Trask herd, level of relatedness to prominent early American Hereford ancestors, and level of inbreeding.

LITERATURE REVIEW

Two common bovine subspecies exist in the United States, *Bos indicus* and *Bos taurus*. *Bos taurus* beef cattle in the United States mainly include two different classifications: British breeds and Continental European breeds. Generally, British cattle breeds are (or traditionally have been) of a moderate mature size, reach maturity early, have high marbling ability, and maintain body condition more easily. Hereford cattle are a British breed of which has historically been a dominating breed in the American west since their first importation to the western ranges in the early 1870's (Putnam and Warwick, 1975; Briggs and Briggs, 1980).

Hereford Cattle

Numerical Importance

Multiple written sources provide evidence that the Hereford breed quickly gained popularity among American cattle men and were heavily imported in the late 1800's and early 1900's (Sanders, 1914; Briggs and Briggs, 1980; American Hereford Association, 2009). The beef cattle breed registrations from 1910 to 1970 are illustrated in Table 1, in five-year increments. Between 1910 and 1925 Hereford cattle registrations increased from 24,000 to 75,000. This lifted the breed from being the second largest to becoming the breed with the largest number of registered beef cattle of all the beef breeds listed in the 1975 revised edition of the U.S. Department of Agriculture Farmers' Bulletin No. 2228 (Putnam and Warwick, 1975). Within that 15-year span, Hereford registrations (excluding registered Polled Herefords) increased 200.1% compared to the 100.4% increase in registrations of Shorthorn cattle, the former leader in the number of cattle registrations

Table 1. American Cattle Registrations (thous.)

Breed	1910	1915	1920	1925	1930	1935	1940	1945	1950	1955	1960	1965	1970
Hereford	24	44	97	75	96	117	181	275	383	422	364	302	236
Polled Hereford		2	6	4	6	6	10	28	44	101	111	160	160
Angus	10	16	23	11	11	15	32	56	110	186	236	384	352
Shorthorn	29	58	106	69	49	25	23	30	37	35	38	38	35
Brahman	–	–	–	2	2	2	4	10	19	17	13	16	18
Red Poll	3	4	6	3	3	1	2	4	5	3	2	2	2
Milking Shorthorn	–	–	–	–	–	10	15	24	29	22	10	6	5
Brown Swiss[1]									22	22	24	18	16
Holstein[1]									184	198	266	257	309
Santa Gertrudis											7	12	19
Charolais											8	8	45
Red Angus											1	2	5
Polled Shorthorn						3	4	8	12	14	11	11	12
Brangus									4	6	4	4	7

[1]**Not listed prior to 1950 since use for beef as a straightbred or for crossing was slight until recently.**

(Putnam and Warwick, 1975)

In 1980, Briggs and Briggs estimated, according to public auction records, Herefords accounted for two thirds of the registered beef cattle sold in the U.S. in 1937, and this volume remained about the same (69%) in 1953. They also stated, at the time of publication (1975-1980) that "more registered Hereford bulls were being sold than all other breeds combined." The 45 year rise in both Hereford and Polled Hereford registrations, shown in Table 1, plateaued and began to decrease after 1955 (Putnam and Warwick, 1975).

The trend of the total number of purebred American Hereford cattle registered with the American Hereford Association (AHA) for the last 21 years, is shown in Figure 1 (these numbers include both Hereford and Polled Hereford cattle). At its lowest point in recent history (2007), the total number of Hereford cattle registered dropped to 63,943 from about 500,000 in 1955, the highest number of registrations in the available data. That is, the number of registered Hereford cattle has greatly decreased when, compared to the peak numbers as seen in Table 1 (*i.e.* 422,000 Herefords in 1955 and 160,000 Polled Herefords in 1965-1970) (Stacey Sanders and the American Hereford Association, Personal Communication, 2017). Largely associated with the desire to increase quality grade, and the increase in the popularity of black cattle, other breeds gained in popularity over the Hereford cattle. The marketing campaign of Certified Angus Beef combined with the registration of black cattle in most of the continental European beef breeds led to a decrease in the demand for Hereford bulls in commercial herds (Dr. J. O. Sanders personal communication, 2019). In Table 3, the Hereford registration counts from Figure 1 are compared to a selection of other breeds in the United States.

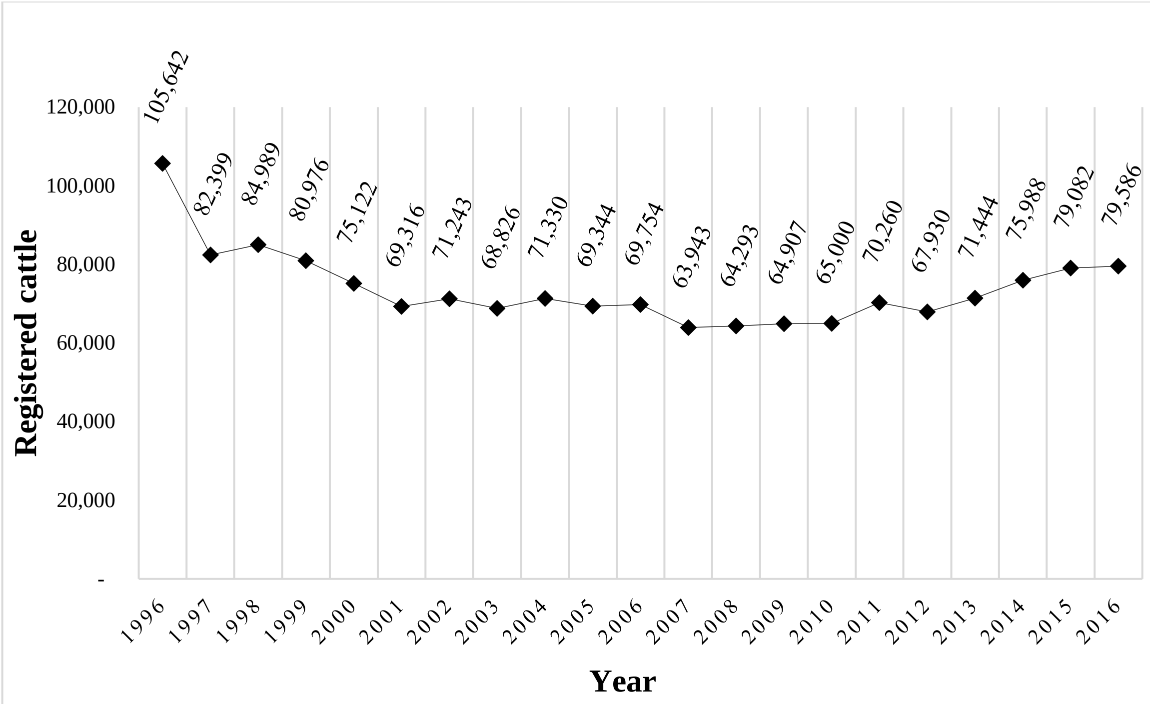

Figure 1. The Total number of Hereford Cattle Registered with the American Hereford Association **(Stacey Sanders and The American Hereford Association, Personal Communication, 2017)**

In 2005, during the experimental design period of the current Germplasm Evaluation project (GPE) at the United States Meat Animal Research Center (USMARC), it was estimated that Hereford cattle comprised roughly 9.5% of registered purebred cattle breeds in the United States. The total number of living registered animals for each breed was reported to the National Pedigreed Livestock Council (NPLC) by member beef cattle breed organizations. The sampling goal was to mirror, on a smaller scale, the proportion of each cattle breed in the national cattle population with a scale population model in the GPE project. Since, only 16 breeds were used in the calculations, the proportions of each breed used in the GPE project were adjusted. Hereford cattle accounted for 14.1% of the total cattle in the project sample size (Dr. R. M. Thallman, personal communication, 2016).

Similar numbers were reported by the NPLC in a book created for the 100^{th} anniversary of the NPLC, originally named the National Society of Livestock Record Associations (Morris, 2011). Illustrated in Table 2, this researcher personally calculated the following estimate from the number of registrations for each breed, the numbers used are listed in Morris (2011). In 2011, Hereford Cattle were 9.457% of the total number of U.S. registered beef cattle, reported to the NPLC by the member beef cattle breed organizations. These two estimates from 2005 and 2011 are not accurate depictions of breed proportions and influence on the overall U.S cattle population, but they are the best estimates currently available, even though they exclude non-registered purebred cattle, cross-bred cattle, and nonmember breeds of the NPLC.

Table 2: 2011 NPLC Cattle Breed Registration Numbers Data

Breed and Assoc.	Active Members	Transfers	Whole Herd Reporting	Animal Registrations	% NPLC Reg. Beef Cattle
Angus (AAA)	31,461	176,199	0	282,911	41.614%
Beefmaster (BBU)	2,815	7,712	0	17,236	2.535%
Brahman (ABBA)	900	7,400	0	9,000	1.324%
Brangus (IBBA)	1,500	16,068	43,000	29,643	4.360%
Braunvieh (BAA)	401	1,577	6,700	2,770	0.407%
Charolais (AICA)	3,316	19,546	0	65,954	9.701%
Chianina (ACA)	914	5,391	0	9,208	1.354%
Corriente (NACA)	675	795	0	2,349	0.346%
Gelbvieh (AGA)	1,500	11,694	0	37,488	5.514%
Hereford (AHA)	3,434	31,747	107,523	64,293	9.457%
Limousin (NALF)	3,104	11,532	15,218	25,336	3.727%
Maine-Anjou (AMAA)	1,825	5,246	0	8,382	1.233%
Red Angus (RAAA)	2,231	21,890	89,397	44,722	6.578%
Salers (ASA)	396	2,930	11,529	6,040	0.888%
Santa Gertrudis (SGBI)	1,000	3,500	0	7,500	1.103%
Shorthorn (ASA)	2,574	9,014	20,639	15,036	2.212%
Simmental (ASA)	5,298	27,532	0	49,718	7.313%
Texas Longhorn (TLBAA)	1,159	708	0	2,254	0.332%
Column Totals	64,503	360,481	294,006	679,840	100%

[1]**Modified and calculated from numbers in Morris 2011**

(Morris,2011)

Depicted in Table 3, for selected breeds and listed by year, are the total numbers of cattle registered with the respective breed associations in the United States in recent years. These numbers were directly supplied by and used with the permission of the relevant breed associations. Looking at Table 3, it is clear that the total Hereford registrations have significantly decreased since 1996 from 105.6 thousand registered animals to 79.6 thousand. This is in stark contrast with the total Angus registrations, which have greatly increased from 220.6 thousand, in 1996, to 334.6 thousand registered animals in 2016. All of the listed breeds have experienced increases and decreases in total registrations throughout the measured time period between 1996 and 2016. Some of these fluctuations may be attributed to times of economic stress and/or drought conditions. It is important to note that out of all the breeds listed here, the *Bos indicus* breed (Brahman) and one of the *Bos indicus – Bos taurus* composite breeds (Santa Gertrudis) consistently have the two lowest numbers of total registrations each year. To gain perspective, in terms of the national cattle population, Hereford cattle account for only 13.02% of the cattle registrations listed in 2016, versus the Angus breed’s 54.73%.

Table 3. Registrations of American cattle from 1996 to 2016 (thous.)

Breed	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Hereford	105.6	82.4	85.0	81.0	75.1	69.3	71.2	68.8	71.3	69.3	69.8	63.9	64.3	64.9	65.0	70.3	67.9	71.4	76.0	79.1	79.6
Angus	220.6	239.5	253.0	260.9	271.2	271.2	282.0	281.7	298.8	324.3	347.6	347.8	333.8	282.9	297.1	295.0	315.0	288.8	298.4	320.4	334.6
Brahman	14.1	15.1	11.3	11.1	10.8	9.3	8.7	8.5	7.0	7.9	8.1	8.4	8.3	8.8	9.4	8.6	8.3	9.6	9.5	9.2	11.4
Charolais	44.7	49.2	45.5	42.7	45.4	53.1	55.0	47.1	43.4	45.9	45.7	41.7	35.3	33.5	31.9	29.2	32.2	33.2	33.6	36.0	34.9
Red Angus	33.3	33.8	37.3	39.1	41.4	42.7	40.9	41.5	43.9	45.8	45.7	46.9	46.2	46.0	47.0	46.0	50.3	52.3	57.2	47.0	70.4
Santa Gertrudis	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4.5	4.1	4.8	5.6	6.3
Shorthorn	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	12.4	12.8	13.4	13.8	15.1	14.9
Simmental	–	–	–	–	–	44.9	45.2	43.7	46.5	50.6	51.5	51.4	51.4	50.9	51.9	55.6	57.9	60.6	63.7	68.2	59.3

[1] **The missing values were either unavailable or no longer on recored, with the respective breed association, at the time the data was collected.**

(Personal Communications with various Personnel of the Respective Breed Associations, 2017)

Valuable Traits

This relatively quick rise in the Hereford breed's popularity during the first half of the twentieth century (Table 1) has been attributed to the breed's ability to meet the needs of the American cattlemen (Briggs and Briggs, 1980). According to a "Fact Sheet" from the American Hereford Association, in today's industry the traits offered by Hereford cattle are fertility, reproductive performance, feed efficiency, optimum size and growth, documented feedlot and carcass superiority, low maintenance costs, optimum muscling, optimum milk, adaptability and hardiness, superior disposition, soundness, and crossbreeding advantages (American Hereford Association, 2009). Specifically, Hereford cattle are known for their superior foraging ability, adaptability, high fleshing ability, medium muscling and marbling, early maturing, and grazing ability (Putnam and Warwick, 1975; Briggs and Briggs, 1980; Hammack, 2013).

According to Hammack (2013), compared to Angus cattle and other British breeds, as shown in Table 4, Hereford cattle are on average at medium or optimal levels regarding most common production traits. The following quote is a testament to the performance, quality, and value of the Hereford breed: "The adaptability of the modern Hereford is best emphasized by stating that the breed presently is found in every one of the 50 states of the United States and in 20 other countries of the world" (Briggs and Briggs, 1980). According to Putnam and Warwick (1975) and, Briggs and Briggs (1980), Hereford crossed offspring are marked uniformly, have high merit carcasses, and perform well prior to slaughter. When compared to cross-bred cattle, with *Bos indicus*, *Bos taurus – Bos indicus* composites, and other *Bos taurus* sire breeds, Hereford-sired cattle have shorter gestation lengths, medium-high average daily gain, excellent marbling score, beef flavor intensity and juiciness, moderate 205 day weaning weight, heifer pregnancy rate percent, yield grade, retail product percent, and tenderness (Wheeler et al., 2006). The fact that Hereford cattle are used both in seed stock and commercial operations in multiple countries around the world, indicates that this breed has performance traits that are desirable in widely different geographical locations.

Table 4. Functional Levels of Purebreds of the Major Cattle Breeds in Texas.[1]

Functional Type Breed	Growth and Size[2]	Milking Potential[3]	Age at Puberty	Hot Climate Adaptability	Fleshing Ability	Muscling	Cutability[4]	Marbling[4]
British Beef								
Angus	H	M	E	L	H	M	L	H
Hereford[5]	H	L	M	L	H	M	L	M
Red Angus	H	M	E	L	H	M	L	H
Shorthorn	H	M	E	L	H	M	L	H

[1]Breeds most numerous or familiar in Texas. Evaluations are estimates of pure bred breed-wide averages compiled from research reports, particularly U.S. Meat Animal Research Center. Productive functions are characterized above as VL= very low, L= low, M= medium, H= high, VH= very high, EH= extremely high, except for age at puberty where VE= very early, E= early, M= medium, L= late, VL= very late. Range exists within these categories, so breeds with the same designation do not necessarily average exactly the same level. Also, considerable individual variation exists within breeds. Levels for cattle of multi-breed background can be estimated from proportions of the constituent breeds.
[2]Rate of gain and mature weight at similar body condition.
[3]In relation to body size.
[4]Under similar nutrition.
[5]Horned and Polled.

(Modified from Hammack, 2013)

Influential Ancestors in the Hereford Breed and the Trask Cattle Pedigree

Not only is the Trask cattle herd an important part of American Hereford history, it is a genetic link to the past. Using records from the American Hereford Association (AHA), this researcher has traced the Trask cattle line back to England, in the early to middle 19th century. As expected, the pedigree of the Trask cattle herd includes numerous important and/or prominent ancestors of the modern Hereford and the American Hereford breed as a whole. Included among the important ancestors are, most notably, Anxiety 4th 9904, Dowager 6th 6932, Polled Plato 353393, Mossy Plato 26th 1719194, and a myriad of others. The following animal descriptions/histories do not include all of the influential ancestors focused upon in this project; descriptions/histories for many of the influential ancestors could not be found and may not exist.

Hereford Breed

Anxiety 4^{th} 9904, born in 1880, was bred in England by T. J. Carwardine. His sire was Anxiety 2238, with Longhorns 2239 as the paternal grandsire. His dam was Gaylass 9905, with Longhorns 2239 as the maternal grandsire (Hazelton, 1935). Anxiety 4^{th}'s parents were ¾ siblings. Both Anxiety 2238 and Gaylass 9905 had Longhorns 2239 and De Cote 2243 in their pedigrees as their sire and maternal grandsire respectively. This caused Anxiety 4^{th} 9904 to be inbred (Ornduff, 1960). Anxiety 4^{th} was never shown at fairs or stock shows. He was imported to the United States in 1881, after being purchased by Gudgell and Simpson of Independence, Missouri. They maintained ownership until his death in 1890. "The most noted son of Anxiety 4^{th} 9904 was Don Carlos 33734, sire of Lamplighter 51834, and Beau Brummel 51817." Anxiety 4^{th} had 102 daughters and 71 sons that were recorded (Hazelton, 1935).

North Pole 8946, born in 1880, was bred in England by Aaron Rogers. His sire was Mars 12^{th} 4462, with Wrexham 2411 as the paternal grandsire and Chance 2413 as the paternal great grandsire. In 1881, he was purchased by Gudgell and Simpson and imported to the United States with Anxiety 4^{th} 9904. With one exception, North Pole 8946 did not sire any bulls of prominence, nor any bulls that were used in the Gudgell and Simpson herd for that matter. However, North Pole 8946 was a noteworthy sire of females (Hazelton, 1935; Hazelton, 1939). South Pole 8948, the only North Pole 8946 son to "achieve any prominence," was out of the dam Spot 5th 8949, and used as a herd sire by E. M. Price in Rocheport, Missouri (Hazelton, 1939). Hazelton (1935) stated that "The mating of the get of Anxiety 4th 9904 and the get of North Pole 8946 was regarded as the most successful "nick" in the history of American Hereford breeding." The term "nicking", most often used by animal breeders, means the fortuitous outcome of mating together two separate family lines within a specific breed (Bourdon, 1985). The AHA pedigree shows, that Anxiety 4th 9904 and North Pole 8946 are distantly related, five to seven generations back. The two bulls have a familial relationship through common ancestors such as, Sir Thomas 20, Sir Benjamin 36, and Sir David 68. Anxiety 4th 9904 and North Pole 8946's "closest blood tie… was through Sir Thomas 20" (Hazelton, 1939). Although North Pole 8946 never sired any prominent bulls, many of his daughters were the dams of influential bulls such as, Lamplighter 51834, Beau Brummel 51817, Paladin 126248, Publican 189221, and Prince Domino 499611 (Hazelton, 1935).

Prince Rupert 79539, born in 1897, was bred in Missouri by H. B. Watts. His sire was Beau Donald 58996, and his paternal grandsire was Beau Brummel 51817 (Hazelton, 1935). Beau Donald 58996, the paternal grandson of Don Carlos 33734 and the maternal grandson of Anxiety 4th 9904, was the sire of several of the progenitors of prominent cattle family lines such as the Ruperts, and several others (Hazelton, 1939). Prince Rupert 79539's dam, Sallie Morton 44785, was a granddaughter of Anxiety 4th 9904. He sired Prince Rupert 8th 142701 and was used as a herd sire by W. H. Curtice at Eminence, Kentucky. Prince Rupert 8th 142701 was the sire of numerous noted show and breeding animals such as, Don Perfect 400000, and Prince Rupert 80th 544903 (Hazelton, 1935). Prince Rupert 79539 was the progenitor of the Rupert cattle family line (Hazelton, 1939).

(**Note**: Prince Rupert 79539 was apparently misidentified in Hazelton (1939) as Prince Rupert 73539; according to volume 17 of the AHA herd book, the registration number 73539 belongs to a cow named Abigal 73539, also born in 1897.)

Prince Domino 499611, born in 1914, was bred in Missouri by Gudgell and Simpson. His sire was Domino 264259, with Publican 189221 as his paternal grandsire. Beau Brummel 51817 was his maternal grandsire. Bright Stanway 366600 was his half-brother, through their dam Lady Stanway 9th 171354. Prince Domino 499611 sired numerous show champions such as, Ruth Domino 814903, Prince Domino 115th 1091970, and Princeps Domino 793463 (Hazelton, 1935). Prince Domino 499611 was very influential in the Trask pedigree (which was compiled by Stacey Sanders of the AHA and will be used to calculate data for this project); he was the sire of 231 animals that are listed in the Trask pedigree.

According to Ornduff (1960), Prince Domino 499611's "influence on the Hereford breed in America undoubtedly was greater than that of any other sire beyond the mid-point of the 20th century." In other words, this bull's influence stood the test of time, and his influence continued through his offspring long after his death. Within the opening statement of chapter 14 "Prince Domino's Story" in Ornduff (1960), Mr. Ornduff went as far as saying Prince Domino 499611 "deserves to be recognized as the Anxiety 4th of modern times." Prince Domino 499611 was originally purchased by Otto Fulscher from Gudgell and Simpson at their ranch in Edmond Kansas in 1915. Mr. Fulscher came up with Prince Domino 499611's name and requested that Gudgell and Simpson register him under that name before he purchased the bull; this was due to the fact that Prince Domino 499611 had not yet been named or registered at the time (Ornduff, 1960).

In 1924, the Ken-Caryl Ranch Co. purchased a half-interest in Prince Domino 499611. The bull died in 1930 (Hazelton, 1935). During a span of almost two decades after his death, Prince Domino 499611's influence on the American Hereford population continued to intensify. At the time of his death, few of the noted Hereford ranches, in the United States, lacked significant Prince Domino 499611 influence in their herds. However, important exceptions are noted, such as the cattle owned by Robert H. Hazlett (Ornduff, 1960).

<u>Beau Aster 412145</u>, born in 1912, was bred by the Mousel Bros. in Nebraska. His sire was Beau Mischief 268371, and Beau President was his paternal grandsire (Hazelton, 1929). He had Onward 91043 as a maternal grandsire, and Lincoln 76024, the sire of Onward, as his maternal great grandsire. According to Hazelton (1935), Beau Aster 412145 was the sire of many of Fulscher and Kepler's show winning cattle. He was first owned by Fulscher and Kepler of Colorado and was later bought by H. J. Gramlich of Nebraska (Hazelton, 1935). Ornduff (1960) stated that the "Prince Domino 499611-Beau Aster 412145 nick" attained fame as one of the "most successful in the history of American Herefords. It was the product of this mating which established Prince Domino 499611's reputation as a sire." A few of those Prince Domino 499611 sired, Beau Aster 412145 maternal grandsons and/or granddaughters are: Wilton Domino 67706, who gained his prominence in the David Firm and Sons herd in LaVeta, CO; Leo Domino 706077 and Princess Domino 716898 "were made the champions of the Western Hereford Futurity", a

feature at the National Western Stock Show in 1918; and Ruth Domino 814903 was the champion female at Denver's 1920 National Western Stock Show (Ornduff, 1960).

Woodford 500000, born in 1911, was bred in Kentucky by W. H. Curtice. He was previously named Beau Perfection 24th 394173. His sire was Perfection 92891 and his dam was Belle Donald 114th 267191. Woodford 500000's maternal grandsire was Beau Donald 76th 187362 and his maternal great grandsire was Beau Donald 58996. In 1935, J. M. Hazelton wrote that "the mating of the Belle Donalds with Perfection produced the noted family of Beau Perfections, the greatest of which was Woodford 500000." He was bought by Col. E. H. Taylor in 1914, for $12,000 (Hazelton, 1935). That is equivalent to $305,042.40 in March of 2019 (Bureau of Labor Statistics). He sired many distinguished breeding and show animals such as, Woodford Prince 500005, Donald Woodford 862935, and Belle Woodford 28th 720716. Woodford 500000 died in a fire in 1918 (Hazelton, 1935) "If he had lived longer, he may have been as influential as Prince Domino" (Dr. J. O. Sanders, Personal communication, 2017).

Hazford Rupert 25th 1209734, born in 1923, was bred in Kansas by Robert H. Hazlett. His sire was Hazford Rupert 634535 and his dam was Hazford Lass 6th 634534. His maternal grandsire was Publican 4th 429762 and had Beau Brummel 10th 167719 as a distant ancestor (Hazelton, 1935). As a junior yearling bull, Hazford Rupert 25th 1209734 initially drew notice when, he placed second in the American Royal Livestock Show in 1924 (Ornduff, 1960). According to Ornduff (1960), the judge at that show described him as "a large, growthy, well-fleshed, mellow bull with two good ends and good legs." The finest of several important family lines were used to create the "great sire Hazford Rupert 25th 1209734" (Ornduff, 1960). His sons and daughters made his name for him with their success in major shows across the country, as well as national and international stock shows (Ornduff, 1960).

Hazford Rupert 81st 2348825, born in 1935, was bred by Robert H. Hazlett. In his 1960 book, Donald R. Ornduff stated that Hazford Rupert 81st 2348825 "represented the culmination of the dreams which his breeder had vaguely recognized when he acquired his first Herefords… Hazford Rupert 81st was the last great champion produced by Robert H. Hazlett." His sire was Hazford Rupert 25th 1209734, and his dam was Delsona 1759102. His paternal grandsire was Hazford Rupert 634535, and his maternal grandsire was Hazford Tone 8th 1456786. Hazford Rupert 81st 2348825 was "greatest of the sons of Hazford Rupert 25th 1209734." In 1937, in the dispersal sale after Hazlett's death, Hazford Rupert 81st 2348825 was sold to Harper and Turner of Sulphur, OK for $18,800 (Ornduff, 1960). Ornduff (1960) stated that Hazford Rupert 81st 2348825 "later became famed as the sire of the T. Royal Ruperts."

TR Zato Heir 5380000, born in 1946, was bred by the Patterson Land Company (Ornduff, 1960). His Sire was HandD Tone Lad 105th 3488354, with HandD Zato Tone Lad 8th 2863405 as his paternal grand sire. His dam was Leola Flowers 2846628, and his maternal grandsire was Beau Flowers 2226361. TR Zato Heir 5380000 was purchased by the Turner Ranch (near Sulphur Oklahoma) in 1948 and became the ranch's top herd sire in the early 1950's. Originally named Zato Heir L. 22nd 4864184, his name was changed to TR Zato Heir 5380000 after he was bought by Turner Ranch. At the Turner Ranch, TR Zato Heir 5380000 produced numerous sons and grandsons that sold for over $30,000. TR Royal Zato 27th, son of TR Zato Heir 88th 7500000 and grandson of TR Zato Heir 5380000, "set a record valuation of $204,000" because, Turner Ranch sold half and quarter breeding/ownership interests on separate occasions. In the 1957 National Western Sale, all of the top three animals sold were descendants of TR Zato Heir 5380000 (Ornduff, 1960).

Ornduff (1960) stated “few great sires have been used as extensively as TR Zato Heir 5380000… literally hundreds of his sons served in herds from coast to coast.” The TR Zato Heirs were helped in their rise to prominence by the historic necessities of the times, which required a “change in bloodlines” in numerous Hereford herds (Ornduff, 1960). One reason for TR Zato Heir 5380000’s rise in popularity was the use of his bloodline as a non-dwarfism bloodline (Dr. J. O. Sanders personal communication, 2018).

Polled Hereford Breed

Polled Plato 353393, born in 1910, was bred in Missouri by J. W. Wyant. His sire was Polled Quality 304549 and his dam was Polled Purity 295550. His maternal grandsire was Polled Admiral 2nd 230299. Polled Plato was first owned by Wallace Libbey and later sold to Grube and Scherzer of Larned Kansas (Hazelton, 1935). Polled Plato 353393 was the patriarch of the Polled Plato family line which, at that time, was considered a “popular modern-day Polled Hereford family”. He lived to the age of 16 before he died in 1926. Polled Plato 353393’s son, Mossy Plato 1341320, continued the family line, and its popularity, by siring Mossy Plato 26th 1719194 (Ornduff, 1960).

Polled Admiral 2nd 230299, born in Des Moines Iowa in 1905, was bred by Warren Gammon. His sire was Giant 101740, and his paternal grandsire was McKinley 74548. His dam was Hannah Ernst 106066, and his maternal grandsire was Duke of York 58674. He was owned by J.W. Wyant in Missouri and was a full-sibling of Polled Admiral 170209 (Hazelton, 1935). Ornduff (1960) stated “Polled Quality 304549 became the historically significant son of Polled Admiral 2nd, even though he was overshadowed in his earlier years by such half-brothers as Echo Grove 306948, Polled Echo 313327, and Polled Ito 322148" (Ornduff, 1960).

Mossy Plato 1341320, Born in 1924, was bred in Kansas by Grube and Scherzer. His sire was Polled Plato 353393 and his dam was Mossy Maid 1037288. His maternal Grandsire was Mossy Beau 681985 (Hazelton, 1935).

Mossy Plato 26th 1719194, born in approximately 1928-1929 (birth year was approximated, for this animal, and specified for others using birth dates of his/their offspring and his/their parents). He was bred in Kansas by Grube and Scherzer. Mossy Plato 26th 1719194 was purchased in-dam by Frank Brannon of Kansas and was sold as a yearling to Leslie Brannon of Timken Kansas, Frank's brother (Ornduff, 1960). His sire was Mossy Plato 1341320, and his paternal grandsire was Polled Plato 353393. His dam was Miss Pride 2nd 1167319, and his maternal grandsire was Mossy's Pride 934498 (AHA Pedigree data; Personal Communication with Stacey Sanders of the AHA, 2016). Mossy Plato 26th 1719194 sired several noted offspring, but his most influential offspring to this research is Victor Domino 14th 2220966 because, he sired the patriarch of the Trask cattle line (Plato Domino 1st 2350712).

Victor Domino 14th 2220966, born in approximately 1931, was bred in Kansas by Leslie Brannon (Ornduff, 1960). His sire was Mossy Plato 26th 1719194, and his paternal grandsire was Mossy Plato 1341320. His dam was Victoria Domino 1st 1655765, and Prince Domino 148th 1288879 was his maternal grandsire (AHA Pedigree data; Personal Communication with Stacey Sanders of the AHA). While at the Leslie Brannon Ranch, Victor Domino 14th 2220966 sired Plato Domino 1st 2350712 before, he was sold to a new owner in New Zealand (Ornduff, 1960).

Early Trask Foundation Cattle

Hazford Seminole 1815001, born in 1926, was bred by Frank Robert Condell of El Dorado, Kansas (Hazelton, 1935). His sire was Hazford Rupert 25th 1209734 and his paternal grand sire was Hazford Rupert 634535. His dam was Hazford Lass 27th 1294641 and his maternal grandsire was Bocaldo 17th 685018. He was owned by P. S. Cummings and Sons in Donalsonville, Georgia. The Cummings herd was, at one time, the leading Hereford herd in the Southeastern United States (Hazelton, 1935).

Plato Domino 1st 2350712, born in approximately 1935, was bred in Kansas by Leslie Brannon (Ornduff, 1960; Bible, 1981). His sire was Victor Domino 14th 2220966 and Mossy Plato 26th 1719194 was his paternal grandsire. His dam was Belle Domino 39th 1212635 and his maternal grandsire was Prince Domino 499611 (AHA Pedigree data; Personal Communication with Stacey Sanders of the AHA). Plato Domino 1st was the progenitor of the Trask Cattle Line. He produced both show cattle and herd sires such as, the National Grand champion Real Plato Domino 2839351 and Plato Domino 43rd 3080818, respectively (Bible, 1981).

M P Domino 3rd 1967033, born in approximately 1931 and was bred by Leslie Brannon. His sire was Mossy Plato 26th 1719194 and his paternal grandsire was Mossy Plato 1341320. His dam was Miss Domino 5th 1570017 and his maternal grandsire was Prince Domino 148th 1288879 (Stacy Sanders personal Communication, 2018).

Plato Domino 43rd 3080818, born in 1940, was bred by Neil Trask (when the bull was conceived, his sire, Plato Domino 1st, was still owned by Leslie Brannon and his dam was owned by Trask) (Bible, 1981). His sire was Plato Domino 1st 2350712 and his paternal grandsire was Victor Domino 14th 2220966. His dam was Lady Real 52nd 2523366 and Real Prince Dom 33rd 2140675 was his maternal grandsire (Stacy Sanders personal Communication, 2018).

Pure Plato Domino 3775927, born in 1937, was bred by Frank C. Brannon. His sire was Plato Domino 1st 2350712 and Victor Domino 14th 2220966 was his paternal grandsire. His dam was Della 2nd 2269164 and his maternal grandsire was M P Domino 3rd 1967033 (Stacy Sanders personal Communication, 2018).

Battle Domino 18th 3320225, born in 1941, was bred by John M. Lewis and Sons. His sire was Battle Domino 5th 2718243 and Battle Mischief 7th 1810925 was his paternal grandsire. Miss Bullion 6th 1861531 was his dam and Mossy Bullion 1855506 was his maternal grandsire (Stacy Sanders personal Communication, 2018).

Palmetto Woodford 5249256, born in 1947, was bred by Neil W. Trask. His sire was Plato Hazford 4279424 and his paternal grandsire was Perfection Lad 5th 3283347. His dam was Palmetta PLD Plato 3871770 and his maternal grandsire was Pure Plato Domino 3775927 (Stacy Sanders personal Communication, 2018).

Plato Hazford 4279424, born in 1944, was bred by Neil W. Trask. His sire was Perfection Lad 5th 3283347 and his paternal grandsire was Beau Perfection 231st 2729217. His dam was Belle Domino 77th 3555225 and his maternal grandsire was Plato Domino 1st 2350712 (Stacy Sanders personal Communication, 2018).

Plato Mischief 6285578, born in 1950, was bred by Neil W. Trask. His sire was Palmetto Woodford 5249256 and Plato Hazford 4279424 was his paternal grandsire. His dam was Palmetta P Plato 8th 3998707 and his maternal grandsire was Pure Plato Domino 3775927 (Stacy Sanders personal Communication, 2018).

Victor Plato 35th 7314476, born in 1952, was bred by Neil W. Trask. His sire was Quarter Victor Dom 5390000 and his paternal grandsire was Victor Domino 128th 2857153. His dam was Miss Ninety-Five 5879307 and his maternal grandsire was Palmetto Real 32nd 4948673 (Stacy Sanders personal Communication, 2018).

Plato Woodford 34th 7363063, born in 1952, was bred by Neil W. Trask. His sire was Palmetto Woodford 5249256 and his paternal grandsire was Plato Hazford 4279424. His dam was Palmetta Real 55th 4843480 and Plato Domino 43rd 3080818 was his maternal grandsire (Stacy Sanders personal Communication, 2018).

Double Domino 5th 5745343, born in 1948, was bred by Mr. and Mrs. Cameron Morrison. His sire was Rollo Domino Lad 4415899 and his paternal grandsire was Victor Domino 128th 2857153. His dam was Phyliss Domino 3286529 and his maternal grandsire was Victor Domino 4th 2113325 (Stacy Sanders personal Communication, 2018).

Rupert Gem 7809132, born in 1953, was bred by Macarthur and Co. His sire was James Rupert 5655431 and his paternal grandsire was Doctor Rupert 3679205. His dam was Lassie Ruperta 6441891 and his maternal grandsire was Ivan Rupert 5213940 (Stacy Sanders personal Communication, 2018).

NT Rupert 9446404, born in 1956, was bred by Neil W. Trask. His sire was Rupert Gem 7809132 and James Rupert 5655431 was his paternal grandsire. His dame was Queen

Repeater 40th 7895524 and his maternal grandsire was Plato Hazford 4th 5491457 (Stacy Sanders personal Communication, 2018).

Hartland Rupert 48th 12199616, born in 1962, was bred by Neil W. Trask. His sire was NT Rupert 9446404 and his paternal grandsire was Rupert Gem 7809132. His dam was Queen Repeater 12th 7303128 and his maternal grandsire was Plato Hazford 4th 5491457 (Stacy Sanders personal Communication, 2018).

FF Battle R948 11213062, born in 1960, was bred by Fowken Farms. His sire was Repeater Plato 6th 7324692 and his paternal grandsire was Plato Hazford 4th 5491457. His dam was NRF Lady Domino 1st 6116506 and his maternal grandsire was Battle Domino 18th 3320225 (Stacy Sanders personal Communication, 2018).

Hartland Rupert 66th 13219124, born in 1964, was bred by Neil W. Trask. His sire was NT Rupert and his paternal grandsire was Rupert Gem 7809132. His dam was NT Battle Lass 12th 10854427 and his maternal grandsire was NRF Battle Domino 2nd 6116499 (Stacy Sanders personal Communication, 2018).

NT Mischief Mixer 20015879, born in 1967, was bred by Trask Ranch in Calhoun Falls, SC. His sire was Hartland Rupert 48th 12199616, and NT Rupert 9446404 was his paternal grandsire. Miss Mischief 22nd 8421156 was his dam, and Plato Mischief 6285578 was his maternal grandsire. NT Mischief Mixer 20015879 was a horned bull with herd ID 354 (American Hereford Association, 2014-2018).

Hazford Bocaldo 14628869, born in 1967. His breeder is unconfirmed but is believed to be Neil W. Trask. His sire was Rupert Donald 13219114, and his paternal grandsire was Hartland Rupert 23rd 11471130. His dam was Carla Bocaldo 20th 10814008, and his maternal grandsire was Plato Bocaldo 8487233 (Stacy Sanders personal Communication, 2018).

Most Influential Cattle in the Trask Pedigree

The cattle listed in this category were determined to be the 30 most influential bulls in the Trask pedigree. This was determined by calculating the number of each bull's offspring that are present in the Trask cattle pedigree. All 30 of these bulls will not be listed in this subsection. This is due to the fact that they were written about in previous Influential Ancestors subsections. Specifically, Prince Domino 499611, Beau Aster 412145, Anxiety 4th 9904, and Polled Plato 353393 are the bulls, which appear in more than one ancestor group.

Domino 264259, born in 1905, was bred in Missouri by Gudgell and Simpson. His sire was Publican 189221, and Donna Anna 22nd 189218 was his dam. Paladin 126248 was his paternal grandsire, and Lamplighter 51834 was his paternal great grandsire. He had Beau Brummel 51817 as his maternal grandsire. He was sold to J. C. Robinson and Son, from Wisconsin, in the Gudgell and Simpson dispersion for $1,625, in 1916. He was the sire of Lord Domino 374313, Geronimo 305447, Prince Domino 499611, and many others. Domino 264259 died in 1920 (Hazelton, 1935).

Beau Brummel 51817, born in 1890, was bred in Missouri by Gudgell and Simpson. His sire was Don Carlos 33734, and his dam was Belle 24629. His paternal grandsire was Anxiety 4th 9904, and his maternal grandsire was North Pole 8946. There are registrations in the herd books for 221 of his daughters and 186 of his sons. He sired numerous prominent bulls and cows including Plutarch 66670, Lady Stanway 9th 171354, Militant 71755, Lamplight 102799, Beau President 171349, and Beau Beauty 192235 (Hazelton, 1935). According to Hazelton (1939), the highest concentration of Anxiety 4th 9904's blood that was passed to later generations of American Herefords, was through Don Carlos 33734 and his two most prominent sons Beau Brummel 51817 and Lamplighter 51834. Governor Simpson was quoted, in Hazelton (1939), for saying "Beau Brummel 51817 is our bull sire, and Lamplighter 51834 is our cow sire." As said by Dr. J. O. Sanders, Beau Brummel 51817 and Lamplighter 51834 were by far, both the most prominent sons of Don Carlos 33734, and two of the most prominent bulls of Gudgell and Simpson breeding (Dr. J. O. Sanders personal communication, 2018).

Bright Stanway 366600, born in 1909, was bred in Missouri by Gudgell and Simpson. His Sire was Bright Donald 128131. His dam was Lady Stanway 9th 171354, who was also the dam of Prince Domino 499611. Beau Brummel 51817 was Bright Stanway 366600's maternal grandsire. He was purchased, for $3,600 at the Gudgell and Simpson dispersal sale, in 1916 by E. M. Cassady and Son, and was brought to their property in Iowa. He sired Lily Stanway 699128, Bright Stanway Jr. 977105, Good Stanway 2nd 862598, and various others. Bright Stanway 366600 died in 1921 (Hazelton, 1935).

Beau Mischief 268371, born in 1906, was bred in Missouri by Gudgell and Simpson. Beau President 171349 was his sire, and Mischievous 71758 was his dam. His maternal grandsire was Lamplighter 51834. Beau Mischief 268371 was a half sibling of Beau Mischief 209411 through his dam. Anxiety 4th 9904 had a strong influence on his pedigree. Beau Mischief 268371 was the sire of Beau Aster 412145, Beau Blanchard

362904, Mischief Mixer 508606, and Mischief Mixer 7th 590252 and the maternal grandsire of Prince Domino Mischief 1003879. Beau Mischief 268371 was originally purchased by J. A. Larson of Kansas for $500 and was later bought by the Mousel Bros. from Nebraska (Ornduff, 1960).

The Mousel Bros. first saw Beau Mischief 268371 at the American Royal show, in 1907, where he placed fourth in the junior class. The Mousel Bros. bull place third at the show in that same class. They attempted to buy him from Mr. Larson and were told he was not for sale. Two years went by before the bull was "turned back" to Gudgell and Simpson by Mr. Larson. The reason being that he was "a shy breeder and had been badly foundered." The Mousel Brothers bought him for $150, took him home, and slowly nursed him back to health. From 1911 to 1917 he sired 222 progeny at the Mousel Bros. Ranch (Ornduff, 1960). He died in 1917 (Hazelton, 1935). Note that there were two other bulls with the same name as this Beau Mischief, but with different registration numbers.

The Grove 3rd 2490, born in 1874, was bred in England by Benjamin Rogers. The sire was Horace 2492 and his dam was Blossom 2493. His maternal grandsire was Sir Thomas 20, who was sired by Sir Benjamin 36. He was a herd sire in Philip Turner's "famous herd at The Leen, Hereford, 1882-1883" (Hazelton, 1935). The Grove 3rd 2490 was bought by C. M. Culbertson of Newman, Illinoi for $4,150 in 1883, when the Turner herd was dispersed. According to Hazelton (1935) that was "the highest price paid for a Hereford up to that time." He was the sire of Rudolph 13478, Hesiod 11975, Royal Grove 21500, and Merlin 17929. At 11 year of age, The Grove 3rd 2490 was sold again, this time he was sold to Earl and Stuart from Indiana for $7,000 (Hazelton, 1935).

Lamplighter 51834, born in 1891, was bred in Missouri by Gudgell and Simpson. His sire was Don Carlos 33734, and his dam was Lady Bird 3rd 31101. His paternal grandsire was Anxiety 4th, and his maternal grandsire was North Pole 8946. He won first place in the Chicago World's Fair in 1893. He was the sire of Paladin 126248, Mischievous 71758, Lamplighter Jr. 69251, and Pretty Lady 25th 121411 (Hazelton, 1935). According to Hazelton (1939), the highest concentration of Anxiety 4th 9904's blood that was passed to later generations of American Herefords, was through Don Carlos 33734 and his two most prominent sons Beau Brummel 51817 and Lamplighter 51834. Governor Simpson was quoted, in Hazelton (1939), for saying "Beau Brummel 51817 is our bull sire, and Lamplighter 51834 is our cow sire." As said by Dr. J. O. Sanders, Beau Brummel 51817 and Lamplighter 51834 were by far, both the most prominent sons of Don Carlos 33734, and two of the most prominent bulls of Gudgell and Simpson breeding (Dr. J. O. Sanders personal communication, 2018). Lamplighter 51834 died in 1902 (Hazelton, 1939).

Beau President 171349, born in 1903, was bred in Missouri by Gudgell and Simpson. His sire was Beau Brummel 51817, and his dam was Pretty Lady 25th 121411. He had Lamplighter 51834 as his maternal grandsire. He sired Beau Perfection 254963, Beau Randolph 418893, Beau Picture 308177, and Beau Mischief 268371 (Hazelton, 1935). Considered Beau Brummel 51817's "greatest son," Beau President 171349 was an exceptional sire of both bulls and heifers. Gudgell and Simpson regarded Beau President 171349 with high esteem and denied numerous "flattering offers" for the bull (Hazelton, 1939). Hazelton (1939) stated that the highest concentration of Beau Brummel 51817's blood was passed to later generations of American Herefords through Beau President

171349. According to Dr. J. O. Sanders, Beau Brummel was the maternal grandsire, a paternal great grandsire (through the paternal grandam), and a paternal great-great grandsire (through the paternal grandam of Domino) of Prince Domino; Beau Brummel's biggest contribution to the Hereford breed was probably through Prince Domino. Since the Hereford breed tends to account for relationship through the sire side of the pedigree, important contributions through females are often overlooked.

Beau Blanchard 362904, born in 1910, was bred in Missouri by Gudgell and Simpson. His sire was Beau Mischief 268371 and his dam was Blanche 23rd 141623. His paternal grandsire was Beau President 171349, with Beau Brummel 51817 as his paternal great grandsire. Beau Brummel 51817 was also his maternal grandsire. Jesse Engle and Sons, of Missouri, bought him as a yearling in 1911. Although he was never shown, he sired numerous bull and heifer calves that later became noteworthy show animals. A few of the show champions he sired were Beau Blanchard 48th 619552, Beau Blanchard 94th 886646, and Belle Blanchard 511791. Beau Blanchard 362904 died in 1922 (Hazelton, 1935). Beau Blanchard was one of three bulls that were sired by Beau Mischief after he had been returned by Larson and before he was purchased by the Mousel brothers (Dr. J. O. Sanders personal communication, 2019).

Lord Wilton 4057, born in 1873, was bred in England by Wm. Tudge. His sire was Sir Roger 3850 and his dam was Lady Claire 4116. His paternal grandsire was Sir Thomas 20 and his maternal grandsire was Marmion 4117. He was a sire in the cattle herd owned by T. J. Carwardine (the breeder of Anxiety 4th). When the herd was dispersed, he was purchased by Thos. Fenn and Wm. Tudge for $5,000. He sired Prince Edward 7001, Lord

Wilton 2nd 7964, Sir Evelyn 9650, and numerous others. Many of his offspring were imported into North America by breeders such as C. M. Culbertson of IL, Hon. M. H. Cochrane of Canada, and T. L. Miller of IL. Lord Wilton 4057 died in 1886 (Hazelton, 1935).

Beau Dandy 145564, born in 1902, was bred in Missouri by Gudgell and Simpson. He was sired by Beau Brummel 51817, and Daisette 3rd 37194 was his dam. His maternal grandsire was Don Juan 11069. He was first purchased by J. A. Shade of Iowa and was later sold to G. E. Leslie of Missouri. A few of the cattle sired by Beau Dandy 145564 are Beau Maximus 228502, Beau Meridian 550200, and Beau Mischief 209411 - not to be confused with the Beau Mischief 268371 that was used by the Mousel brothers (Hazelton, 1935).

Beau Randolph 418893, born in 1911, was bred by Gudgell and Simpson. Beau President 171349 was his sire, and Alice 3rd 312596 was his dam. His paternal grandsire was Beau Brummel 51817, his paternal great grandsire was Lamplighter 51834. His maternal grand sire was Dandy Rex 71689, and his maternal great grandsire was Lamplighter 51834. Jowell and Jowell, from Hereford, Texas bought him in 1915 for $5,000. He was sold twice more, once to Mrs. H. M. Pegues and Sons of Odessa Texas and then to H. Gaudreault and Son from Nebraska (Hazelton, 1935).

Beau Picture 308177, born in 1907, was bred in Missouri by Gudgell and Simpson. His sire was Beau President 171349, and his dam was Penelope 2nd 149630. His paternal grandsire was Beau Brummel 51817, and his maternal grandsire was Perfection 92891. He sired Bonny Brummel 512944, Barnstormer 557926, and Beau Gorgeous 463939. He was sold, on two separate occasions, to Rankin Farms of Missouri and J. T. Waters of Iowa. Beau Picture 308177 died in 1920 (Hazelton, 1935).

Advance Domino 1381854, born in 1925, was bred by the Mousel Bros. in Nebraska. His sire was Prince Domino Mischief 1003879, and his dam was Donna Agnes 20th 1085598. His paternal grandsire was Prince Domino 499611, and his maternal grandsire was Spartan 464109. Advance Domino 1381854, along with Advance Mischief 1323063, was one of the two most influential sons of Prince Domino Mischief 1003879, and both were major herd sires in the Mousel herd. Apparently, Mrs. L. R. Bradly of Hereford, Texas, was at least a part owner of Advance Domino at one point (Hazelton, 1935).. Very importantly, Advance Domino 1381854 became one of the most influential animals of the breed, because of his two grandsons Advance Domino 20th 2035127 and Advance Domino 54th 2120894, both were sired by Advance Domino 13th (1668403), and were the foundation sires of the Line One cattle (Hazelton, 1935; Ornduff,1960; MacNeil, 2009).

Perfection Fairfax 179767, born in 1903, was bred by G. H. Hoxie of Thornton, Illinois (Hazelton, 1935). He was owned by W. T. McCray of Kentland, Indiana (Hazelton, 1939). His sire was Perfection 92891 and his paternal grandsire was Dale 66481. His dam was Berna 138482 and his maternal grandsire was Fairfax 84159. A few of his well-known offspring were Anxiety Fairfax 627072, Perfection Fairfax 6th 266757, and Juliet 568169 (Hazelton, 1935). According to Ornduff (1960), during the beginning of the 1900's the Dales (the line sired by Dale 66481) were among the "most noteworthy contributors" to the Hereford breed; at that time, the Dales were in the "limelight" more than the Anxiety

4th's. Ornduff (1960) attributes the Dales' period of higher popularity than the Anxiety 4th's, in part to the "superior salesmanship" of the Dales' owners/breeders compared to that of Gudgell and Simpson. Dale 66481's fame mostly comes from the calves out of the consecutive matings to Melley May 41752, who's great grandsire was Anxiety 2238. Of these calves, sired by Dale and out Melley May, the historically most important one is Perfection 92891. He was a "landmark bull" of the time. Perfection 92891's most influential sons were Perfection Fairfax 179767, and Woodford 500000 (Ornduff, 1960). Perfection Fairfax 179767 died in 1920 (Hazelton, 1935).

Beau Donald 58996, born in 1893, was bred by Gudgell and Simpson in Independence, Missouri. He was purchased from Gudgell and Simpson by H. B. Watts of Fayette, Missouri (Hazelton, 1939). His sire was Beau Brummel 51817, and his paternal grandsire was Don Carlos 33734. His dam was Donna 33735, with Anxiety 4th 9904 as his maternal grandsire (Sanders, 1914). Under the Ownership of H. B. Watts, the most noted bull that Beau Donald 58996 sired was Prince Rupert 73539, the progenitor of the prominent Rupert cattle line. H. B. Watts "got a few crops of calves" by Beau Donald 58996 before selling him to W. H. Curtice of Eminence, Kentucky. As a sire in the Curtice herd, Beau Donald 58996 became the progenitor of the Beau Donald and Belle Donald cattle family (Hazelton, 1939). According to Hazelton (1939), a few of the distinguished families that had Beau Donald 58996 as direct ancestor were "the Disturbers, the Repeaters, and the Bonnie Brae 3rd's".

Onward Domino 812380, born in 1919, was bred by Fulscher and Kepler of Holyoke, CO. Prince Domino 499611 was his sire, and Domino 264259 was his paternal grandsire. Miss Tommy 538056 was his dam, and Beau Aster 412145 was his maternal grandsire. Onward Domino 812380's son, Onward Domino 2nd 1383121, was the 1926 Denver Junior Champion. Onward Domino 812380 was purchased from his breeders by the Kimberling Bros. of Champion, NE (Hazelton, 1925).

Advance Mischief 1323063, born in 1924, was bred by the Mousel Bros. in Cambridge, NE. Prince Domino Mischief 1003879 was his sire, and Prince Domino 499611 was his paternal grandsire. Blanche Mischief 6th 1085894 was his dam, and Young Anxiety 4th 659395 was his maternal grandsire (Hazelton, 1929). Advance Mischief 1323063, along with Advance Domino1381854, was one of the two most influential sons of Prince Domino Mischief 1003879 (Dr. J. O. Sanders personal communication, 2017).

Superior Mischief 590259, born in 1915, was bred by the Mousel Bros. of Cambridge, NE. His sire was Beau Mischief 268371, and Beau President 171349 was his paternal grandsire. Miss Caroline 423874 was his dam, and Domino 264259 was his maternal grandsire. On January 6, 1920, P. J. Sullivan of Wray, CO, purchased Superior Mischief 590259 for $22,000 (Hazelton, 1929).

Don Carlos 33734, born in 1886, was bred by Gudgell and Simpson in Independence, MO. Anxiety 4th 9904 was his sire, and Anxiety 2238 was his paternal grandsire. Dowager 6th 6932 was his dam, and Young Sir Frank 2669 was his maternal grandsire. "Don Carlos 33734 was 2nd in class, 3rd in herd, 2nd in get, and 2nd in bull any age at the Chicago World's Fair in 1893." Out of his numerous offspring, the most notable bulls were Lamplighter 51834, and Beau Brummel 51817 (Hazelton, 1925). Don Carlos 33734 was the most influential son of Anxiety 4th 9904 and one of the most influential bulls in the Hereford breed (Ornduff, 1960; Dr. J. O. Sanders personal communication, 2017). His greatest offspring came from mating him to North Pole 8946's daughters (Ornduff, 1960).

Sir Thomas 20, born in 1860, was bred by Roberts of Ivingtonbury, England. His sire was Sir Benjamin 36. His dam was Lady Ann 40, and Arthur Napoleon (910) was his maternal grandsire. Registration numbers in parentheses are British registration numbers. Sir Thomas 20 was purchased in 1864 by Mr. Monkhouse of "The Stow," who died in 1866. His herd was dispersed, and Sir Thomas 20 was sold to Mr. Benjamin Rogers of "The Grove." This was the birthplace of his sire Sir Benjamin 36 (Sanders, 1914).

Militant 71755, born in 1916, was bred by Gudgell and Simpson in Independence, MO. Beau Brummel 51817 was his sire, and Don Carlos 33734 was his paternal grandsire. Miss Charming 8th 46850 was his dam, and Don Carlos 33734 was also his maternal grandsire. Militant 71755 was the sire of Mischief Maker 97907 (Hazelton, 1925).

Repeater 289598, born in 1907, was bred by E. W. and M. A. Heath of Chicago, IL. Distributor 176433 was his sire, and Disturber 139989 was his paternal grandsire. Mina 184985 was his dam, and Mo. Chief 2nd 104368 was his maternal grandsire. He was owned by O. Harris and Sons of Harris, MO. According to the source below, Repeater 289598 sired several prize-winning offspring such as Repeater Jr. 696362, though he did not mention the prizes won by the offspring he listed (Hazelton, 1925).

Dandy Domino 2nd 1090962, born in 1921, was bred by Fulscher and Kepler of Holyoke, CO. Prince Domino 499611 was his sire, and Domino 264259 was his paternal grandsire. Rosabelle Aster 586269 was his dam, and Beau Aster 412145 was his maternal grandsire. Dandy Domino 2nd 1090962 sired Prince Domino 101st 1904037, the champion of the 50th Anniversary Hereford show, in 1932. Domino 2nd 1090962 was owned by Banning-Lewis Ranches in Colorado Springs, CO (Hazelton, 1935).

Beau Modest 160589, born in 1901, was bred by Gudgell and Simpson of Independence, MO. Beau Brummel 51817 was his sire, and Don Carlos 33734 was his paternal grandsire. Mignonette 7th 46847 was his dam, and Don Quixote 37205 was his maternal grandsire (Hazelton, 1929).

Anxiety 3rd 4466, born in 1879, was bred by T. J. Carwardine in Leominster, England. Anxiety 3rd 4466 is listed in the English Hereford Herd Book under the name Sir Garnet (6181). His sire was Anxiety 2238, and Longhorns 2239 was his paternal grandsire. Tiny 4467 was his dam, and Longhorns 2239 was also his maternal grandsire (Hazelton, 1925). Both Anxiety 3rd 4466 and Anxiety 4th 9904 were sired by Anxiety 2238. Though they did not have the same dam, Anxiety 3rd 4466 and Anxiety 4th 9904 each had Longhorns 2239 as both their paternal and maternal grandsires. In other words, Anxiety 3rd 4466 was more than a ¾ brother to Anxiety 4th 9904 (Hazelton, 1939).

Garfield 7015, born in 1881, was bred by John Price, Court House in Pembridge, England. Quickset 6853 was his sire, and Regulus 3849 was his paternal grandsire. Plum 7016 was his dam, and Challenge 1561 was his maternal grandsire. Garfield 7015 sired the Earls of Shadeland including the 22nd, the 30th, the 41st, and the Earl of Shadeland 47th 36644, who was owned by Gudgell and Simpson (Hazelton, 1935).

Neil Trask

History

In 1931, Neil Trask, a vegetable farmer at that time, gained possession of a herd of 70 commercial cattle as a part of his purchase of Big Barnwell Island off the coast of South Carolina near Beaufort, SC (Chase, 1949; Trask, 1958; Bible, 1981). According to a quote from Neil Trask, in Bible (1981), these were "native cattle of Spanish extraction," analogous to the Texas Longhorn. Trask said that the native cattle were conceived by natural selection and were raised in an environment regulated by "survival of the fittest." Meaning that they lived on pasture exposed to the elements under pasture conditions, were given little hay, and essentially had to be able to acclimate to the environment or perish (Trask, 1958). In 1933, Neil Trask purchased and began breeding both registered Polled Hereford and registered Hereford Bulls to his native cattle herd (it is unknown where these first Herefords were purchased). He later stated that the profitable, and hearty qualities of the native cattle facilitated the establishment of the Trask cattle line (Chase, 1949; Trask, 1958; American Polled Hereford Association, circa 1975; Bible, 1981). Trask joined the American Polled Hereford Association (APHA) in 1937 and was inducted into the APHA Polled Hereford Hall of fame in 1975 (American Polled Hereford Association, circa 1975).

A few years after the purchase of his first Hereford cattle, Mr. Trask began to research Hereford histories and pedigrees to determine which breeders he would visit and potentially purchase cattle from. During the ranch visits, Trask would observe the cattle on pasture to see the soils, grasses, and management practices that produced them. Trask was researching pedigrees, while simultaneously researching soil types to find out which soil types paired best with his preferred forage species and looking for land locations with these soil types (Chase, 1949; Trask, 1958). In 1937, Trask set out on several trips to visit ranches in multiple different states including Colorado, Georgia, and Kansas. During one of those visits, Mr. Trask saw for the first time Plato Domino 1st 2350712 in Timken, KS, at the Leslie Brannon Ranch. Both he and his grandsire (Mossy Plato 26) were known to have a pedigree heavily influenced by the bulls Beau Brummel and Don Carlos. Plato Domino 1st 2350712's dam was sired by Prince Domino 499611 (Bible, 1981; Chase, 1949; Trask, 1958).

At the Brannon Ranch, Trask bought several cattle and continued on to the Otto Fulscher Ranch in Colorado. There he purchased several females, daughters of both Real Prince Domino 33rd and Real Prince Domino. On his way home, Mr. Trask returned to the Brannon Ranch to pick up the cattle he had purchased during his previous visit. When he arrived, Lady Real 52nd (a daughter of Real Prince Domino 33rd) and a daughter of Real Prince Domino were both in heat. Mr. Brannon offered to breed them to Plato Domino 1st, provided that Mr. Trask would sell him one of the resulting calves. The two men struck a deal and Mr. Brannon purchased Real Plato Domino, the bull calf born to the daughter of Real Prince Domino. Real Plato Domino was shown by Mr. Brannon and earned the titles of National Reserve Champion in 1939 and National Grand Champion in 1940, at the National Polled Hereford Show (Chase, 1949; Ornduff, 1960; Bible, 1981). Real Plato Domino 43rd 3080818, the bull produced by that first mating of Lady Real 52nd to Plato Domino 1st, spent his life as a senior herd bull at the Trask ranch (Bible, 1981; Chase, 1949). In 1938, Plato Domino 1st was purchased from the Leslie Brannan Ranch in Timken, Kansas. In that same year Neil Trask located and purchased 1,600 acres for $12 per acre near Calhoun Falls, South Carolina. The purpose of which, Trask said, was to “expand the herd and to give Plato Domino 1st a better chance” (Bible, 1981; Chase, 1949; Trask, 1958).

Popularity and Valuable Traits of the Trask Cattle

Changes in selection practices, due to changes in both industry and consumer demands (and also due to fads that have little to do with either industry or consumer demands), are responsible for periodic changes in the performance traits and characteristics of a given animal breed within a species. That being said, not all seed stock producers follow the popular trends, and therefore, preserve the breed’s characteristics. In the 1930s Neil Trask did not prescribe to the popular breeding selection trends and chose to select for moderate framed cattle while the industry followed trends from one extreme of small frame cattle to the other extreme of large frame cattle (Bible, 1981). Neil W. Trask was one of the Hereford breeders who aided in the restoration of the breed’s genetics after the outbreak of harmful genetic mutations such as dwarfism (Dr. J. O. Sanders personal communication, 2016).

Around 1910, the popularity of small framed, earlier maturing, and earlier weight gaining cattle slowly began to grow (Ritchie, 2002; Dr. J. O. Sanders personal communication, 2016). According to Ritchie (2002), “there was intense selection pressure” for these types of cattle between the 1930’s to around 1955. The expression “baby beef” began to be used around 1915 because cattle were now being slaughtered as yearlings instead of being slaughtered at around four years of age (Ritchie, 2002; Dr. J. O. Sanders personal communication, 2016). Several years before Mr. Trask started his breeding program, the small framed cattle trend had become popular and continued to be popular until the middle to late 1960’s. Less than forty years after Mr. Trask started in the 1930’s, the cattle industry began to change course and follow a trend of selecting for much larger cattle (Ritchie, 2002).

According to Ritchie (2002), "dwarfism erupted in the early 1950's, and was a holocaust to the purebred industry." The first known cases of dwarfism were before 1920, and starting in the late 1930's, dwarfism hit some of the most important Hereford herds (Dr. J. O. Sanders personal communication, 2019). In 1955 the cattle frame size evened out at a moderate size (small by today's standards) and later began to increase in the 1960's (Ritchie, 2002; Dr. J. O. Sanders personal communication, 2019). There are three types of genetically caused dwarfism; they are Snorter Dwarfism, Long Head Dwarfism, and Compress Dwarfism. Out of the three types of dwarfism, Snorter Dwarfism appeared most often in Hereford cattle. In general, genetically caused types of dwarfism arise from genetic mutations resulting in bodily deformations such as malformed bone growth to the extremities, trunk of the body, nasal cavities, head, and neck areas. These deformations may appear on a given animal in different combinations depending upon, the specific type of dwarfism the animal has been diagnosed with (Schalles, 2013). When the industry began selecting for large framed cattle, Trask's cattle were bigger than most everyone else's, and therefore, quickly gained in popularity around the country. According to his grandson, Mr. Trask disliked the "push for growing larger framed cattle" (James W. Wright Personal communication, 2018). Later came the period where beef cattle were too large, and the industry set on a trend of selecting for moderately sized cattle. Once again, Trask cattle were in high demand, being that they were of the moderate size the industry was moving towards (Bible, 1981; Ritchie, 2002; Dr. J. O. Sanders personal communication, 2016).

Neil Trask and Trask-bred cattle were at one time household names within the world of Polled Hereford cattle. Though Mr. Trask has passed away, "The Trask Cattle are still known today as being economical, beef-making, profit-making, grazing animals" (Stump Denton, 2013). According to Neil Trask, the Trask cattle owed their popularity to being "…accepted nationwide as cattle that will produce on grass;" some of them are good enough to "sell themselves" (Bible, 1981). In other words, Trask cattle have a high grazing performance under pasture conditions with minimal supplementation. His cattle have a low amount of imperfections (genetic diseases/disorders), most of the problems and/or undesirable traits were eliminated through line breeding (Bible, 1981). Trask's cattle herd has a long history of producing high performance animals with superior natural fleshing and weight gaining ability (Chase, 1949; Trask and Goodwin, 1958; Bible, 1981; Dr. J. O. Sanders, personal communication, 2016).

End of the Trask Cattle Ranch

According to Wright v. Trask, in 1983, James W. Wright, Neil Trask's grandson, quit his job and took over management of the Trask Ranch in exchange for the cattle, land, equipment, and facilities being willed to him in the event of Mr. Trask's death. This was an oral "contract to make a will." In 1994 Mr. Neil W. Trask endured a stroke and declined in health. Mr. Trask and Mr. Wright soon entered into disagreements over Mr. Wright's leasing of hunting rights on the ranch, terminating their lease of land from a neighboring family member's ranch, and the selling of some of Trask's "best" cattle that were in fact solely owned by Mr. Wright. After almost fifteen years of working to improve the land, facilities, and cattle, as per the oral agreement, Mr. Wright was fired and disinherited. He took legal action in March of 1996. The courts found in favor of Mr. James W. Wright Jr., and ordered a written will securing Mr. Wright's inheritance of the Trask Ranch and its cattle (Wright v. Trask, 1997). Mr. Trask later died in 1998 (James W. Wright personal communication, 2017).

Due to the legal expenses accrued by both parties during the lawsuit, the Trask cattle had to be sold to pay the lawyers. "Teddy Gentry of the band Alabama had bought cattle from us previously and liked them. He purchased them all and I gave him the records. I kept them and managed them for about six to eight months till he was able to move them" (James W. Wright personal communication, 2018).

Cattle management philosophy

Not long after his success with improving the traits of the native cattle herd on Big Barnwell Island South Carolina, Neil Trask studied and began to formulate his ideas for prosperous cattle production (Chase, 1949; Trask, 1958). He deduced that the aspects of making his cattle operation successful were: (1) "Good permanent type pastures" are essential to a sturdy bedrock for cattle production (Mr. Trask built his "permanent type pastures" by purchasing land with the soil types most befitting to the native and/or desired forages); (2) Cattle should be able to acclimate to their environment under range conditions and minimal management input, ensuring a profitable operation; (3) Herefords were ideal for his type of grazing and breeding program (Chase, 1949). In the case of Mr. Trask's ranch, he found and, in 1938, purchased 1,600 acres near Calhoun Falls, South Carolina. His new ranch was located in the northeastern corner of the state about 180 miles northeast from his previous farm/ranch on Big Barnwell Island. After researching soil types, he concluded that Davidson, Mecklenburk, and allied soil types were the best for the use of his preferred forage types, which were blue grass, Dallis grass, lespedeza, and white clover (Chase, 1949; Trask, 1958).

It is important to note that the word adapt is sometimes misused (as it was in Chase, 1949) to denote a given animal's adjustment and/or ability to adjust to a new environment, after being relocated from a different environment. According to Herring (2014), the correct term for this type of adjustment is acclimatization because, the "animal's physiological processes are adjusting to the new stresses it is being subjected to" within its lifespan. Adaptation to an environment takes place over more than one generation through the genetic variability of a given population and a number of genetic mechanisms (Herring, 2014).

Cattle Management System

On the subject of herd management, Mr. Trask would spend large amounts of time riding his pastures, observing both the state of his cattle and the pastures. He actively culled animals that did not meet his criteria. Mr. Trask selected for cattle that were "good grazers" (meaning they easily put on flesh while eating only grass), and have a "large expressive heart girth" (Dr. Steven Meadows personal communication, 2017). According to Mr. Trask's grandson, the cattle "had to make it on grass…. He did not worm cattle or use creep feed. He believed in survival of the fittest" (James W. Wright personal communication, 2018). The following description of the way cattle were managed at the Trask ranch is an excerpt from a Polled Hereford World Magazine article which, was written by Mr. Neil W. Trask:

"*All animals run on pasture the year around and the breeding herd is wintered on small grain and milo with soybean silage. A small amount of hay is fed to the breeding herd during wet weather. The heifer calves are wintered the same way with the addition of one pound of cotton seed meal. During bad winter weather, we feed 2 or 3 pounds of grain if it is available. No creep feeding of either bull or heifer calves is done.*

Most of our calves come during February and March with a few in April and May. The bull calves are weaned around October 7, and they usually weigh from 450 to 660 pounds with no feed except their mother's milk and grass. After weaning, they are fed 4 pounds of hammered ear corn and oats a day on pasture, until December 1. Then, all the silage and hay they will eat is added and the grain increased to 4 pounds of hammered ear corn, 2 pounds of rolled oats, and 1½ pounds of cottonseed meal a day, until April 1. After this date they have only pasture, except for periods of extreme drought, until the following October. At that time, they are again started on grain, hay, and silage in increased amounts up to 14 pounds of mixed corn grain until sold, which is usually from 18 months to 2 years of age.

Developed this way, these bulls carry thick red meat and good bone. The better of them will weigh 1,000 pounds at 14 months of age and 1,400 pounds at 2 years of age. This year, we had several that reached 950 pounds a few days before they were 15 months old and one that reached 1,000 pounds before he was 15 months old.

The bull calves are carried as prospective bulls until sometime in January, just 90 days after they are weaned. If there are any weaknesses or undesirable qualities, they will *show up in this critical, after weaning period, and only the strong, hardy, fast gaining, thick fleshed calves are retained as herd bulls.*

Both calves and yearling bulls are fed from the same long trough running out from an upright silo. After feeding, the bulls return to pasture (Trask, 1958)."

The above excerpt is from a magazine article which is difficult to obtain. The copy obtained was an old scan that contained areas on the edge of the page that shadowed and/or obscured some of the text. The few obscured words were decrypted and retained to the best of this researcher and the committee co-chair's ability.

During James (Billy) Wright's time as the Trask Ranch manager, the feeding of silage was discontinued, and they started calving heifers at two years of age instead of the heifers birthing their first calves at three years of age. Billy wright stated, that a low-input cattle management system was, and has always been both his and his grandfather's objective (James W. Wright personal communication, 2018).

Breeding Program

In the mid to late 20th century, Trask cattle were well known by Polled Hereford breeders as line bred cattle. Line breeding is defined in Lush (1940) as the mating of animals within a specific pedigree/family line. It is a form of inbreeding, used to maintain a certain degree of relationship to one or more high valued ancestors. All unnecessary inbreeding, that is not needed to maintain the relationship, is avoided as much as possible. Compared to other forms of inbreeding, line breeding is distinctive because it is devoted to preserving a high degree of relationship to a specific ancestor. It is a less extreme form of inbreeding (Lush, 1943). With regard to Neil Trask and his cattle, the Trask Cattle were line bred to Plato Domino 1 and his offspring/descendants.

Dr. Steve Meadows, who personally knew Mr. Trask, stated Mr. Trask did not breed close relatives. Instead he would try to mate animals “with a common sire in the last two or three generations.” This was done to secure a trait in his cattle line. After he established a trait in his breeding cattle, he followed his philosophy that “like animals produced like kind.” The type of cattle that Mr. Trask selected for were deep bodied, easy fleshing, wide muzzled, but the females still maintained some level of femininity. Mr. Trask was very selective/mindful on the soundness of the feet of each animal (Dr. Steven Meadows personal communication, 2017). Billy Wright stated Mr. Trask “would not use a bull that did not have brown pigment around the eye lid.” He even used a grading/classification system, at weaning, for the calves’ eyes, “B for brown, W for white, and M for mixed. Mr. Wright also said that his grandfather (Trask) based his cattle selection on the animal having good hair and hide, a thick heart girth, a big loin, and a good walking stride. Another selection requirement was, the animals had to be “easy keepers” (James W. Wright personal communication, 2018).

When asked what cattle types he selected for during his time as the Trask Ranch manager, Mr. Wright stated “I have always preferred a masculine, athletic type bull that weighs 1800-2100 lbs. on pasture. I like a good feminine cow that is not a heavy milker, but produces enough milk to wean a 475 lb. to 600 lb. calf and still be in good shape at weaning (around 1200 lbs.). I chose herd bulls from cows that matched what I wanted my herd to look like. It's simple, but I consider it common sense” (James W. Wright personal communication, 2018).

According to Mr. James W. Wright (Billy Wright), Mr. Trask did not have a set breeding plan designating how often to introduce new blood (from other breeders) to the Trask cattle line, for the purpose of reducing the herd's level of inbreeding. Trask's reason for this was "he felt there wasn't a place, where he could buy cattle to improve his own herd." He disliked the larger framed cattle, which were being promoted by the Polled Hereford Association at the time. (James W. Wright personal communication, 2018).

A few of the breeders that Mr. Trask bought replacement bulls and heifers from are: George D. Queener of Chickamauga, GA, J. K. Rogers, Clayton Numode, General Fowler of Fowken Farms, Leslie Brannon of Timken, Kansas, Glen Burrows in New Mexico, and a man whose last name was Blackman (Dr. Steven Meadows personal communication, 2017; James W. Wright personal communication, 2018). According to Dr. Meadows, the cattle Clayton Numode sold to Trask Ranch were culled from the Trask herd. Both Dr. Meadows and Mr. Wright stated that General Fowler and Mr. Trask bought, sold, and traded cattle between each other several times throughout the years. The cattle that Mr. Trask bought from Glen Burrows did not do well in the South Carolina environment. Regarding Mr. Trask, "He also purchased two Polled Hereford bulls and 20 cows from a man named Blackman in Texas, in the early 1970s…. They were excellent cattle and gentle, except when they were corralled. They would rear up and crush the fence down. Most were sold because of this, but I do know if they left some good calves in the herd" (James W. Wright personal communication, 2018).

Preservation of the Trask cattle line

Over time popular selection trends tend to be potentially hazardous to the performance and genetics of individual cattle breeds. This is evident in the expression of harmful recessive genes, which are more likely to appear in inbred populations and/or may be the result of selectively breeding for only a single trait (Lynch and Walsh, 1998). A good example of the expression of harmful recessive genes is the "eruption" of snorter dwarfism in Hereford cattle. This occurred during the same period of time as the past trend of selecting for small framed early maturing cattle in the Hereford breed (Ritchie, 2002).

After the dwarfism mutation "erupted", many Hereford breeders were forced to turn to less popular cattle breeders (or intermediates), such as Mr. Trask, whom were not affected by this mutation (Ritchie, 2002; Dr. J. O. Sanders personal communication, 2018). These cattle breeders were the ones that did not select for smaller cattle, had not bred to the popular small bulls that passed the mutation, and therefore were able to save the Hereford breed from dwarfism. Cattle lines like this, throughout all breeds, are very important to keep around for their use as a stabilizing force for their respective cattle breeds (Dr. J. O. Sanders personal communication, 2018). Without cattle lines like the Trask cattle, it would be considerably more difficult to prevent a harmful mutation like dwarfism from spreading through one or more cattle breeds.

The popular selection trends in the beef cattle industry have been described as a "pendulum swinging back and forth…. if you stand in the middle, it will hit you going both directions" (Dr. J. O. Sanders personal communication, 2018). In other words, moderately sized cattle, between the extreme ends of the selective breeding trends, will be in demand each time the breed starts to move from one extreme to another. Breeders are constantly attempting to increase/decrease the appearance of different performance (and/or conformation) traits, to "move" their herd in the direction of the current fad.

As previously stated, Mr. Trask always focused on producing moderately sized cattle that perform well and yield good quality beef, while eating nothing but grass. He did not follow the fad of producing small framed early maturing fat cattle, nor did he follow when the larger framed cattle became popular (Bible, 1981; James W. Wright personal communication, 2018; Dr. J. O. Sanders personal communication, 2014). This was an important factor in Neil Trask's success. The demand for his cattle increased at a time when the cattle industry began selectively breeding for larger framed cattle, along with making them leaner, and more muscular (Ritchie, 2002; Dr. J. O. Sanders personal communication, 2016). Intermediates like the Trask herd were important to Hereford breeders at this time, because they provided these breeders with the ability to easily increase the size of their herds, and in a relatively short period bring them up to the standards of the newest breeding trends.

Sometime after WWII, a surplus existed in American grain production due to the availability of chemical fertilizers, and development of irrigation potential on the high plains. The surplus was also caused, in part, by the development of higher yielding varieties of corn and sorghum. This spurred the development of large-scale feedlots. The smaller framed cattle, which had been popular up until that time, became too fat too early in the feedlots. These cattle could not stay at the feedlots long enough, to gain the amount of weight needed to make a profit. Both this, and the USDA's initiation of yield grading (in 1965) pushed the industry towards selecting for leaner larger-framed cattle with the ability to gain muscle while eating grain, without getting too fat (Ritchie, 2002; Dr. J. O. Sanders personal communication, 2018). Breeders continued to produce larger and larger cattle undiminished for decades, until around 1988 when carcass traits and structural soundness became more important (Ritchie, 2002). In the late 1980s, to restrain the trend of producing extremely large framed cattle, the American Polled Hereford Association (APHA) created a new rule that stipulated that cattle larger than a frame size 8 would no longer be able to earn show points. After the implementation of this rule, but not necessarily in response to the new rule, the industry slowly began to move toward producing more moderately sized cattle. Mr. Trask's Hereford cattle line was now in high demand because it already possessed the more moderate size, for which the industry was now aiming (Dr. J. O. Sanders personal communication, 2018).

It is important to preserve intermediate cattle lines like the Trask cattle, which do not follow the cattle breeding fads. They fill important and overlooked roles such as: being an uncorrupted source of breeding stock that can aid in the elimination of harmful recessive genes (For example: snorter dwarfism), and they act as a stabilizing force by giving their breed the ability to genetically bring its performance traits back to a more intermediate type, with relative ease (Dr. J. O. Sanders personal communication, 2018). The intermediate breeders, who have created their own breeding program, also, have the potential to become the spark that starts the next popular breeding trend. They provide cattle breeds with a stabilizing force, and the ability to evolve, without the need for long term selection, crossbreeding, or grading up.

MATERIALS AND METHODS

A combined pedigree for a sample group of 26 recently and/or currently living bulls of Trask breeding (Trask Bulls) was obtained from the American Hereford Association (AHA). Included in the pedigree are 42,718 individual cattle, spanning from the early 21st century back to the middle 19th century. The pedigree format received from the AHA was not in chronological order and contained a few minor format errors. Both of these issues were corrected using formatting tools and formulas, which are available in Microsoft Excel and ASReml (Gilmour et. al., 2009). Once the corrections had been made, the combined pedigree was put into a three-column format using only the animal's registration numbers for individual identification. Of the three columns, the first lists the registration number for each animal in the pedigree, the second and third columns list the corresponding sire and dam, respectively, of each animal in the first column. This was done to meet the requirements of ASReml.

The R Project for Statistical Computing (R) computer program was used to calculate the additive genetic covariance (a_{xy}) between each of the 26 Trask Bulls and their ancestors (R Core Team, 2017). In performing these calculations, the computer program created the additive genetic relationship matrix (**A matrix**). The A Matrix contains an additive covariance value for the relationship between each pair of animals in the pedigree. The diagonal elements of the A Matrix are the additive covariances of each individual animal with itself ($a_{xx} = 1 + F_x$). This provided the inbreeding coefficients ($F_X = a_{xx} - 1$; Van Vleck, 1993) for the 26 bulls of concern, and all of the 42,718 animals in the Trask cattle pedigree. The additive covariance ($\boldsymbol{a_{xy}}$), sometimes known as the additive or numerator relationship, between two individuals (x and y), is defined as two times the likelihood of these individuals having genes identical by decent. This implies that the two genes stem from the duplication of a gene within a third individual from a preceding generation (Van Vleck, 1993; Falconer and Mackay, 1996).

Due to the immense size of the pedigree and the resulting data file, the data calculations were performed using the Texas A&M Institute for Genome Sciences and Society (TIGSS) computer cluster. The output file containing the data was too large to import and save from the TIGSS computer cluster to the researcher's computer. Therefore, only the A Matrix data columns for the 26 Trask bulls and ancestors of interest identified in the Trask pedigree for this work, and the diagonal elements for the entire A Matrix/pedigree were imported from the computer cluster and saved as those were the only numbers needed. Within the data columns for the ancestor groups, for each group the rows corresponding to the animals in that group were removed. This was done to prevent the possibility of double sampling those values. Also, the size of the data and the amount of active memory needed to perform the calculations severely limited the number of R program packages compatible with the data calculation requirements (R Core Team, 2017). Therefore, the R package 'kinship2' (Therneau and Sinnwell, 2015) was used to calculate the A Matrix values.

It is necessary to point out that the kinship2 package does not have a command for calculating the A Matrix, instead it calculates a matrix of kinship coefficients for the animals. The kinship coefficient is defined as the probability that two single genes, drawn at random from two individuals, are identical by decent (Lynch and Walsh, 1998).

According to Lynch and Walsh (1998), $A_{ij} = 2\Theta_{ij}$, where A_{ij} is the additive genetic relationship matrix, and Θ_{ij} is the kinship coefficient matrix. In other words, the A Matrix is equal to two times the kinship coefficient matrix. Therefore, the kinship2 package is able to be used to calculate the A Matrix.

The A Matrix data were used to illustrate and assess the relationships of the 26 Trask bulls with three different categories of their ancestors in the Trask pedigree. The first category was 15 influential ancestors of the Hereford and Polled Hereford breeds (**Key Breed**), the second included 19 early foundation ancestors of the Trask herd (**Trask Herd**), and the third included the 30 most influential ancestors in the pedigree (**Top 30**). The ancestors in the key breed category were chosen because they are widely considered historically significant ancestors to the American Hereford breed. The animals in the Trask herd category were included because they are considered to have had significant influence on the pedigree of the Trask ranch herd. The third category was determined by ranking each individual animal by the number of offspring in the Trask pedigree. Tables 5 through 8 contain full lists of names and registration numbers for each of the 26 Trask bulls and the 3 categories of ancestors respectively.

Table 5. Trask bulls

Animal Name	Registration No.	Animal Name	Registration No.
NT Plato Rupert 167	23453801	Plato Rupert MOH 172	42650292
BTF 511 6007	23905741	BTF 9245 4108 ET	42656366
NT Plato Rupert 123	24046601	BTF252 4168 ET	42656370
BTF 61 0178	42186827	Edisto 136 Battle Rupert T352	42860368
DPH BTF E132 M636 ET	42373311	Edisto 167 Plato Rupert U347 ET	42904180
BTF6104 M171	42453113	Edisto 810 Excel Plato U336 ET	42904253
DPH BTF 123 M179	42505661	HCC 178 P001	42935103
BTF 4 3100 ET	42586465	PPH Domino Plato Rupert 2	42965967
BTF 4 3119 ET	42586488	HPH 6007 Plato Real P-17	43011115
BTF E132 3120 ET	42586489	BTF HCC 834 M636 5095	43142302
BTF E132 4064	42586515	BTF M035 M179 5003	43142667
BTF E132 4087	42586554	HPH 6007 Plato Vic P-5	43182206
BTF DPH E132 4091	42590228	BTF 167 5100 ET	43275810

Table 6. Key breed ancestors

Animal Name	Registration No.	Animal Name	Registration No.
North Pole	8946	Hazford Rupert 25	1209734
Anxiety 4th	9904	Mossy Plato	1341320
Prince Rupert	79539	Mossy Plato 26	1719194
Polled Admiral 2d	230299	Victor Domino	2060000
Polled Plato	353393	Victor Domino 14	2220966
Beau Aster	412145	Hazford Rupert 81	2348825
Prince Domino	499611	TR Zato Heir	5380000
Woodford	500000		

Table 7. Trask herd ancestors

Animal Name	Registration No.	Animal Name	Registration No.
Hazford Seminole	1815001	Victor Plato 35	7314476
M P Domino 3	1967033	Plato Woodford 34	7363063
Plato Domino 1	2350712	Rupert Gem	7809132
Plato Domino 43	3080818	NT Rupert	9446404
Battle Domino 18	3320225	FF Battle R948	11213062
Pure Plato Domino	3775927	Hartland Rupert 48	12199616
Plato Hazford	4279424	Hartland Rupert 66	13219124
Palmetto Woodford	5249256	Hazford Bocaldo	14628869
Double Domino 5	5745343	NT Mischief Mixer	20015879
Plato Mischief	6285578		

Table 8. Top 30 ancestors

Animal Name	Registration No.	Animal Name	Registration No.
Sir Thomas	20	Domino	264259
The Grove 3rd	2490	Beau Mischief	268371
Lord Wilton	4057	Repeater	289598
Anxiety 3	4466	Beau Picture	308177
Garfield	7015	Polled Plato	353393
Anxiety 4	9904	Beau Blanchard	362904
Don Carlos	33734	Bright Stanway	366600
Beau Brummel	51817	Beau Aster	412145
Lamplighter	51834	Beau Randolph	418893
Beau Donald	58996	Prince Domino	499611
Militant	71755	Superior Mischief	590259
Beau Dandy	145564	Onward Domino	812380
Beau Modest	160589	Dandy Domino 2	1090962
Beau President	171349	Advance Mischief	1323063
Perfection Fairfax	179767	Advance Domino	1381854

Hypotheses

- H_0: the average relationship between the 26 Trask bulls and the Top 30 ancestors is similar to the average relationship between the Top 30 ancestors and the Trask pedigree.
- H_0: the average relationship between the 26 Trask bulls and the Trask herd ancestors is similar to the average relationship between the Trask herd ancestors and the Trask pedigree.
- H_0: the average relationship between the 26 Trask bulls and the key breed ancestors is similar to the average relationship between the key breed ancestors and the Trask pedigree.
- H_0: the average level of inbreeding for a sample of (n = 26) Trask bulls is similar to the average inbreeding level of the entire Trask cattle pedigree.

Data Analysis

The beta (**β**) distribution, in this case, is a bivariate distribution with a parameter space of 0 to 1 and is used as a prior distribution to correlate relationships in data analysis (Bouguila et al, 2006; Olkin and Trikalinos, 2014). In this paper the β distribution were used to calculate probabilities (*P*-values) for the mean relative to the population; that is, the general procedure was to match a β distribution to the data, using the mean and variance and different parameters that characterize a β distribution. Because the additive relationship value ($\boldsymbol{a_{xy}}$) has a range of 0 to 2 (Falconer and Mackay, 1996), the beta distribution could not be used as a possible distribution for this parameter. Therefore, Wright's coefficient of relationship between the Trask bulls, the 3 ancestor groups, and all the remaining animals in the Trask pedigree was calculated because it has a parameter space from 0 to 1 (Wright, 1922). This was done using the additive relationship values and the diagonal elements from the A Matrix. The coefficient of relationship (**R_{xy}**), also known as Wright's relationship coefficient, is a way of measuring relationship within a pedigree. It is defined as the probable proportion of one individual's genes that are identical by decent to genes of a second individual (Bourdon, 2000). The equation for Wright's relationship coefficient is:

$$R_{xy} = \frac{a_{xy}}{\sqrt{(1+F_x)(1+F_y)}},$$

in which a_{xy} is the additive covariance value, and F_x and F_y are the respective inbreeding coefficients of animals x and y (Van Vleck, 1993; Falconer and Mackay, 1996; Bourdon, 2000).

Both the R_{xy} and F_x β distributions, and their respective probability (**P**) values were calculated for each of the ancestor groups using functions in the R computer program. A system was used to solve for the random sample's alpha (**α**) and beta (**β**) parameters (which are the parameters which characterize completely a β distribution), where α and β were functions of each other, the known variance (**σ^2**), and the known mean (**μ**) R_{xy} between a given ancestor group and the Trask pedigree. The following are the corresponding formulas used for this method:

$$\mu = \frac{\alpha}{\alpha+\beta}; \qquad \sigma^2 = \frac{\alpha\beta}{(\alpha+\beta)^2(\alpha+\beta+1)}; \quad \alpha = \left(\frac{1-\mu}{\sigma^2} - \frac{1}{\mu}\right)\mu^2;$$

$$\beta = \alpha\left(\frac{1}{\mu} - 1\right)$$ (Farnum and Stanton, 1987).

Then for each comparison, α and β values were iteratively altered while constrained to the first 2 moments of the distribution. Plotted β distributions were then visually compared to the plotted density of the actual values, and thereby a β distribution that reasonably matched the distribution of the actual values was identified.

Hypotheses for each comparison of R_{xy} and the F_x were additionally tested with bootstrap methodology (Hesterberg, 2014). For each hypothesis test, 100,000 bootstrap samples were generated; each consisted of 26 rows (animals) and the number of columns in the respective data file for each of the three comparisons (ancestor groups). A computational loop was used to perform the bootstrap sampling in R. Both the R_{xy} and F_x bootstrap data were visualized as plots, and respective empirical P values were calculated using functions in the R computer program.

RESULTS AND DISCUSSION

A general comparison of the average R_{xy} values between each of the three Ancestor groups, the Trask Bulls sample, and the entire Trask pedigree is illustrated in Table 9. On average, the animals within each of the three ancestor groups were more closely related to the sample of Trask Bulls than the rest of the cattle in the Trask cattle pedigree. As one would expect, the Trask Herd ancestors had the closest relationship with the Trask Bulls, followed by the Top 30 ancestors, and then by the Key Breed ancestors. Data tables (illustrating the relationships between the Trask bulls sample, the three ancestor groups, and the Trask pedigree) are located in the appendix.

Table 9. Average R_{xy} values

	Top 30 Ancestors	Key Breed Ancestors	Trask Herd Ancestors
Trask Bulls Sample	0.150	0.132	0.208
Trask Cattle Pedigree	0.104	0.074	0.072

R_{xy} values between the Trask Bulls sample and the ancestor groups

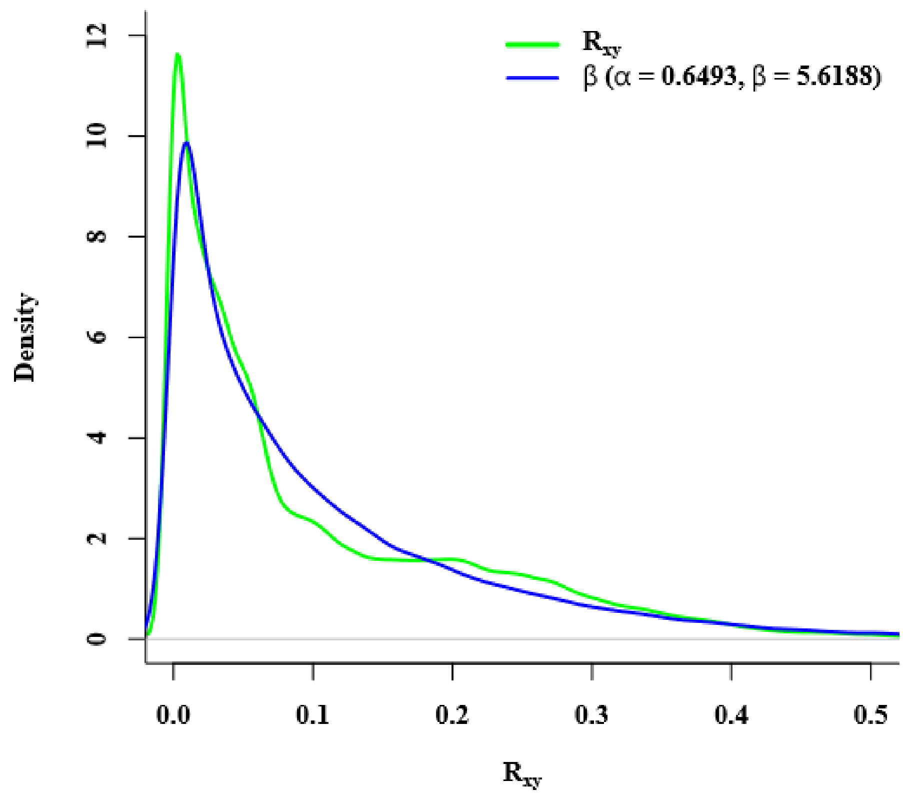

Figure 2. Plotted R_{xy} values and β (α = 0.6493, β = 5.6188) density for 26 Trask bulls and the top 30 ancestors

The curves for the estimated β distribution and the actual R_{xy} distribution (26 Trask bulls with the Top 30 Ancestors) were not an identical match (Figure 2). The distribution of actual values has a higher peak and deviates slightly at that peak and from R_{xy} from about 0.08 to 0.32. The mean R_{xy} of the Trask Bulls with the Top 30 Ancestors appeared to fit appropriately into this distribution (P = 0.246), and we fail to reject H_0: The mean R_{xy} of the (n = 26) Trask Bulls sample with the Top 30 ancestors is similar to the overall mean R_{xy} of the Trask pedigree with the Top 30 ancestors.

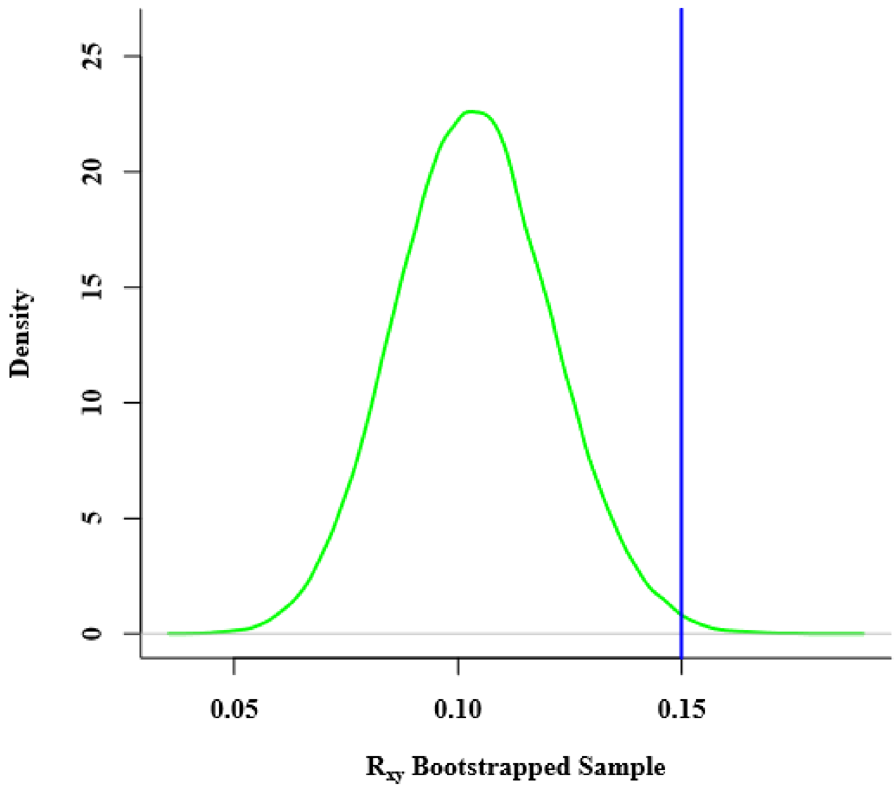

Figure 3. Bootstrapped R_{xy} values (green) and mean (blue vertical line) R_{xy} for 26 Trask bulls and the top 30 ancestors

The observed mean R_{xy} ($\mu = 0.150$) for the Trask Bulls with the Top 30 ancestors was located in the far-right tail of the distribution of the bootstrapped samples (Figure 3). The mean of the R_{xy} bootstrap sample ($\mu = 0.104$) was a very close match to the mean R_{xy} of the Top 30 Ancestors with the Trask pedigree ($\mu = 0.104$). The bootstrap sample had a standard error (SE) smaller than 0.02 (SE = 0.017). The empirical *P*-value ($P = 0.005$) resulted in rejection of the null hypothesis and conclusion that the mean R_{xy} of the (n = 26) Trask bulls sample differed from the overall mean R_{xy} of the Trask pedigree with the Top 30 ancestors.

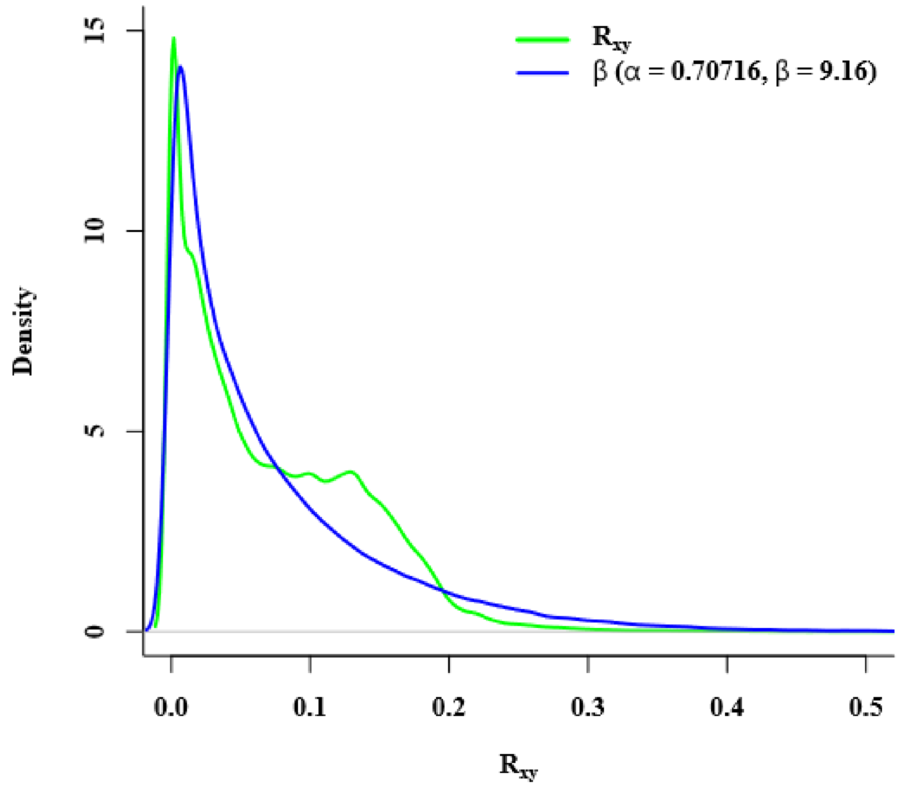

Figure 4. Plotted R_{xy} values and β (α = 0.70716, β = 9.16) density for 26 Trask bulls and the Trask herd ancestors

The curves for the actual R_{xy} distribution (26 Trask bulls with Trask herd ancestors) and the estimated β distribution were not an identical match (Figure 4). The R_{xy} distribution curve has a taller peak and diverges just to the left of the estimated distribution from there to approximately 0.8 on the x-axis. Then the curve strays from the estimated β at about 0.08 to 0.35. The mean R_{xy} of the Trask bulls with the Trask herd ancestors seems to reasonably fit this estimated β distribution (P = 0.069). We fail to reject H_0: The mean R_{xy} of the Trask Bulls sample with the Trask Herd ancestors is similar to the overall mean R_{xy} of the Trask pedigree with the Trask Herd ancestors.

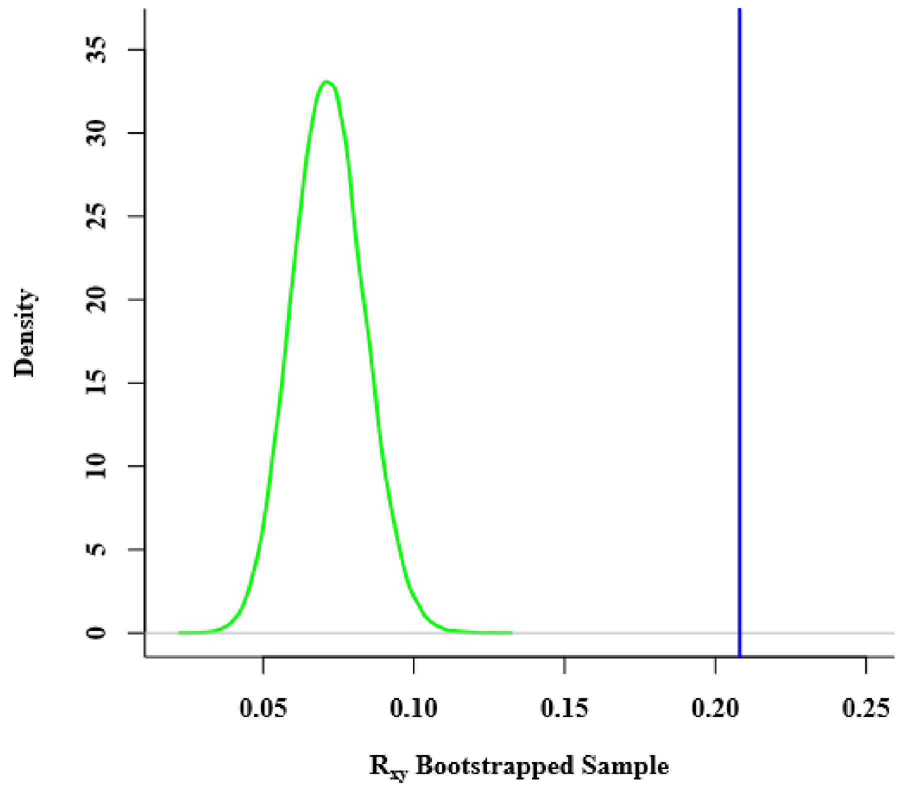

Figure 5. Bootstrapped R_{xy} values (green) and mean (blue vertical line) R_{xy} for 26 Trask bulls and the Trask herd ancestors

The observed mean R_{xy} (μ = 0.208) for the Trask bulls with the Trask herd ancestors was positioned beyond the right most end of the distribution for the bootstrapped samples (Figure 5). The mean of the R_{xy} bootstrap sample (μ = 0.072) was a near match to the mean Rxy of the Trask Herd ancestors with the Trask pedigree (μ = 0.072). The bootstrap sample had a standard error (SE) smaller than 0.05 (SE = 0.012). The empirical *P*-value ($P = 0$) prompted the rejection of the null hypothesis. We conclude that the mean R_{xy} of the (n = 26) Trask bulls sample differed from the overall mean R_{xy} of the Trask pedigree with the Top 30 ancestors.

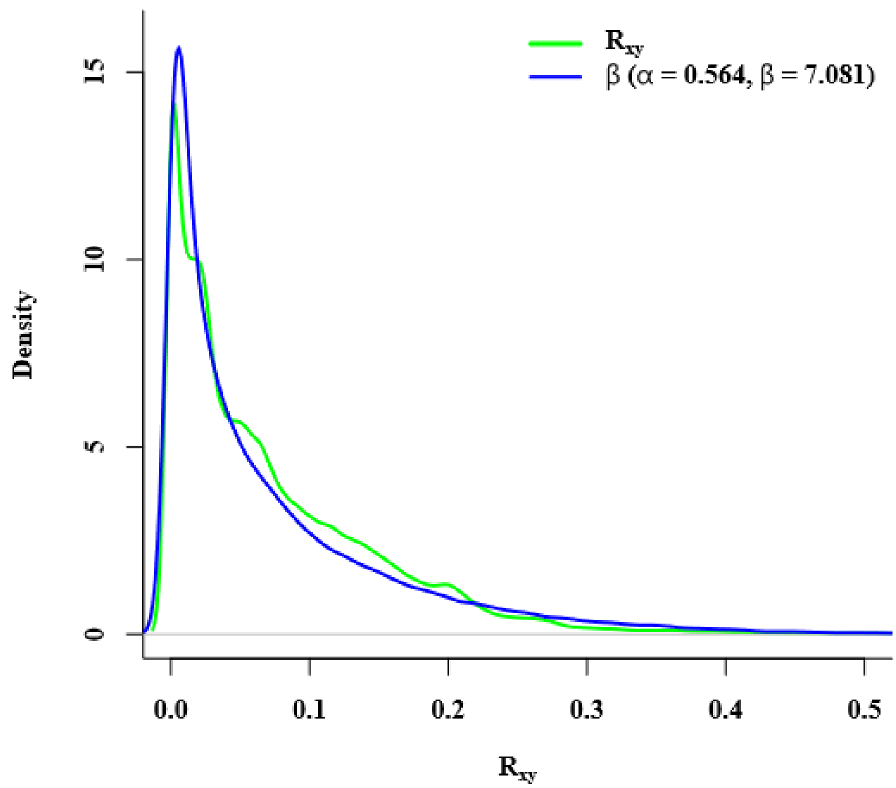

Figure 6. Plotted R_{xy} values and β (α = 0.564, β = 7.081) density for 26 Trask bulls and the key breed ancestors

There is not an identical match between the curves for the actual R_{xy} distribution (26 Trask bulls with key breed ancestors) and the estimated β distribution (Figure 6). The distribution of the R_{xy} values has a shorter peak which, slightly deviates from the β curve, and marginally diverges from about 0.04 R_{xy} to 0.36 R_{xy} on the x-axis. The mean R_{xy} of the Trask bulls with the key breed ancestors looks to match appropriately with the estimated β distribution (P = 0.190), and we fail to reject H_0: the mean R_{xy} of the Trask bulls sample with the key breed ancestors is similar to the overall mean R_{xy} of the Trask pedigree with the key breed ancestors.

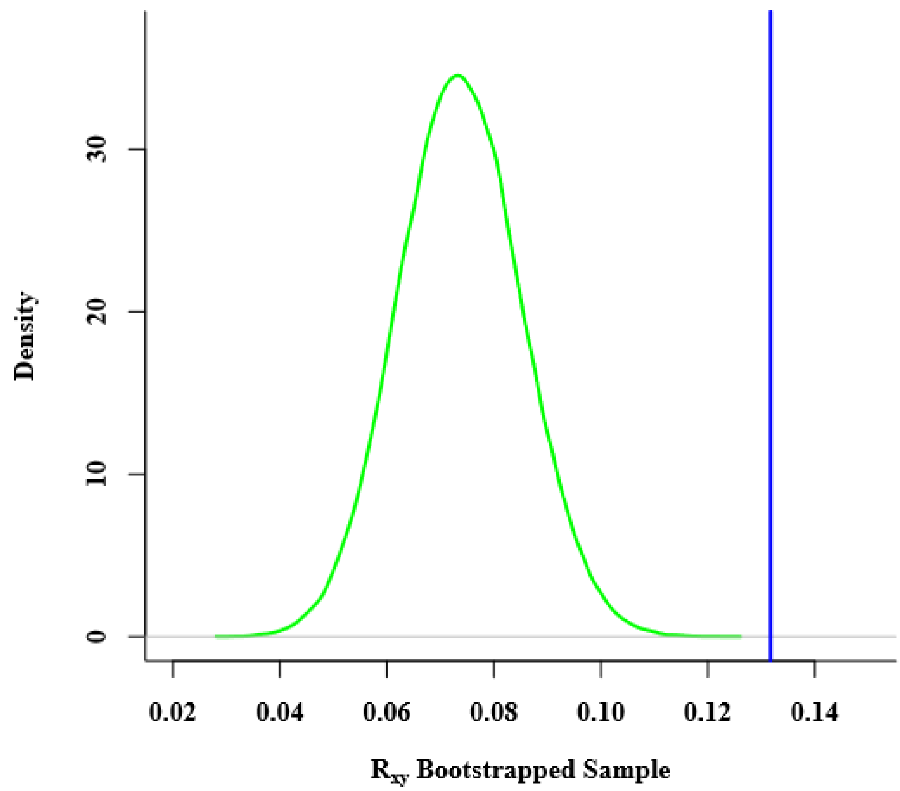

Figure 7. Bootstrapped R_{xy} values (green) and mean (blue vertical line) R_{xy} for 26 Trask bulls and the key breed ancestors

The observed mean R_{xy} ($\mu = 0.132$) for the Trask bulls with the key breed ancestors is beyond the right-side tail of the distribution for the bootstrapped R_{xy} samples (Figure 7). The mean of the R_{xy} bootstrap sample ($\mu = 0.074$) was quite a close match to the mean R_{xy} of the key breed ancestors with the Trask pedigree ($\mu = 0.074$). The bootstrap sample had a standard error (SE) smaller than 0.02 (SE = 0.012). The empirical P-value ($P = 0$) instigated the rejection of the null hypothesis, and we conclude that the mean R_{xy} of the (n = 26) Trask bulls sample differed from the overall mean R_{xy} of the Trask pedigree with the key breed ancestors.

F_x values between the Trask Bulls sample and the ancestor groups

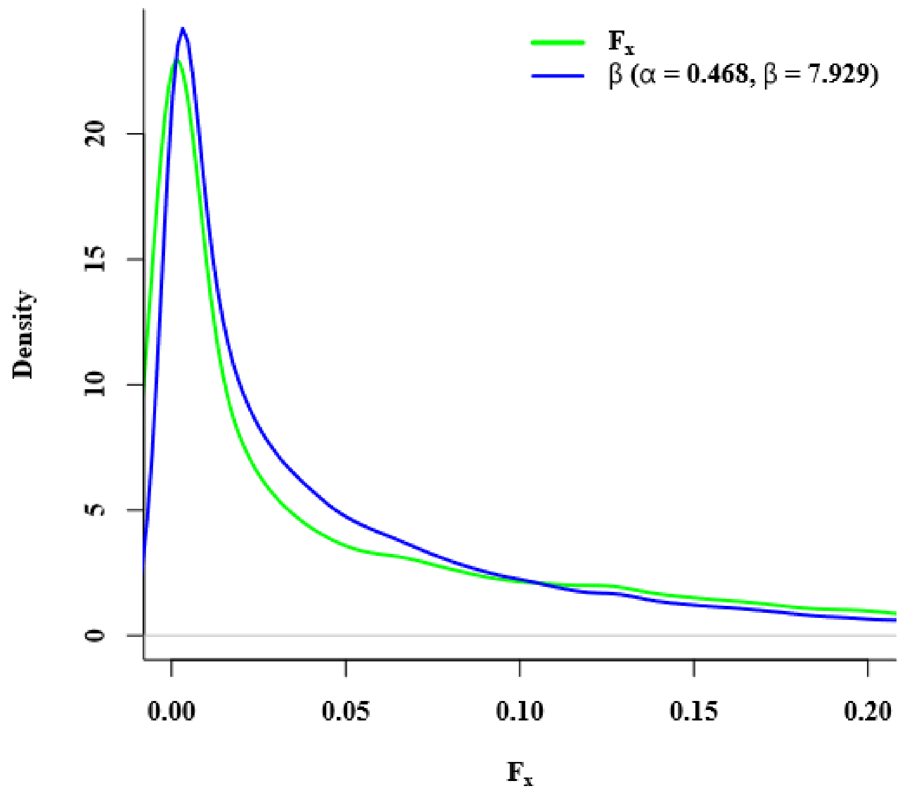

Figure 8. Plotted F_x values and β (α = 0.468, β = 7.929) density for 26 Trask bulls and the Trask Pedigree

The estimated β distribution and the actual F_x distribution of the Trask Pedigree did not match identically (Figure 8). The F_x distribution has a shorter peak and slight deviation from the peak to about 0.1 on the x-axis. The mean F_x of the Trask pedigree appeared to fit this β distribution (P = 0.105). We fail to reject the H_0: the mean Fx of the (n = 26) Trask Bulls sample is similar to the overall mean Fx of the Trask pedigree.

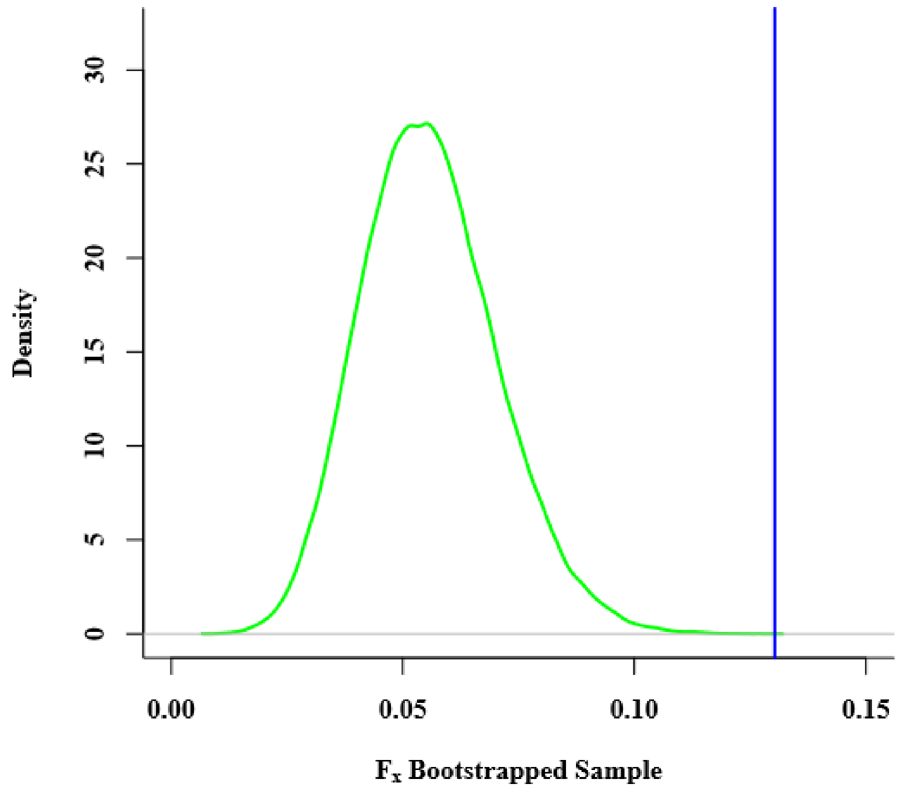

Figure 9. Bootstrapped F_x values (green) and mean (blue vertical line) F_x for 26 Trask bulls and the Trask pedigree

The observed mean F_x ($\mu = 0.130$) of the Trask bulls sample sits within the far-right tail of the distribution of the bootstrapped F_x samples (Figure 9). The mean of the F_x bootstrap sample ($\mu = 0.056$) was a very close fit to the mean F_x of the Trask pedigree ($\mu = 0.056$). The bootstrap sample had a standard error (SE) smaller than 0.05 (SE = 0.015). The empirical *P*-value ($P = 0$) was equal to less than 0.05, and we reject the null hypothesis. We can now conclude that the mean F_x of the (n = 26) Trask bulls sample differed from the overall mean F_x of the Trask pedigree.

Across all comparisons, the R_{xy} and the F_x beta sample *P*-values (for all of the animal groups) were large enough that we failed to reject the null hypothesis. However, the opposite occurred with the *P*-values for the bootstrap samples; their values were all low enough ($P < 0.05$) to reject the null hypothesis. The reason for these conflicting results is different between the two sampling methods used in this analysis. The beta *P*-values were calculated using one sample of (n = 26) Trask bulls from the population (i.e. Trask pedigree), whereas the bootstrap resampling method used the means of numerous random samples (size: n = 26), pulled from the Trask pedigree, to calculate the empirical *P*-values. In general, resampling methods like the bootstrap are more reliable, because they are better at accounting for the variation that occurs among samples drawn from a given population (Hesterberg, 2014). In other words, resampling produces more uniform and/or repeatable results.

CONCLUSIONS

1) Results provide a scientific assessment of both Trask breeding and Hereford Breeding for a time span of approximately 150 years.

2) Results provide a scientific assessment on the genetic influence of the Trask pedigree ancestors on the Trask bred bulls in recent/current herds.

3) The beta (**β**) distributions and their parameters produced *P*-values which resulted in type **II** errors.

4) Bootstrapping is a useful resampling method for the analysis of large data sets.

5) Mean relationship coefficients for the ancestors show the Trask herd ancestors had the closest relationship with the Trask bulls (mean R_{xy} = 0.208), followed by the top 30 ancestors (mean R_{xy} = 0.150), and then the key breed ancestors (mean R_{xy} = 0.132).

6) The Trask herd ancestor group not only had the closest relationship to the Trask bulls, they also had the smallest relationship coefficient (mean R_{xy} = 0.072) with the Trask pedigree as a whole. This indicates the genetic distance that accumulated between the Trask cattle and the rest of the Hereford breed is due to linebreeding.

7) Mean R_{xy} values show the top 30 ancestors had the closest relationship to the Trask pedigree as a whole.

8) The key breed ancestors had the lowest mean R_{xy} with the Trask bulls (R_{xy} = 0.132). They also had a very small R_{xy} with the Trask pedigree (R_{xy} = 0.074). This may be indicative of the fact that the bulls within the key breed ancestors group are the progenitors of their own family lines, and therefore, are not closely related to the Trask pedigree.

9) The mean F_x values show that the sample of (n = 26) Trask bulls (F_x = 0.130) was more inbred than the animals in the Trask pedigree (F_x = 0.056).

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APPENDIX 1

Appendix 1 Table Key

*Bull #	Bull Name	Bull Reg. #
B1	NT PLATO RUPERT 167	23453801
B2	BTF 511 6007	23905741
B3	NT PLATO RUPERT 123	24046601
B4	BTF 61 0178	42186827
B5	DPH BTF E132 M636 ET	42373311
B6	BTF 6104 M171	42453113
B7	DPH BTF 123 M179	42505661
B8	BTF 4 3100 ET	42586465
B9	BTF 4 3119 ET	42586488
B10	BTF E132 3120 ET	42586489
B11	BTF E132 4064	42586515
B12	BTF E132 4087	42586554
B13	BTF DPH E132 4091	42590228
B14	PLATO RUPERT MOH 172	42650292
B15	BTF 9245 4108 ET	42656366
B16	BTF 252 4168 ET	42656370
B17	EDISTO 136 Battle Rupert T352	42860368
B18	EDISTO 167 PLATO RUPRT U347 ET	42904180
B19	EDISTO 810 EXCEL PLATO U336 ET	42904253
B20	HCC 178 P001	42935103
B21	PPH Domino Plato Rupert 2	42965967
B22	HPH 6007 PLATO REAL P-17	43011115
B23	BTF HCC 834 M636 5095	43142302
B24	BTF M035 M179 5003	43142667
B25	HPH 6007 PLATO VIC P-5	43182206
B26	BTF 167 5100 ET	43275810

*The Bull # is used in the appendix as a space-saving replacement for the Trask bulls' names and registration numbers.

Table A-1 Trask bulls R_{xy} values with each other

Bull #	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16	B17	B18	B19	B20	B21	B22	B23	B24	B25	B26
B1	1.000	0.160	0.686	0.432	0.335	0.152	0.488	0.303	0.361	0.335	0.224	0.221	0.250	0.417	0.195	0.378	0.517	0.624	0.519	0.517	0.335	0.138	0.295	0.398	0.131	0.588
B2	0.160	1.000	0.150	0.215	0.181	0.372	0.153	0.210	0.163	0.181	0.371	0.174	0.173	0.149	0.141	0.173	0.148	0.179	0.158	0.179	0.152	0.563	0.163	0.158	0.562	0.272
B3	0.686	0.150	1.000	0.349	0.312	0.142	0.648	0.271	0.337	0.312	0.207	0.209	0.236	0.328	0.189	0.289	0.395	0.462	0.423	0.394	0.296	0.130	0.280	0.468	0.123	0.422
B4	0.432	0.215	0.349	1.000	0.271	0.208	0.298	0.290	0.259	0.271	0.288	0.231	0.247	0.260	0.184	0.220	0.287	0.354	0.304	0.643	0.252	0.164	0.249	0.269	0.158	0.325
B5	0.335	0.181	0.312	0.271	1.000	0.173	0.306	0.285	0.445	0.615	0.426	0.401	0.443	0.251	0.179	0.218	0.257	0.402	0.322	0.272	0.263	0.147	0.636	0.320	0.141	0.258
B6	0.152	0.372	0.142	0.208	0.173	1.000	0.144	0.203	0.156	0.173	0.364	0.162	0.165	0.141	0.127	0.277	0.141	0.171	0.150	0.171	0.142	0.254	0.155	0.148	0.254	0.260
B7	0.488	0.153	0.648	0.298	0.306	0.144	1.000	0.253	0.291	0.306	0.234	0.241	0.447	0.306	0.197	0.268	0.318	0.391	0.368	0.322	0.289	0.135	0.463	0.628	0.127	0.322
B8	0.303	0.210	0.271	0.290	0.285	0.203	0.253	1.000	0.434	0.285	0.300	0.237	0.258	0.227	0.169	0.189	0.241	0.296	0.275	0.266	0.238	0.160	0.252	0.252	0.155	0.256
B9	0.361	0.163	0.337	0.259	0.445	0.156	0.291	0.434	1.000	0.445	0.232	0.213	0.237	0.242	0.169	0.206	0.266	0.300	0.325	0.270	0.257	0.136	0.334	0.330	0.130	0.263
B10	0.335	0.181	0.312	0.271	0.615	0.173	0.306	0.285	0.445	1.000	0.426	0.401	0.443	0.251	0.179	0.218	0.257	0.402	0.322	0.272	0.263	0.147	0.446	0.320	0.141	0.258
B11	0.224	0.371	0.207	0.288	0.426	0.364	0.234	0.300	0.232	0.426	1.000	0.404	0.436	0.210	0.165	0.177	0.198	0.358	0.234	0.242	0.207	0.238	0.335	0.222	0.233	0.295
B12	0.221	0.174	0.209	0.231	0.401	0.162	0.241	0.237	0.213	0.401	0.404	1.000	0.421	0.208	0.294	0.181	0.195	0.338	0.228	0.216	0.226	0.144	0.329	0.223	0.139	0.195
B13	0.250	0.173	0.236	0.247	0.443	0.165	0.447	0.258	0.237	0.443	0.436	0.421	1.000	0.250	0.186	0.218	0.217	0.384	0.278	0.235	0.248	0.144	0.541	0.329	0.137	0.211
B14	0.417	0.149	0.328	0.260	0.251	0.141	0.306	0.227	0.242	0.251	0.210	0.208	0.250	1.000	0.173	0.228	0.276	0.328	0.302	0.280	0.238	0.131	0.258	0.261	0.124	0.284
B15	0.195	0.141	0.189	0.184	0.179	0.127	0.197	0.169	0.169	0.179	0.165	0.294	0.186	0.173	1.000	0.156	0.176	0.193	0.187	0.183	0.219	0.127	0.186	0.190	0.123	0.164
B16	0.378	0.173	0.289	0.220	0.218	0.277	0.268	0.189	0.206	0.218	0.177	0.181	0.218	0.228	0.156	1.000	0.243	0.294	0.298	0.242	0.204	0.162	0.224	0.228	0.161	0.275
B17	0.517	0.148	0.395	0.287	0.257	0.141	0.318	0.241	0.266	0.257	0.198	0.195	0.217	0.276	0.176	0.243	1.000	0.368	0.341	0.326	0.256	0.128	0.238	0.275	0.123	0.335
B18	0.624	0.179	0.462	0.354	0.402	0.171	0.391	0.296	0.300	0.402	0.358	0.338	0.384	0.328	0.193	0.294	0.368	1.000	0.393	0.382	0.298	0.147	0.348	0.325	0.141	0.405
B19	0.519	0.158	0.423	0.304	0.322	0.150	0.368	0.275	0.325	0.322	0.234	0.228	0.278	0.302	0.187	0.298	0.341	0.393	1.000	0.335	0.279	0.136	0.306	0.327	0.129	0.341
B20	0.517	0.179	0.394	0.643	0.272	0.171	0.322	0.266	0.270	0.272	0.242	0.216	0.235	0.280	0.183	0.242	0.326	0.382	0.335	1.000	0.269	0.145	0.250	0.282	0.139	0.350
B21	0.335	0.152	0.296	0.252	0.263	0.142	0.289	0.238	0.257	0.263	0.207	0.226	0.248	0.238	0.219	0.204	0.256	0.298	0.279	0.269	1.000	0.133	0.264	0.275	0.127	0.243
B22	0.138	0.563	0.130	0.164	0.147	0.254	0.135	0.160	0.136	0.147	0.238	0.144	0.144	0.131	0.127	0.162	0.128	0.147	0.136	0.145	0.133	1.000	0.139	0.136	0.407	0.198
B23	0.295	0.163	0.280	0.249	0.636	0.155	0.463	0.252	0.334	0.446	0.335	0.329	0.541	0.258	0.186	0.224	0.238	0.348	0.306	0.250	0.264	0.139	1.000	0.365	0.132	0.229
B24	0.398	0.158	0.468	0.269	0.320	0.148	0.628	0.252	0.330	0.320	0.222	0.223	0.329	0.261	0.190	0.228	0.275	0.325	0.327	0.282	0.275	0.136	0.365	1.000	0.130	0.278
B25	0.131	0.562	0.123	0.158	0.141	0.254	0.127	0.155	0.130	0.141	0.233	0.139	0.137	0.124	0.123	0.161	0.123	0.141	0.129	0.139	0.127	0.407	0.132	0.130	1.000	0.195
B26	0.588	0.272	0.422	0.325	0.258	0.260	0.322	0.256	0.263	0.258	0.295	0.195	0.211	0.284	0.164	0.275	0.335	0.405	0.341	0.350	0.243	0.198	0.229	0.278	0.195	1.000

Table A-2 Trask bulls R_{xy} values with the top 30 ancestors

Top 30 ancestors		Bull #																									
Ancestor Name	**Reg. #**	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16	B17	B18	B19	B20	B21	B22	B23	B24	B25	B26
Sir Thomas	20	0.081	0.080	0.077	0.081	0.080	0.074	0.082	0.079	0.078	0.080	0.077	0.085	0.080	0.081	0.088	0.080	0.077	0.081	0.079	0.080	0.084	0.077	0.081	0.083	0.077	0.079
The Grove 3rd	2490	0.055	0.053	0.052	0.055	0.055	0.051	0.054	0.054	0.053	0.055	0.054	0.054	0.053	0.054	0.053	0.053	0.052	0.054	0.053	0.053	0.054	0.052	0.054	0.054	0.052	0.054
Lord Wilton	4057	0.053	0.054	0.051	0.054	0.054	0.053	0.053	0.054	0.053	0.054	0.053	0.053	0.052	0.053	0.052	0.054	0.051	0.053	0.052	0.053	0.053	0.053	0.052	0.053	0.053	0.054
Anxiety 3	4466	0.092	0.092	0.088	0.091	0.090	0.086	0.093	0.090	0.088	0.090	0.087	0.097	0.092	0.092	0.100	0.094	0.088	0.092	0.090	0.092	0.096	0.088	0.092	0.094	0.088	0.091
Garfield	7015	0.040	0.040	0.038	0.041	0.040	0.040	0.039	0.042	0.040	0.040	0.040	0.039	0.039	0.041	0.036	0.041	0.039	0.041	0.040	0.040	0.039	0.040	0.039	0.039	0.040	0.041
Anxiety 4	9904	0.160	0.156	0.152	0.157	0.156	0.144	0.162	0.155	0.151	0.156	0.149	0.171	0.159	0.159	0.178	0.158	0.152	0.159	0.156	0.159	0.167	0.148	0.160	0.163	0.149	0.155
Don Carlos	33734	0.200	0.197	0.190	0.197	0.196	0.179	0.204	0.194	0.189	0.196	0.186	0.217	0.201	0.200	0.231	0.198	0.190	0.200	0.195	0.198	0.211	0.186	0.201	0.206	0.187	0.194
Beau Brummel	51817	0.236	0.226	0.225	0.231	0.230	0.202	0.241	0.226	0.221	0.230	0.216	0.258	0.236	0.233	0.276	0.227	0.222	0.234	0.230	0.234	0.250	0.212	0.237	0.244	0.213	0.224
Lamplighter	51834	0.165	0.166	0.156	0.162	0.162	0.148	0.169	0.161	0.156	0.162	0.154	0.184	0.167	0.166	0.201	0.165	0.158	0.166	0.161	0.162	0.176	0.155	0.167	0.174	0.158	0.160
Beau Donald	58996	0.191	0.182	0.182	0.187	0.186	0.167	0.194	0.184	0.180	0.186	0.176	0.205	0.190	0.189	0.216	0.185	0.180	0.190	0.186	0.189	0.200	0.172	0.191	0.195	0.173	0.182
Militant	71755	0.182	0.176	0.173	0.178	0.177	0.159	0.185	0.175	0.171	0.177	0.167	0.198	0.182	0.180	0.211	0.177	0.172	0.181	0.177	0.180	0.192	0.166	0.182	0.188	0.167	0.174
Beau Dandy	145564	0.144	0.140	0.137	0.141	0.140	0.127	0.147	0.138	0.135	0.140	0.132	0.156	0.144	0.143	0.166	0.141	0.136	0.143	0.140	0.143	0.152	0.132	0.144	0.148	0.133	0.138
Beau Modest	160589	0.156	0.150	0.149	0.153	0.153	0.136	0.160	0.150	0.147	0.153	0.144	0.170	0.156	0.155	0.181	0.152	0.148	0.156	0.152	0.155	0.165	0.142	0.157	0.161	0.143	0.149
Beau President	171349	0.203	0.200	0.193	0.199	0.199	0.175	0.208	0.196	0.191	0.199	0.188	0.229	0.205	0.203	0.253	0.197	0.193	0.203	0.198	0.200	0.218	0.185	0.205	0.216	0.188	0.194
Perfection Fairfax	179767	0.041	0.042	0.039	0.041	0.041	0.040	0.041	0.040	0.040	0.041	0.039	0.043	0.040	0.041	0.045	0.043	0.039	0.041	0.040	0.040	0.042	0.041	0.040	0.042	0.041	0.042
Domino	264259	0.214	0.207	0.204	0.209	0.210	0.184	0.219	0.205	0.201	0.210	0.196	0.234	0.215	0.211	0.254	0.207	0.201	0.213	0.208	0.209	0.226	0.192	0.216	0.223	0.194	0.203
Beau Mischief	268371	0.207	0.202	0.195	0.202	0.203	0.176	0.211	0.202	0.195	0.203	0.192	0.232	0.209	0.206	0.257	0.198	0.196	0.208	0.202	0.201	0.219	0.186	0.208	0.219	0.189	0.197
Repeater	289598	0.066	0.058	0.062	0.065	0.064	0.056	0.065	0.064	0.062	0.064	0.061	0.064	0.063	0.064	0.062	0.060	0.062	0.065	0.064	0.064	0.065	0.055	0.064	0.063	0.055	0.062
Beau Picture	308177	0.132	0.130	0.125	0.129	0.129	0.115	0.134	0.127	0.124	0.129	0.122	0.146	0.132	0.132	0.160	0.129	0.125	0.132	0.128	0.129	0.140	0.121	0.132	0.139	0.122	0.126
Polled Plato	353393	0.098	0.087	0.092	0.096	0.099	0.087	0.095	0.098	0.095	0.099	0.097	0.088	0.096	0.098	0.073	0.093	0.093	0.098	0.097	0.092	0.090	0.083	0.096	0.091	0.083	0.093
Beau Blanchard	362904	0.187	0.180	0.177	0.183	0.183	0.159	0.191	0.181	0.176	0.183	0.173	0.206	0.188	0.185	0.224	0.179	0.177	0.187	0.183	0.184	0.198	0.167	0.188	0.195	0.168	0.178
Bright Stanway	366600	0.168	0.165	0.160	0.165	0.165	0.148	0.172	0.162	0.159	0.165	0.156	0.183	0.169	0.167	0.196	0.165	0.158	0.168	0.163	0.164	0.176	0.154	0.169	0.173	0.155	0.161
Beau Aster	412145	0.142	0.131	0.134	0.139	0.140	0.116	0.143	0.138	0.135	0.140	0.132	0.152	0.141	0.139	0.162	0.130	0.132	0.142	0.138	0.135	0.145	0.120	0.142	0.146	0.120	0.132
Beau Randolph	418893	0.165	0.164	0.157	0.162	0.162	0.144	0.169	0.160	0.156	0.162	0.153	0.186	0.166	0.166	0.205	0.161	0.157	0.165	0.161	0.162	0.177	0.152	0.167	0.176	0.154	0.158
Prince Domino	499611	0.264	0.246	0.252	0.261	0.263	0.219	0.270	0.255	0.252	0.263	0.246	0.286	0.266	0.258	0.306	0.247	0.247	0.264	0.259	0.255	0.274	0.227	0.268	0.273	0.227	0.247
Superior Mischief	590259	0.185	0.180	0.175	0.181	0.181	0.159	0.189	0.179	0.174	0.181	0.171	0.205	0.186	0.184	0.224	0.179	0.175	0.185	0.180	0.180	0.196	0.167	0.186	0.193	0.170	0.176
Onward Domino	812380	0.168	0.157	0.160	0.166	0.166	0.139	0.171	0.163	0.160	0.166	0.157	0.180	0.169	0.165	0.192	0.156	0.157	0.168	0.164	0.162	0.173	0.144	0.169	0.172	0.144	0.157
Dandy Domino 2	1090962	0.164	0.153	0.156	0.162	0.163	0.136	0.167	0.159	0.157	0.163	0.153	0.178	0.165	0.160	0.191	0.153	0.153	0.164	0.160	0.158	0.170	0.141	0.166	0.170	0.142	0.154
Advance Mischief	1323063	0.204	0.200	0.194	0.200	0.202	0.176	0.209	0.198	0.194	0.202	0.190	0.228	0.207	0.204	0.252	0.198	0.193	0.205	0.199	0.198	0.216	0.185	0.208	0.215	0.187	0.195
Advance Domino	1381854	0.211	0.209	0.200	0.207	0.209	0.179	0.217	0.205	0.200	0.209	0.197	0.242	0.215	0.211	0.272	0.203	0.200	0.212	0.206	0.205	0.226	0.191	0.215	0.227	0.195	0.201

Table A-3 Trask bulls R_{xy} values with the Trask herd ancestors

Trask Herd ancestors		Bull #																									
Ancestor Name	**Reg. #**	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16	B17	B18	B19	B20	B21	B22	B23	B24	B25	B26
Hazford Seminole	1815001	0.158	0.131	0.152	0.155	0.154	0.120	0.162	0.146	0.147	0.154	0.141	0.160	0.155	0.151	0.154	0.135	0.144	0.154	0.153	0.163	0.167	0.121	0.158	0.157	0.118	0.142
M P Domino 3	1967033	0.190	0.156	0.180	0.183	0.189	0.150	0.187	0.181	0.179	0.189	0.179	0.179	0.185	0.182	0.166	0.168	0.172	0.188	0.187	0.178	0.180	0.145	0.186	0.181	0.142	0.172
Plato Domino 1	2350712	0.264	0.194	0.254	0.266	0.267	0.184	0.262	0.254	0.256	0.267	0.251	0.238	0.255	0.243	0.213	0.204	0.237	0.261	0.263	0.249	0.246	0.170	0.260	0.250	0.162	0.227
Plato Domino 43	3080818	0.264	0.201	0.257	0.267	0.272	0.188	0.269	0.253	0.258	0.272	0.251	0.252	0.263	0.247	0.238	0.213	0.240	0.264	0.262	0.251	0.258	0.179	0.268	0.258	0.173	0.229
Battle Domino 18	3320225	0.160	0.134	0.143	0.155	0.146	0.123	0.144	0.178	0.150	0.146	0.158	0.144	0.147	0.164	0.131	0.123	0.148	0.161	0.146	0.150	0.145	0.114	0.141	0.138	0.110	0.145
Pure Plato Domino	3775927	0.262	0.176	0.243	0.248	0.258	0.169	0.253	0.239	0.242	0.258	0.239	0.225	0.250	0.230	0.193	0.198	0.226	0.256	0.259	0.237	0.234	0.157	0.253	0.236	0.149	0.218
Plato Hazford	4279424	0.234	0.165	0.218	0.235	0.232	0.158	0.222	0.225	0.227	0.232	0.219	0.204	0.219	0.209	0.171	0.170	0.209	0.227	0.236	0.223	0.215	0.142	0.223	0.215	0.134	0.199
Palmetto Woodford	5249256	0.261	0.175	0.237	0.259	0.262	0.169	0.244	0.249	0.249	0.262	0.251	0.223	0.248	0.224	0.178	0.184	0.229	0.256	0.264	0.245	0.232	0.149	0.249	0.235	0.141	0.217
Double Domino 5	5745343	0.102	0.107	0.097	0.113	0.109	0.105	0.102	0.115	0.103	0.109	0.115	0.102	0.107	0.107	0.101	0.103	0.097	0.107	0.101	0.103	0.106	0.099	0.105	0.100	0.099	0.105
Plato Mischief	6285578	0.250	0.173	0.233	0.254	0.253	0.165	0.242	0.235	0.232	0.253	0.245	0.229	0.250	0.219	0.189	0.184	0.222	0.251	0.252	0.234	0.231	0.151	0.245	0.228	0.141	0.210
Victor Plato 35	7314476	0.241	0.170	0.229	0.215	0.244	0.163	0.235	0.210	0.222	0.244	0.223	0.209	0.231	0.220	0.179	0.184	0.204	0.231	0.225	0.211	0.210	0.154	0.236	0.215	0.146	0.205
Plato Woodford 34	7363063	0.241	0.185	0.226	0.255	0.252	0.177	0.230	0.262	0.250	0.252	0.253	0.221	0.239	0.216	0.182	0.178	0.220	0.246	0.246	0.235	0.225	0.154	0.237	0.225	0.147	0.212
Rupert Gem	7809132	0.213	0.123	0.214	0.190	0.186	0.113	0.221	0.170	0.167	0.186	0.162	0.182	0.202	0.197	0.176	0.153	0.182	0.205	0.199	0.199	0.210	0.114	0.201	0.193	0.107	0.166
NT Rupert	9446404	0.323	0.162	0.298	0.269	0.284	0.153	0.309	0.259	0.267	0.284	0.240	0.245	0.287	0.280	0.210	0.210	0.273	0.298	0.315	0.285	0.285	0.142	0.293	0.277	0.129	0.242
FF Battle R948	11213062	0.202	0.198	0.191	0.250	0.214	0.191	0.184	0.281	0.241	0.214	0.250	0.190	0.194	0.212	0.147	0.146	0.195	0.212	0.204	0.212	0.186	0.153	0.190	0.188	0.146	0.199
Hartland Rupert 48	12199616	0.280	0.158	0.262	0.269	0.261	0.150	0.265	0.258	0.254	0.261	0.225	0.234	0.251	0.243	0.185	0.185	0.247	0.261	0.282	0.259	0.257	0.137	0.257	0.244	0.128	0.218
Hartland Rupert 66	13219124	0.381	0.163	0.320	0.270	0.326	0.155	0.332	0.293	0.307	0.326	0.265	0.265	0.322	0.304	0.209	0.237	0.312	0.346	0.352	0.322	0.313	0.140	0.325	0.303	0.131	0.273
Hazford Bocaldo	14628869	0.243	0.150	0.242	0.237	0.231	0.141	0.272	0.215	0.206	0.231	0.205	0.214	0.258	0.216	0.189	0.186	0.203	0.249	0.239	0.224	0.237	0.135	0.259	0.231	0.127	0.195
NT Mischief Mixer	20015879	0.264	0.160	0.248	0.266	0.263	0.151	0.250	0.252	0.239	0.263	0.235	0.239	0.251	0.225	0.172	0.174	0.236	0.253	0.271	0.246	0.249	0.136	0.250	0.231	0.128	0.211

Table A-4 Trask bulls R_{xy} values with the key breed ancestors

Key Breed Ancestors		Bull #																									
Ancestor Name	**Reg. #**	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16	B17	B18	B19	B20	B21	B22	B23	B24	B25	B26
North Pole	8946	0.093	0.090	0.088	0.091	0.091	0.080	0.095	0.089	0.088	0.091	0.086	0.103	0.094	0.092	0.111	0.090	0.088	0.093	0.090	0.092	0.099	0.084	0.094	0.097	0.085	0.088
Anxiety 4th	9904	0.160	0.156	0.152	0.157	0.156	0.144	0.162	0.155	0.151	0.156	0.149	0.171	0.159	0.159	0.178	0.158	0.152	0.159	0.156	0.159	0.167	0.148	0.160	0.163	0.149	0.155
Prince Rupert	79539	0.125	0.120	0.119	0.123	0.122	0.110	0.127	0.120	0.118	0.122	0.115	0.134	0.124	0.124	0.140	0.122	0.118	0.124	0.121	0.124	0.131	0.113	0.125	0.127	0.114	0.120
Polled Admiral 2d	230299	0.055	0.051	0.052	0.055	0.056	0.053	0.053	0.057	0.054	0.056	0.056	0.047	0.054	0.056	0.038	0.055	0.054	0.056	0.055	0.052	0.050	0.052	0.053	0.050	0.052	0.055
Polled Plato	353393	0.095	0.084	0.089	0.093	0.096	0.084	0.092	0.095	0.092	0.096	0.094	0.085	0.093	0.095	0.071	0.090	0.090	0.095	0.094	0.089	0.087	0.081	0.093	0.088	0.080	0.091
Beau Aster	412145	0.153	0.141	0.145	0.151	0.152	0.125	0.155	0.149	0.146	0.152	0.143	0.164	0.153	0.150	0.175	0.141	0.143	0.153	0.150	0.147	0.157	0.129	0.153	0.158	0.130	0.143
Prince Domino	499611	0.245	0.228	0.234	0.241	0.243	0.202	0.250	0.236	0.233	0.243	0.228	0.264	0.246	0.239	0.283	0.229	0.228	0.245	0.239	0.236	0.254	0.210	0.248	0.252	0.210	0.229
Woodford	500000	0.092	0.086	0.087	0.090	0.090	0.081	0.092	0.088	0.087	0.090	0.085	0.095	0.090	0.090	0.097	0.088	0.087	0.091	0.090	0.090	0.094	0.081	0.090	0.092	0.081	0.087
Hazford Rupert 25	1209734	0.140	0.119	0.135	0.136	0.134	0.108	0.146	0.129	0.128	0.134	0.123	0.144	0.139	0.136	0.141	0.123	0.128	0.137	0.135	0.148	0.152	0.111	0.141	0.140	0.109	0.126
Mossy Plato	1341320	0.118	0.099	0.111	0.115	0.119	0.099	0.115	0.115	0.113	0.119	0.115	0.104	0.115	0.116	0.088	0.108	0.109	0.118	0.117	0.110	0.108	0.095	0.115	0.109	0.093	0.110
Mossy Plato 26	1719194	0.154	0.124	0.146	0.150	0.156	0.125	0.149	0.150	0.148	0.156	0.149	0.133	0.148	0.149	0.109	0.136	0.140	0.153	0.152	0.143	0.139	0.117	0.149	0.140	0.113	0.141
Victor Domino	2060000	0.171	0.160	0.162	0.171	0.176	0.158	0.168	0.173	0.168	0.176	0.172	0.161	0.170	0.172	0.145	0.166	0.159	0.173	0.168	0.163	0.163	0.153	0.170	0.162	0.149	0.165
Victor Domino 14	2220966	0.189	0.144	0.181	0.188	0.190	0.140	0.185	0.182	0.182	0.190	0.180	0.167	0.182	0.177	0.144	0.153	0.170	0.187	0.187	0.177	0.174	0.130	0.184	0.176	0.124	0.166
Hazford Rupert 81	2348825	0.147	0.120	0.144	0.141	0.138	0.108	0.155	0.133	0.131	0.138	0.126	0.150	0.146	0.143	0.148	0.126	0.133	0.144	0.141	0.154	0.160	0.114	0.148	0.146	0.111	0.130
TR Zato Heir	5380000	0.130	0.132	0.124	0.128	0.128	0.115	0.134	0.126	0.123	0.128	0.121	0.144	0.131	0.131	0.156	0.128	0.123	0.130	0.127	0.129	0.139	0.121	0.132	0.136	0.123	0.125

APPENDIX 2: R SCRIPT CODE SAMPLE

```
##############################################################################
##### Generate Rxy values between two groups, using axy values. #####

rxyTop30<-matrix(0,42688,30)
rownames(rxyTop30)<-ac2Top30[,1]
#generate the Rxy values with the following code
ct<-0
j2<-0
i2<-0
for (i in 1:30){
  for (j in 1:42686) {
    rxyTop30[j,i]<-ac2Top30[j,i+2]/sqrt(ac2Top30[j,2]*kaTop30[i,2])
  }
}
mean(rxyTop30) #mean rxy of the Top30 key ancestors with the rest of the pedigree
ltTop30<-as.vector(rxyTop30)
var(ltTop30)                    #variance of the RxyTop30 values.
min(rxyTop30)
max(rxyTop30)

##############################################################################
##### Generate Beta distribution #####

mean(rxyTop30)  #mean = 0.1035934
mean(var(rxyTop30))
a<-0.6493407242
B<-5.618826207

#this serves as a plot for the distribution that appears to model the Rxy values
jfTop30<-rbeta(100000,a,B)

#write.table(jfTop30,file="C:/Users/matt/Documents/1_Graduate School Files/1_Thesis
Project/6_r Scripts from Dr. Riley/Beta_Random_Samples/jfTop30.txt")
jfTop30<-as.matrix(read.table(file="C:/Users/matt/Documents/1_Graduate School
Files/1_Thesis Project/6_r Scripts from Dr. Riley/Beta_Random_Samples/jfTop30.txt"))
mean(jfTop30)
var(jfTop30)

#this is test of the sample mean as belonging to the postulated beta distribution
#will be one presentation statistic for your thesis

pbeta(mean(ryzTop30),a,B,lower.tail=FALSE)
```

#which is 0.2461458 and we fail to reject H0: The mean Rxy of our 26 with the Top30 is outlier with respect to #the apparent distribution

```
##########################################################################
##### Bootstrap the distribution of data means #####

n<-100000
wwTop30<-seq(1,nrow(ac2Top30),by=1)
asplsTop30<-matrix(0,26,30)
rowgetTop30<-matrix(0,26,1)
mnsTop30<-matrix(0,n,1)

for (i in 1:n){
  rowgetTop30<-sample(wwTop30,26)  #this gets a random sample of rows from the A
matrix
  for (j in 1:26){
    asplsTop30[j,]<-rxyTop30[rowgetTop30[j],]
  }
  mnsTop30[i]<-mean(asplsTop30)
}

#write.table(mnsTop30,file="C:/Users/matt/Documents/1_Graduate School Files/1_Thesis
Project/6_r Scripts #from Dr. Riley/Bootstrap_Random_Samples/mnsTop30.txt")
mnsTop30<-as.matrix(read.table(file="C:/Users/matt/Documents/1_Graduate School
Files/1_Thesis Project/6_r Scripts from Dr.
Riley/Bootstrap_Random_Samples/mnsTop30.txt"))

summary(mnsTop30) #gives basic statistics from the bootstrap sample
ss.bsTop30<-(mnsTop30-mean(mnsTop30))^2  #generates matrix of squared deviations
from overall mean
SE.bootstrapTop30<-sqrt(((n-1)^-1)*sum(ss.bsTop30))  #gives SE of the bootstrapped
mean 0.01876018
SE.bootstrapTop30

mean(ryzTop30)

##this then is to get an empirical P value from the bootstrapped sample and our observed
Rxy value
num.pvTop30<-0
for (i in 1:length(mnsTop30)){
  if (mnsTop30[i]>=mean(ryzTop30)) num.pvTop30<-num.pvTop30+1
}

pval.empTop30<-num.pvTop30/n
pval.empTop30
```