Genetic analyses of traditional breeds – the British experience

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Introduction

In the UK there are fourteen pig breeds that have their herdbook databases held and maintained by the British Pig Association (BPA) to comply with national and EU legislation. The BPA holds information on all purebred birth notifications and purebred breeding stock registrations and is updated daily.

In general, the breeds fall within three main categories:

Imported: Mangalitza and Pietrain.

Modern: British Landrace, Duroc, Hampshire, Large White and Welsh.

Traditional: Berkshire, British Saddleback, Gloucestshire Old Spots, Large Black, Middle White, Oxford Sandy and Black and Tamworth.

Among its key committees, the BPA has a Traditional Breed Committee that is charged with ensuring survival of Britain's traditional breeds through the development of niche markets (significant premiums are available for 'Pedigree Pork') and the implementation of conservation programmes.

To aid the analysis of traditional breed data, a specialist software program (Geneped) was developed jointly by the Rare Breeds Survival Trust (RBST) and Grassroots Systems Ltd. specifically designed for the genetic analysis of small pedigree populations.

Data are presented in this paper from Geneped analyses of three traditional breeds (Berkshire, Large Black and Middle White) and from the smallest modern breed (Welsh) – see Appendix One for an outline history of these breeds, together with the British Saddleback. In addition, management practices are outlined that aid genetic conservation of individual breeds. Finally, a brief summary will be given of some breed analyses utilising DNA technologies.

Geneped Analyses

1. Membership/Breed Structure

Summary data for the four breeds are shown below:

	B	L B	MW	W
Members with registered animals	234	163	133	160
Current registered boars	218	127	120	247
Current registered females	795	467	513	928
Total registered animals	1013	594	633	1175
Average boars/herd	0.93	0.78	0.90	1.54
Average females/herd	3.40	2.87	3.86	5.80

B=Berkshire; LB=Large Black; MW=Middle White; W=Welsh

Take home message – as expected, boar and sow numbers are relatively low, with a large number of small herds. However, in addition it is worth noting that all breeds had good geographical distribution aiding effective mating strategies, avoiding isolation and acting as a 'safety net' in health emergencies.

Data on herd size are outlined below showing the distribution of the breeds by herd size, where boars and females are considered together as the inventory for each farm:

Total herd inventory	B	LB	MW	W
>100	0	0	1	2
50-99	1	0	0	1
20-49	1	1	2	6
10-19	17	11	5	15
6-9	20	11	11	19
1-5	195	140	114	85
	234	163	133	160

In Berkshire herds, only 0.9% of herds had 20 or more animals, while 83.3% of herds had five or fewer animals – these data are summarised below together with data for the other breeds:

Herd inventory	B	LB	MW	W
20 or more breeding animals	0.9	4.4	2.2	6.1
5 or less breeding animals	83.3	85.8	84.4	66.1

Take home message – Most herds with traditional breeds are very small.

The distribution of animals across herds within the breeds is variable:

Berkshire: 2 herds have 10.7% and 19 herds have 36.2% of the breed

Large Black: 1 herd has 4.7% and 13 herds have 29.2% of the breed

Middle White: 1 herd has 22.0% and 4 herds have 31.2% of the breed

Welsh: 2 herds have 25.7%, 3 herds hold 34.5% of the breed and 11 herds hold 49.1% of the breed.

Take home message – some breeds have a high proportion of animals in a limited number of herds.

2. Generation turnover

Generation turnover measures the speed at which breeding animals are replaced by offspring and is an important component in the measurement of genetic change in a population. Typically, advanced genetic programmes carried out by international Breeding Companies have fast generation turnover to maximise genetic gains. However, traditional breeds have slower generation turnover as the breeding goals are mostly concerned with maintaining breed standards, as confirmed by these data:

	Boars	Females	Combined
B	3.76	3.56	3.66
LB	2.91	3.16	3.04
MW	3.03	3.40	3.21
W	2.43	2.50	2.46

Take home message – generation turnovers are low, especially in the traditional breeds.

In an era where Breeding Companies are increasingly aware and concerned by poor sow longevity it is interesting to note the age distribution in these breeds:

Females	B	LB	MW	W
% born before 2006	8.4	14.6	7.2	2.5
% born before 2009	39.6	45.2	47.0	27.2

Take home message – sow turnover is significantly lower in traditional breeds.

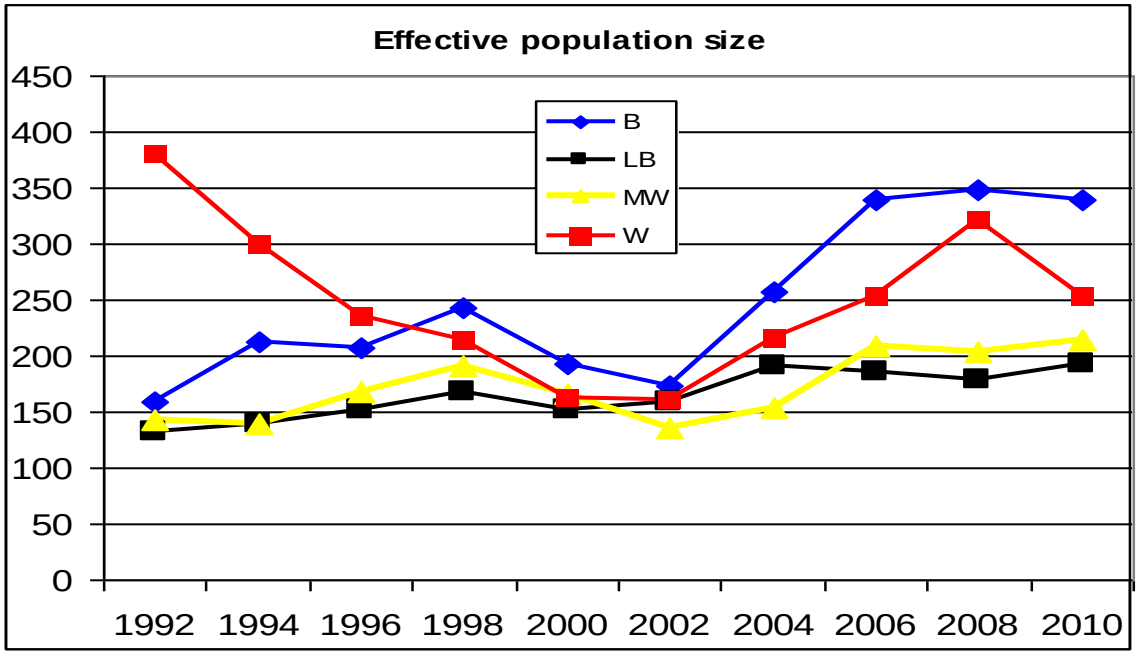
3. Effective Population Size

Effective population size (Ne) is an important concept in breeding as it is a key measure of the loss of genetic diversity. In turn, it reflects the level of inbreeding and is directly related to the number of breeding boars and breeding females and measures the ratio of animals contributing to the next generation. In general, the larger the level of Ne, the higher the genetic 'health' of the breed and the less chance of becoming endangered in the future. Standard mathematical equations are used in the estimation of Ne which assumes random selection of parents from those available and random matings. However, practical pig breeding involves the selection of specific animals for particular planned matings – as a result, Ne tends to be underestimated in practical breed improvement.

Data are presented for Ne from 1992 to 2010 below:

	B	LB	MW	W
1992	159	132	143	381
1994	213	139	140	300
1996	208	152	167	235
1998	243	167	191	215
2000	192	152	166	162
2002	174	159	136	161
2004	258	191	153	216
2006	339	186	209	253
2008	349	179	204	321
2010	340	193	215	254

These data are shown in the graph below:



These data show the following trends in the breeds:

Berkshire: Ne halved in the 1990's but recovered sharply in the last decade.

Large Black and Middle White: Mostly stable with a small upward trend.

Welsh: Rapid decrease in the 90's to a level similar to the traditional breeds. From 2000 there was evidence of a recovery up to 2008, but latest data show a decline.

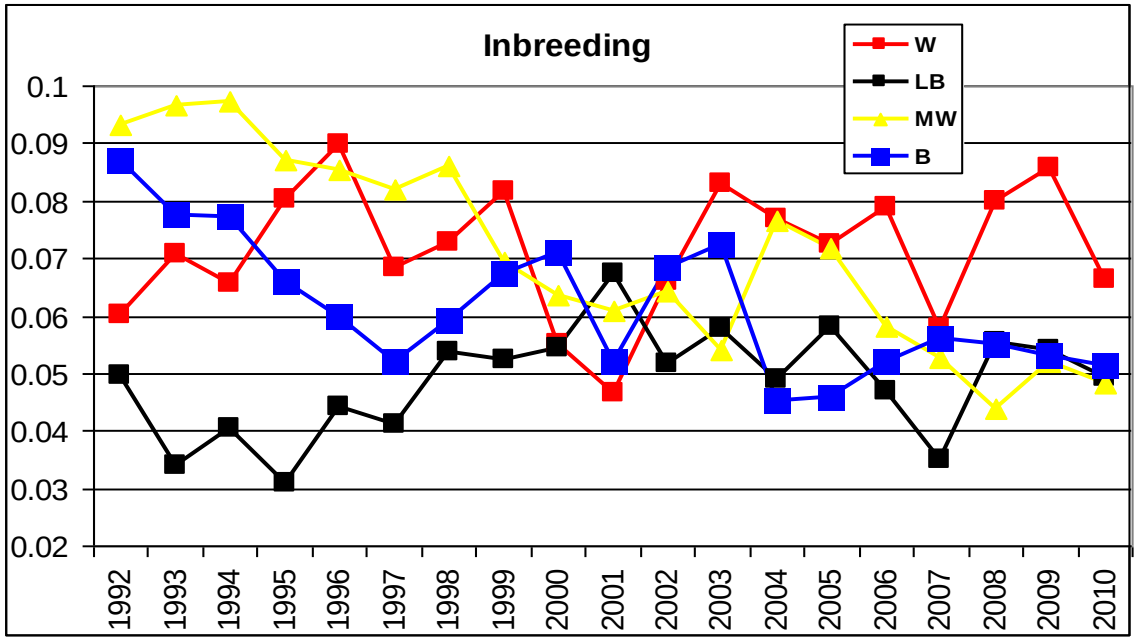
Take home message – effective population sizes have been variable across breeds. However, all breeds show an increase in the past decade.

4. Inbreeding

Inbreeding is the result of mating related animals. The outcome is an increase in the likelihood that pairs of genes in offspring will be identical (in genetic terms, homozygous). Unfortunately, this will lead to an increased homozygosity for deleterious genes. As a result, levels of fertility will fall and there will be an increase in genetic/congenital defects. At its most extreme manifestation, extinction will occur.

The inbreeding coefficient for any one animal is the measure of how many common ancestors appear in its extended pedigree back to the start of records. The mean inbreeding for the breed population is an indication of the amount of genetic variation that has been lost from the population that was present in the foundation animals (the 'founders').

The average inbreeding levels for the breeds, by year from 1992 to 2010, is shown below:



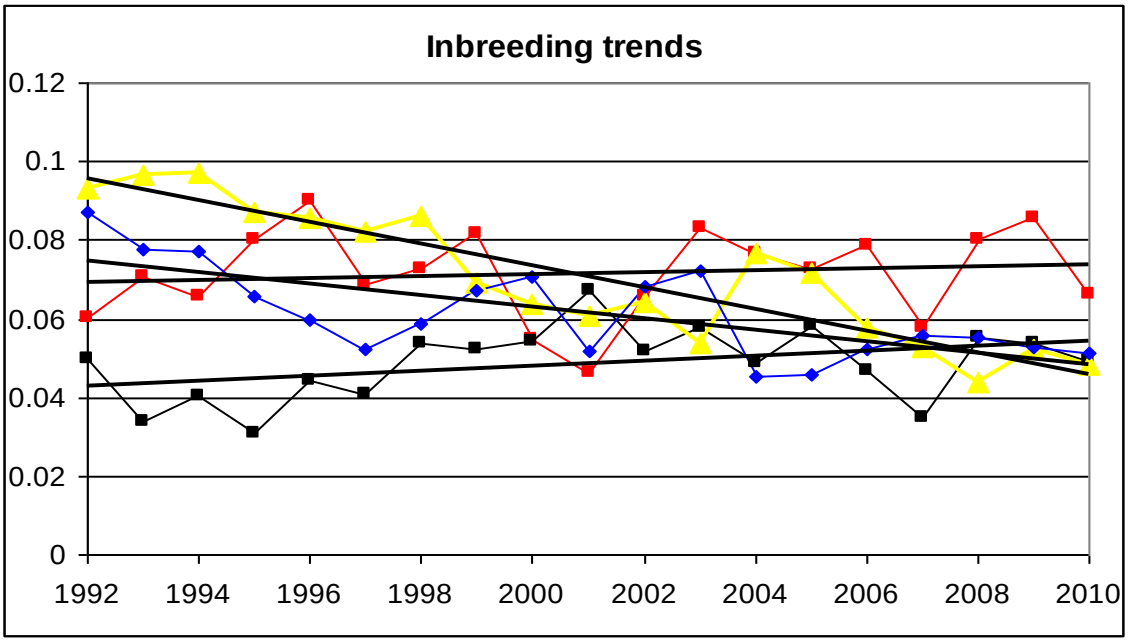
The mean and range for each breed is summarised below:

	B	LB	MW	W
Mean	6.15	4.87	7.07	7.14
Range	4.52-8.71	3.09-6.74	4.44-9.73	4.64-8.99

Take home message – There has been variation between years. However, the data suggest that the mean inbreeding level for the breeds ranges between 5% and 7%.

For conservation purposes, the actual level of inbreeding is not as important as the rate of change in inbreeding. When the inbreeding rate is high it means that there is more likelihood of deleterious effects being observed. Conversely, when the inbreeding rate is low in a population, natural genetic processes replenish the genetic variation and reduce the impact of any deleterious genes over time. Thus, every attempt should be made to minimise the rate of increase of inbreeding through controlled mating plans.

The Table below shows the inbreeding trends from 1992 to 2010:



Note that the trendlines are slightly positive for the Large Black (+0.0006 per annum) and the Welsh (+0.0002) but negative in the Berkshire (-0.00015) and the Middle White (-0.0028).

Take home message – the rate of inbreeding appears to be 'under control' in all the breeds.

5. 'Founders'

Because some conservation geneticists maintain that there it is desirable to have representation of 'founder' animals in the pedigrees of the latest generation in order to maintain genetic diversity, the BPA has identified 'founders' in each breed. However, there are problems and limitations with these analyses. Unfortunately as it is impossible to go back to the true 'start' of a breed, 'founders' are usually defined as those animals that had offspring but no parents in the database at a particular arbitrary start date for the breed. As a result, the concept of 'founders' causes concern among many geneticists because the allocated start date of a breed defines the identification of the specific 'founders'. Thus, a start date of 1980 compared with a start date of 1995 will identify different 'founders'. For this reason, the BPA is not recommending the use of 'founders' in the future genetic evaluations.

Take home message – the concept of 'founders' is flawed and should not be used in conservation genetics of pig breeds.

6. 'Bloodlines'

The nomenclature of pedigree pig breeding involves the use of 'Bloodlines'. However, there is an iInherent problem with the 'bloodline' naming system, which involves the naming of gilt progeny after the dam's name and naming of boar progeny after the sire's name. Obviously, the progeny of a particular mating will have one of two 'family' names according only to the sex of a particular individual. The outcome is that the system can result in high inbreeding as some breeders believe that the family names of animals truly represent different discrete genetic lines. Accordingly, these breeders assume incorrectly that the amount of variation in their herd is directly related to the number of different male and female lines. As a result, it is the goal of the BPA to educate pig

breeders to look further than the 'bloodline' names of potential mates and to investigate the pedigrees for several generations of potential mates to ensure that inbreeding is minimised.

Take home message – The 'bloodline' system of nomenclature should be used very carefully in mating plans for genetic conservation.

Breeding Strategies

Various breeding plans are being implemented by BPA, in association with individually analysed breeds, to aid conservation policies. Some of these are outlined below.

1. Boar contribution

In a conservation programme it is important to ensure the maintenance of genetic variation present in the current population. Ideally, this requires the optimum contribution of all the males currently available. At the practical level this requires attention to the following:

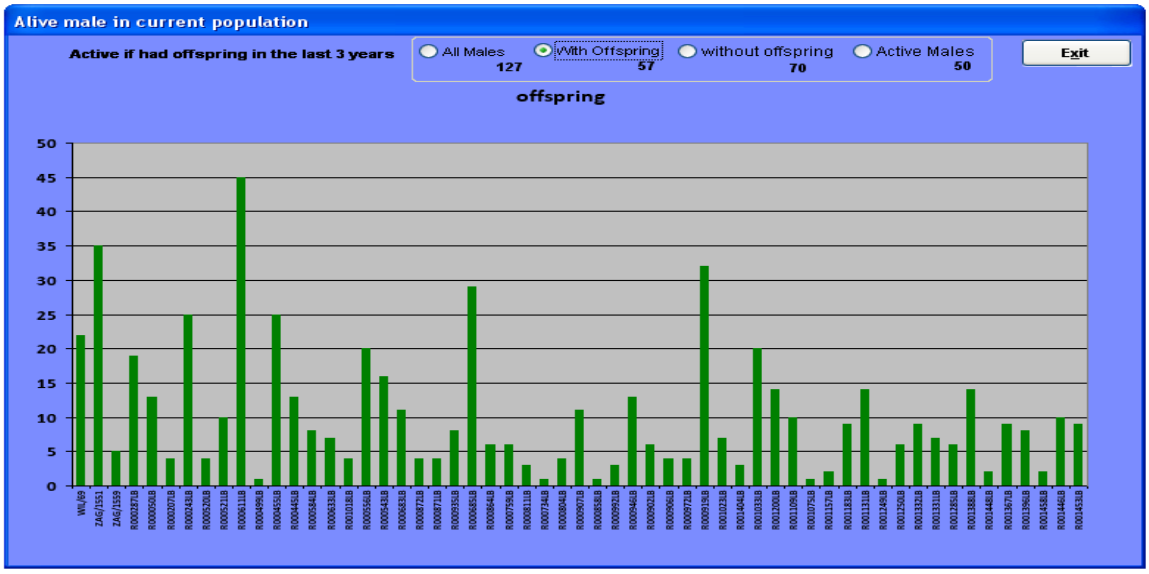
- Use as many boars as possible (whilst maintaining breed standards for conformation, type and performance).
- Do not keep too many offspring from any one male. Ideally keep just one boar from a litter for future breeding.
- Never allow one male to sire more 5% of future breeding generations. This is particularly important when using AI from limited numbers of sires.
- Minimize inbreeding through controlled mating plans.
- Use family line names very carefully – remember the name only gives an indication of one 'side' of the pedigree.

The current status of boars within the four breeds is shown below:

	B	L B	MW	W
Living registered boars	218	127	120	247
Living boars with registered progeny	101	57	52	81
Young boars with no registered progeny	117	70	68	166
% of young boars	53.7	55.1	56.7	67.2
Total registered progeny	828	604	567	818
Average progeny per boar	8.2	10.6	10.9	10.1

Take home message - all breeds have a satisfactory number of living boars with registered progeny together with a large 'pool' of young boars. Furthermore, the average number of registered progeny per boar is close to ten, suggesting that the breeds are limiting the loss of genetic diversity.

In theory, a breed should have an equal spread of progeny representing all sires. The screen capture below shows a graph of the number of registered progeny of every Large Black living boar:



Here, only 6 boars have 25 or more registered progeny. In addition, there are 19 boars with less than five registered offspring. These data may be used to identify 'over-represented' and 'under-represented' sires in future mating plans. For genetic conservation it would be helpful to increase the representation of the 'least popular' boars. However, practical knowledge is needed to decide 'policy' as they may be under-represented for a very good reason!

2. Kinship analyses

Kinship analyses are very important in genetic conservation programmes because they give guidance on mating plans to minimise future inbreeding and maximise genetic variance. They allow the following:

- The identification of the relationship (kinship) of each living animals with all other animals in the breed.
- The estimation of inbreeding coefficients for future matings (sometimes referred to as a 'what if' inbreeding levels for potential matings).
- The identification of unrelated boars matched to females prior to breeding, sometimes known as mate-selection (particularly in BLUP programmes).

A possible breeding plan would be to consider using boars with a low kinship to the male population and a low number of registered offspring. Similarly, a breeding plan might wish to cease using boars which have a larger number of offspring or a higher kinship to the male population as a whole.

The Tables below show a list of the ten Welsh boars with the highest kinship and the ten boars with the lowest kinship, together with the number of registered progeny:

Registration Number	Name	D.O.B	Kinship	Breeder	Owner	Progeny
R000463WE	Tates Earl 10	05/02/2004	0.0581	MIS	MIS	17
R001297WE	Tates Emperor 6	30/10/2007	0.0552	MIS	DJH	25
R001077WE	Tates Earl 17	03/03/2006	0.0516	MIS	MIS	12
R001063WE	Tates Emperor 4	09/06/2006	0.0506	MIS	MIS	9
R001504WE	Tates Ted 11	17/03/2008	0.0498	MIS	MIS	14
R002222WE	Tates Emperor 21	20/05/2009	0.0482	MIS	MIS	2
R001559WE	Tates Emperor 7	08/02/2008	0.0476	MIS	MIS	9
R001761WE	Tates Ted 16	23/12/2007	0.0464	MIS	MIS	4
R001900WE	Tates Emperor 18	24/07/2009	0.0444	MIS	MIS	4
R001329WE	Tates Victor 13	02/06/2007	0.044	MIS	MIS	19
R001503WE	Tates Earl 25	05/10/2007	0.0436	MIS	MIS	42

Registration Number	Name	D.O.B	Kinship	Breeder	Owner	Progeny
R001536WE	Panorama Earl 140	02/01/2009	0.0249	BYP	86291	6
R001558WE	Panorama Earl 141	02/01/2009	0.0249	BYP	DXE	11
R001819WE	Gillbeck Arthur 36	07/05/2009	0.0246	HDC	SAD	6
R001981WE	Trialmawr Emperor 262	02/09/2009	0.0241	DXE	DXE	2
R001464WE	Owersby James 267	03/09/2008	0.0232	SAD	ELL	16
R000983WE	Braemor Imperial 5	30/04/2007	0.0221	WF	ZZZ11	1
R001508WE	Edgcumbe Earl 2373	17/07/2006	0.0219	UEG	UEG	13
R000605WE	Vinery Victor 4261	23/09/2005	0.0201	JAV	UEG	23
R001546WE	Beechwood Arthur 3	15/09/2008	0.0199	MLF	WXY	5
R000753WE	Milday Victor 79	23/03/2006	0.0172	MPC	BXB	2

From Tables such as this it is possible to identify boars that are most likely to aid genetic conservation of the breed. In this particular case, it is not surprising that the largest herd in the Welsh breed (Tates) has high kinship levels as it will have contributed the most to the current breeding population.

A 'traffic light' system is being trialed in two breeds (Large Black and Middle White) where boars are identified as green, amber and red for high, medium and low priority usage. Boar candidates for AI must be classed as green.

Take home message – kinship analyses are powerful tools to promote genetic conservation and low inbreeding. Boars can be selected that have low kinship relationships with the total population and limited numbers of progeny.

3. Mate-selection

In future breeding plan, boars could be matched with specific females using kinship analysis to establish the lowest inbreeding predictions for the future. For the Welsh breed the matrix of all possible matings from the current boars and females includes kinship calculations on more than 200,000 potential litters. A subset is used below to show how future matings could be planned effectively.

Three boars and five young females have been selected at random:

Registration	Name	Sex	D.o.B
R002623WE	Soundvilla Earl 31	M	25/04/2010
R002463WE	Edgcumbe Emperor 2644	M	01/05/2010
R002404WE	Cildu Vulcan C2	M	15/05/2010
R002873WE	Mabon Lucky Girl 13	F	05/03/2011
R002795WE	Beechwood Elenora 8	F	10/03/2011
R002796WE	Beechwood Elenora 9	F	10/03/2011
R002868WE	Danleebar Flora 106	F	22/03/2011
R002865WE	Coed Model 27	F	29/04/2011

Kinship analysis shows the resulting inbreeding from the various mating options:

Boar candidate	Female candidate	Inbreeding
R002404WE	R002795WE	0.0003
R002404WE	R002796WE	0.0003
R002623WE	R002873WE	0.0005
R002463WE	R002865WE	0.0007
R002463WE	R002873WE	0.0029
R002404WE	R002868WE	0.0072
R002404WE	R002880WE	0.0107
R002623WE	R002795WE	0.0159
R002623WE	R002796WE	0.0159
R002623WE	R002865WE	0.0172
R002404WE	R002865WE	0.0203
R002463WE	R002868WE	0.0218
R002623WE	R002868WE	0.0273
R002404WE	R002873WE	0.0349
R002463WE	R002795WE	0.0358
R002463WE	R002796WE	0.0358

As a 'rule of thumb' the BPA suggests that planned matings should aim to have an inbreeding coefficient of 0.02 or less. In this case, ten planned matings fulfil the criteria and will ensure low inbreeding and higher genetic variance for the future.

Looking to the future, it is planned that BPA will introduce a web-based mate-selection program using kinship analyses. The program will be integrated within BLUP evaluations so that both inbreeding and the resulting trait and index Estimated Breeding Values (EBV's) can be utilised to plan the 'best' possible matings between listed boars and sows.

Take home message – mate-selection to minimise future inbreeding is possible using kinship analyses. This could be integrated within BLUP to optimise both EBV's and inbreeding.

DNA Breed analyses

Genetic diversity in pigs has been studied in numerous international studies (see reviews by Ollivier, 2009 and Nidup and Moran, 2011). One of the largest studies was the European PigBioDiv1 project (San Cristobal et al, 2006) to allow 'Characterisation of genetic variation in the European pig to facilitate the maintenance and exploitation of biodiversity'. The study involved 2737 pigs from 68 European breeds, made up of 29 traditional breeds (including Berkshire, Large Black and Middle White), 18 national varieties of modern breeds (not Welsh) and 21 Breeding Company commercial purebreds/ synthetics. All the UK samples were collected by the BPA and RBST. Traditional breeds accounted for 56% of the total diversity, followed by the commercial

pigs and then the modern breeds. Individual breed contributions to between breed diversity ranged from 0.04% to 3.94%. The 'top' 12 breeds in diversity were:

Rank	Breed	Marginal diversity %
1	Basque (France)	3.94
2	Tamworth (UK)	3.27
3	Negro Canario (Spain)	3.19
4	Mangalitza (Hungary)	3.01
5	Berkshire (UK)	2.86
6	Cinta Senese (Italy)	2.84
7	Calabrese (Italy)	2.75
8	Manchado (Spain)	2.60
9	Gloucestershire Old Spot (UK)	2.59
10	Lomousin (France)	2.48
11	Middle White (UK)	2.45
12	Large Black (UK)	2.40

Recently (Wilkinson, Haley, Alderson and Weiner, 2011) looked at the PigBioDiv1 data using the latest statistical methods, including three Bayesian genotypic clustering approaches, principle component analysis and phylogenetic reconstruction methods, in order to evaluate individual-based rather than population-based methods for characterization of genetic diversity.

The practical conclusions from the study were:

- The clustering analyses indicated very little evidence of introgression into breeds. Of 819 animals studied, only 4 individuals appeared to show 'outside blood'.
- All the breeds show discrete characteristics so that they could be differentiated in an 'evolutionary tree'. From this it is possible to verify that, with one exception (see below) British pig breeds are distinct genetic units.
- There is more genetic variation within breeds than between breeds. This is re-assuring for the survival of individual breeds.

Unlike all the other breeds, the British Saddleback split into two discrete genetic groups. The British Saddleback (see Appendix One) is a traditional pig breed with an unusual history. It was formed from an amalgamation in 1967 of two phenotypically similar pig breeds, the Essex and the Wessex Saddleback, both with a white belt. The assumption was that the two merged breeds were still genetically different explaining the genetic substructure in the breed. However, further analysis by Wilkinson, Haley, Walters and Weiner (in press) showed that the two groupings did not correspond to the Essex-Wessex division. Indeed, examination of 4 generation pedigrees of individual pigs showed that there had been repeated crossing between the two 'sub' breeds. As there have been more than twenty generations of breeding since the amalgamation it appears that the Essex and Wessex breeds do not appear to have survived as separate genetic entities. Instead, the subdivision of the British Saddleback into two subpopulations was associated with one herd prefix, whereby one or both of an individuals' parents originated from one particular herd (Rainbarrow) clustered together, whilst individuals from the other subpopulation possessed parents from other sampled herds. The average expected heterozygosity was comparatively high in both subpopulations, with levels similar to that found in European pig breeds. However, the average number of alleles in the subpopulation that constituted the Rainbarrow herd was notably

lower. In addition, the individual inbreeding coefficients were significantly higher than individuals belonging to the Rainbarrow herd as opposed to individuals originating from the other herds. As a result, different management breeding strategies may be required to ensure the future genetic viability of the British Saddleback herds compared with other traditional breeds.

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Wilkinson S, Haley C, Walters R, Weiner P. Genetic diversity, inbreeding and herd divergence in the British saddleback pig breed. J. of Heredity:in press.

Appendix One: Breed Histories

Note that these comments are derived from the breed descriptions published by each individual Breed Club.

Berkshire

Cromwell's troops, during the English Civil War in 1643, when quartered in Reading in the Royal County of Berkshire, made reference to a locally bred pig renowned for its size and the quality of its bacon and ham. This turned out to be one of the earliest records of the Berkshire breed. These pigs were larger and coarser than today's Berkshire. Their colour varied from black to sandy red; they were also sometimes spotted and had variable white patches. However, the breed was influenced by the introduction of Chinese and Siamese blood, which resulted in the development of the Berkshire we are familiar with today. This is a smaller animal, black in colour, with prick ears, white socks, white tip to tail and flash on face. Important strides in breed improvement took place between 1820 and 1830, much of which is attributed to Lord Barrington. During the 19th century the breed became very popular, enjoying patronage from the aristocracy, including Queen Victoria. Its popularity was reflected in the show ring as by 1877, the world-renown Smithfield Show offered separate Berkshire classes and during the last 17 years of the 18th century, the breed produced 12 Smithfield champions, including pigs exhibited by members of the Royal Family. During 1823 the first Berkshire was exported to the USA. This trend continued throughout that century and then at the end of the 19th century, herds were also established in Australia and New Zealand. From that time, and during the first half of the 20th century, the breed grew in popularity reflected by successes at many leading shows.However, as with all coloured pig breeds, the Berkshire suffered a serious decline in popularity following World War II when the demand for leaner bacon from white-skinned pigs increased and then in the 1960s with the development of breeding companies that favoured white breeds. However, due to a few loyal stalwarts, the Berkshire survived. Today's increasing interest in traditional meat produced extensively has renewed interest in the breed. Although it is a coloured breed, the meat dresses out white and, as this is an early-finishing breed, an ideal carcase weighs between 36kg and 45kg. A number of breeders have developed their own specialised markets for Berkshire pig meat and Berkshire breeding stock are also in demand overseas – especially in Japan – where the breed is

very popular and is marketed as Black Pork at a premium price. Japanese buyers still consider Berkshires from Britain to have the best taste and flavour. There have been six boars imported over the past fifty years from Australia and New Zealand. Semen has also been sourced from USA. These importations of new blood - all descended from the original English Berkshire – as well as grading up three female lines has helped broaden the breed's genetic base.

British Saddleback

The British Saddleback is the result of the amalgamation of two similar breeds, the Essex and Wessex Saddleback. The origin of the Improved Essex Pig is better authenticated than most. Lord Western, while traveling in Italy, saw some Neapolitan pigs and came to the conclusion that they were just what he needed to improve the breed of Essex pigs. He procured a pair of Neapolitans and crossed them with Essex sows. One of his tenants Fisher Hobbs of Boxted Lodge availed himself of the opportunity to use the Neapolitan-Essex boars belonging to Lord Western and crossed them with his coarse Essex sows and in process of time established the Improved Essex. Sidney in his last edition of Youatt on the Pig, says "The improved Essex probably date their national reputation from the second show of the Royal Agricultural Society, held at Cambridge, in 1840, when a boar and sow, both bred by Mr. Hobbs, each obtained first prizes in their respective classes." The Essex pig was mainly found in East Anglia. This pig had a black head and neck, as well as a clearly defined belt of white extending over the shoulders and continuing over the forelegs. The rest of the body was black with the exception of white feet and the tip of the tail. The Wessex originated in the New Forest as a cross between two indigenous old English bacon pigs. By 1914 the breed was also found in the South and South West. It was black all over, asides from a continuous belt of white hair over the forelegs and shoulder. W. J. Walden writing in the 1931 NPBA Gazette explains that stringent rules were put in place by the Wessex Saddleback Pig Society at its foundation to prevent alien blood being brought in where the foundation on one side was not of New Forest origin. The breed prided itself on having resisted the trend to introduce Chinese blood. In his article on Wessex Saddleback markings Walden asks " Why then make a feature of the chief colouration marking? Surely it does not take a high intelligence to see the correctness and advantage of the one conspicuous trade mark when two China free breeds are brought together?" The respective breed societies amalgamated in 1918 and the herd books followed suit in 1967 when the British Saddleback breed was established. The two breeds enjoyed great popularity during the Second World War when 47% of the total pedigree sow registrations were from the Essex and Wessex breed. In 1949 there were 2,435 Essex and Wessex boars licensed representing almost 25% of the licensed boars for that year. The sows retained some of their popularity in the post war years. In 1954 they made up 22% of the total registrations for that year. The boars, however, had lost considerable ground to white breeds and in the same year less than 10% of the licensed boars were from the Essex and Wessex breeds. The recommendations of the time were to cross sows of either breed with a white boar to produce a dual-purpose pig for combined pork and bacon production. British Saddlebacks are hardy and noted for their mothering ability. The breed continues to be used mainly to provide coloured dams for the production of first-cross porkers, baconers and heavy pigs. The breed is known for its grazing ability and is very hardy. It has secured a niche in outdoor and organic production.

Large Black

With its lop ears and long, deep body, the Large Black is Britain's only all-black pig. Extremely docile, and very hardy, it is ideally suited to simple outdoor systems. These characteristics, coupled with its black skin, make the Large Black ideal for a wide range of climatic conditions. In fact, by 1935, pigs of this breed had been exported to well over 30 countries. The breed originates from the Old English Hog established in the 16th and 17th centuries. Described by Parkinson in 1810: "They are distinguished by their gigantic size, they are the largest of the kind I

have ever seen, and as perfect a make as possible in pigs; their heads are large, with very long ears hanging down on each side of the face, so they can scarcely see their way." By the late 1880's there were two distinct types of Large Black, one to be found in East Anglia and the other in Devon and Cornwall. However the founding of the Large Black Pig Society in 1889 led to an increase in the exchange of stock between breeders in the two regions. In the early part of the 20th Century, Large Blacks were widely distributed throughout the country and were frequently crossed with Large Whites and Middle Whites to produce bacon and pork pigs. The Large Black breed was also very successful in the show ring at this time; at Smithfield in 1919, the Supreme Championship was awarded to a Large Black sow that subsequently sold for 700 guineas. The same year the breed outnumbered all other breeds at the Royal Show when 121 Large Black pigs were exhibited. A change in demand by the meat trade and a developing prejudice against coloured pigs led to a severe decline in numbers throughout the 1960's.Today Large Blacks can be found throughout the British Isles, mainly in small herds, some of which were established well before World War II. Large Black sows are renowned as excellent mothers with exceptional milking ability. They are able to rear sizeable litters off simple rations and a placid temperament ensures they can be contained behind a single strand of electric fencing. Current demand for meat produced from traditional breeds of pigs raised extensively is now promoting a growth in the number of breeders keeping Large Blacks as this particular breed is much appreciated for its succulent taste and eating quality.

Middle White

The Middle White was first recognised as a breed in 1852 in most unusual circumstances. At the Keighley Agricultural Show in West Yorkshire, Joseph Tuley, a weaver by trade, exhibited several of his famous Large White sows along with other pigs. The judges could not agree, as some of the animals were not considered sufficiently large for the class, and “as the merits of these pigs were so extraordinary, entirely forbidding recourse to disqualification, a committee was summoned, whereupon the judges declaring that, if removed from the Large White class the pigs would not be eligible for the Small White class”, it was decided to provide a third class and to call it the “Middle Breed”. In this way the “Middle White breed was established. The Small White had been developed for showing and derived from crossing the local pigs with imported Chinese and Siamese pigs, from which it inherited the dished face, so much the characteristic of the Middle White. In further establishing the Middle White breed, Tuley took a second cross with a boar of the Small White breed and females from the best type of Large White in his herd. The resulting progeny were as heavy as the pure Large White, although in type and lightness of offal and head they much resembled the best of the Small White breed. The Small White breed became extinct in 1912. Due to the “new” breed’s eating qualities, its early maturing and its very easy management, the Middle White went from strength to strength. When the National Pig Breeders Association, the fore-runner of the British Pig Association, was founded in 1884 the Middle White along with the Large White and Tamworth were the three foundation breeds and their first Herd books were published that same year. The Middle White remained very popular with butchers everywhere, particularly in London where the breed was known as “the London Porker” as the carcases could be cut into the small joints favoured in the first part of 20th Century. The Second World War and meat rationing until 1954 led to a concentration on the “bacon” pig and the specialist pork pig was sidelined. Along with other “pork” breeds the numbers of Middle Whites declined sharply during this period. Fortunately a number of dedicated breeders ensured the continuation of the breed. In recent years the demand for meat with good eating qualities has once again led to Middle White pork appearing on the menus of top London restaurants, with “glowing reports” regarding its outstanding quality. Middle White breeding stock has been exported world wide, and the breed is particularly appreciated in Japan where they are known as “Middle Yorks”. The Middle White has many assets. It is very easily managed. It is docile and can make a significant contribution to cross breeding programmes in order to improve eating quality.

Welsh

The earliest references to a Welsh pig come from the 1870's when there was a considerable trade in Welsh and Shropshire pigs into Cheshire for fattening on milk by-products. "The Welsh pigs are generally a yellow-white, but some are spotted black and white. The (Cheshire) dairymen depend more on these Welshmen and proud Salopians than on breeding. The cross of the Manchester boar with the Shropshire and Welsh produces a larger and coarser breed than the small Yorkshire." Increased demand for pork and bacon during the First World War, when imports were restricted to Canada and the USA, led to the creation of the fist pig breed society in Wales. The Old Glamorgan Pig Society was established in 1918. The first volume of the Herdbook was published in 1919. Pigs of a similar type were also bred in Cardigan, Pembroke and Camarthen. A meeting was held at Carmarthen in 1920 resulting in the foundation of the Welsh Pig Society in West Wales. The first herdbook was published in 1922. These two breed societies amalgamated in 1922 to become the Welsh Pig Society with offices at Shire Hall in Camarthen. In 1923 Volume 4 of the Old Glamorgan Pig Society Herdbook and Volume 2 of the Welsh Herdbook were published separately. Volume 5 published in 1924 was the first issued as the Welsh Pig Society. In 1952 the Welsh Breed joined the six other pedigree breeds already represented by the National Pig Breeders Association, now known as the British Pig Association. The first NPBA herdbook containing entries for Welsh Pigs was published in 1953. The Welsh breed prospered greatly during the period from 1947 when increasing supplies of animal feed led to a dramatic increase in the national pig herd. The number of government licenses issued for Welsh boars increased from 41 in 1949 to 1,363 in 1954, making the Welsh the number three sire breed in Great Britain behind the Large White and Landrace. A similar picture existed for pedigree sow registrations, which rose from 850 in 1952 to 3736 in 1954. The Howitt Committee established in 1955 to advise government on future breeding policy and which included amongst its members the eminent scientist Dr J. Hammond, identified the Welsh Breed together with the British Landrace and Large White as the three breeds on which the modern British pig industry should be founded. "It is from these three breeds we would hope to see developed, through intensive progeny testing in the coming years, the improved bacon pig which would provide boars for use by nearly all commercial breeders for bacon and pork." Nucleus herds of Welsh pigs were established as part of the national testing scheme and throughout the 60s and 70s' the breed was the third most numerous in the testing programmes. The 1974/75 Pig Improvement Scheme Year Book shows performance figures on a par with the other two breeds selected by the Howitt committee. During this period the Welsh breed was widely used in commercial herds. At the same time breeders with a slightly different type of Welsh pig were winning awards in the Show ring. At Smithfield and other Primestock shows the breed enjoyed numerous successes in both the pork and bacon sectors. The Welsh pig is white, with lop ears meeting at the tips just short of the pig's nose. It has a long level body with deep strong hams and legs set well apart. George Eglington acknowledged as the founder of the modern Welsh breed described the perfect Welsh pig as "pear shaped" when viewed from either the side or from above. They are still known for their hardiness and ability to thrive under a wide variety of conditions, both indoor and outside. Since the 1980's the number of registrations has declined however the breed still provides a valuable source of genetic material for breeders following crossbreeding programmes. They make for ease of management with fast liveweight gain at low feed conversion ratio and an excellent killing out percentage in the progeny. Recently, the regional Welsh Assembly has provided finance for the genetic analysis and marketing of prime Welsh pork.