EFECTS OF CHANGES IN THE BREEDING GOAL ON GENETIC IMPROVEMENT FOR MATERNAL TRAITS IN LANDRACE PIGS

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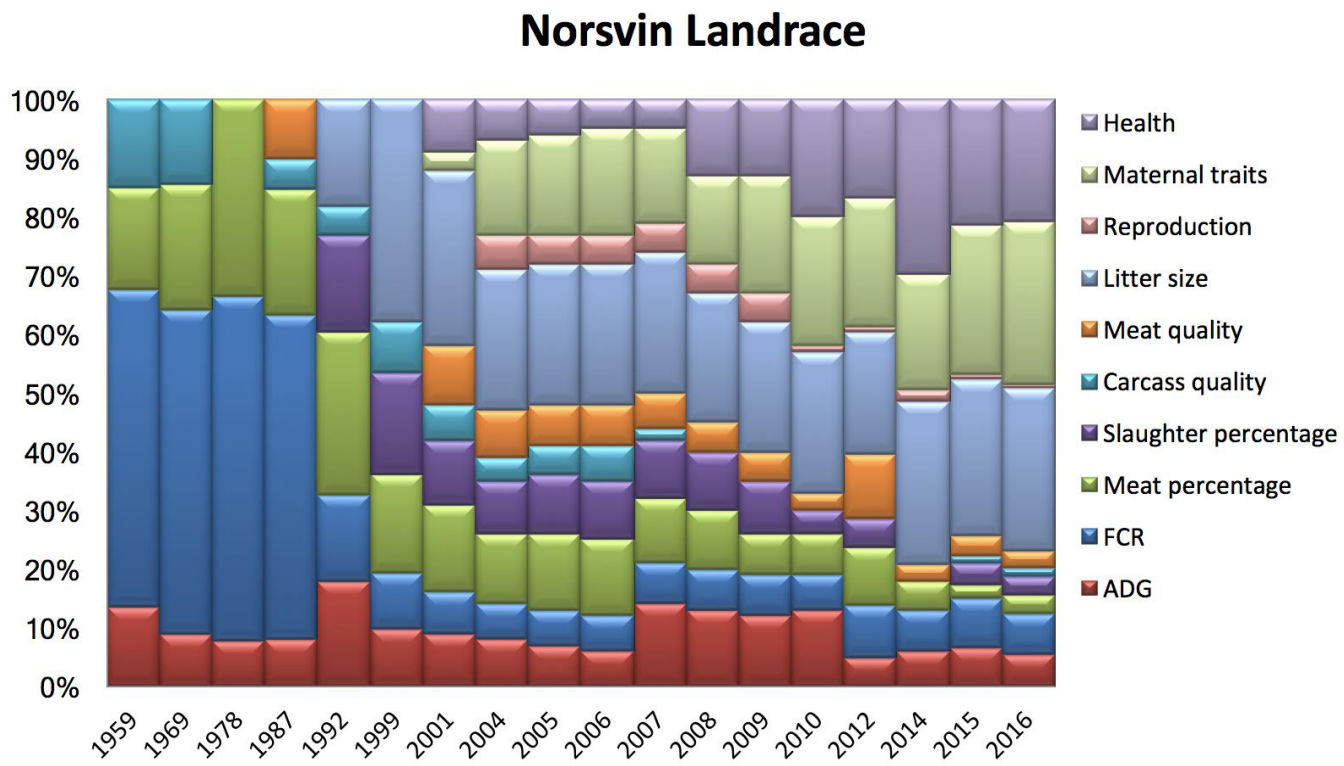
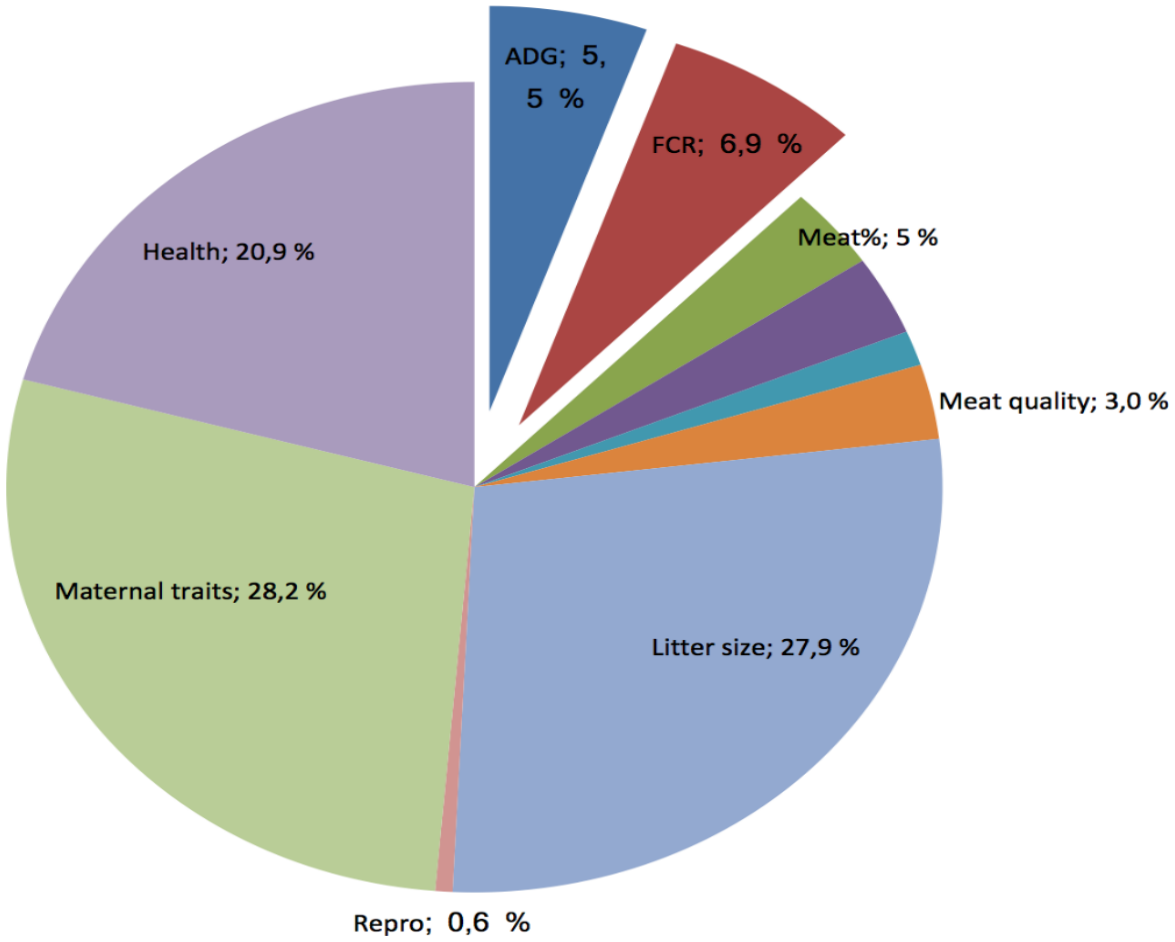
Disposition

- **The breed and breeding goal developments**
- **About the maternal traits included**
- **About the dataset**
- **Phenotypic trends**
- **The genetic parameters**
- **The genetic changes in maternal traits**
- **The effects of changes in breeding goals on genetic responses.**
- **Conclusions**

The development of the breeding goal for Norsvin Landrace from 1959 to 2016: From 4 to 25 traits



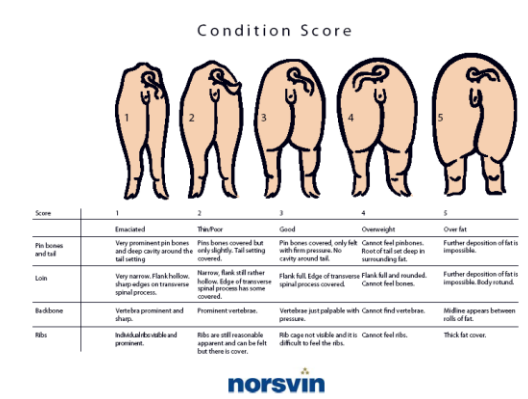
Current weighting of traits Norsvin Landrace- FROM THE ONLY BREED TO A MATERNAL LINE



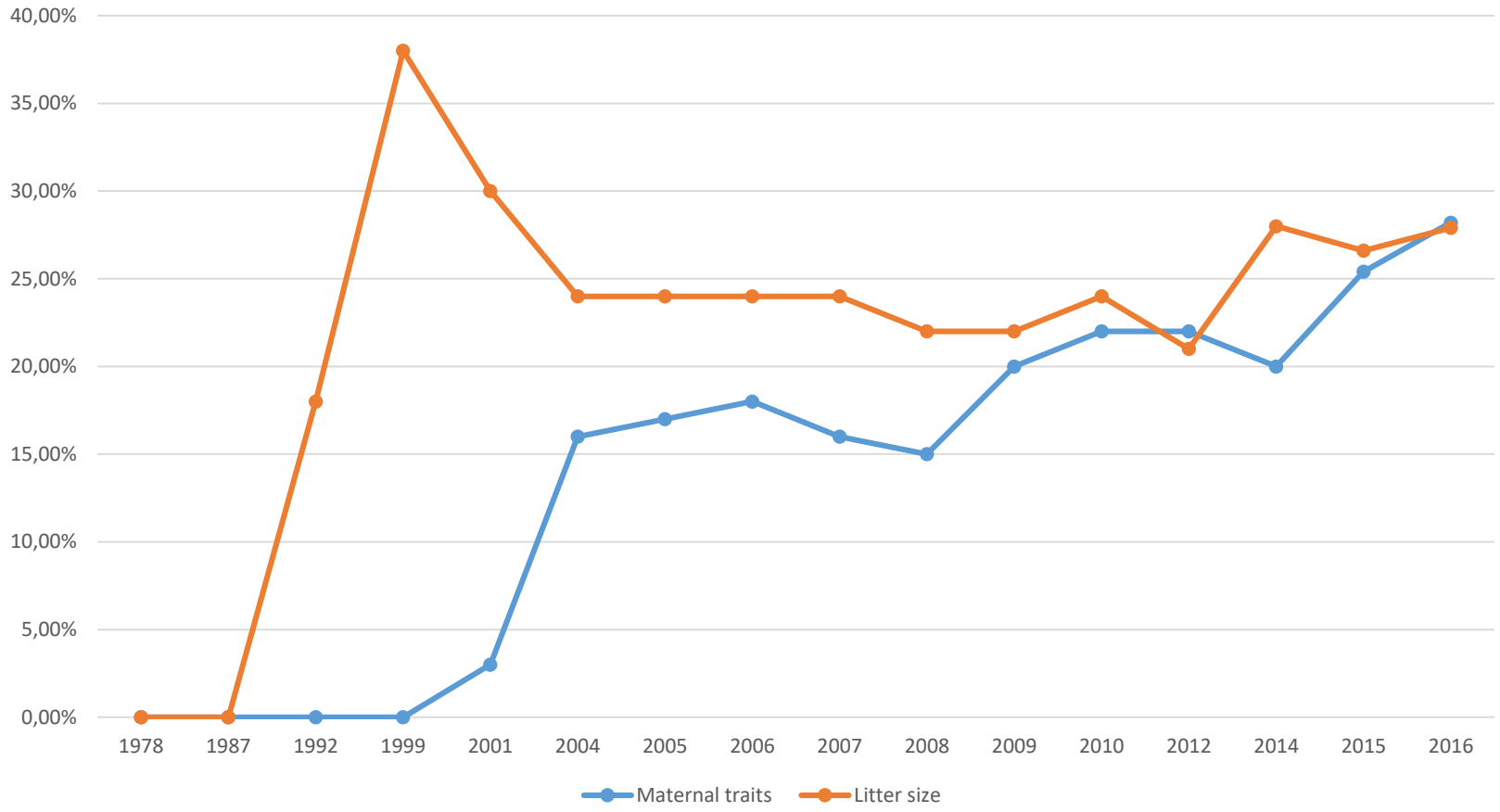
Breeding goal Norsvin Landrace

- **Bred for more than 30 years mainly for growth, leanness and feed efficiency. Became one of the leanest breeds in the world.**
- **The first fertility trait (litter size) included with breeding values (BLUP-values) from 1992, however with limited economic value and limited selection pressure until late 1990s.**
- **Defined as a maternal line in the formal crossing systems from the late 1990s.**
- **From 2002 the economic value for fertility traits was higher than the production and efficiency traits.**
- **From 2010 four more maternal traits were included in the breeding goal, totally counting for more than 50 percent of the breeding goal.**
- **TODAY fertility and other maternal traits plus health traits are 78 percent of the breeding goal, while 22 percent is growth, leanness, feed efficiency and meat quality, and the breed is generally only 25% of the genetic makeup of a Norwegian slaughter pig.**
- **Genomic information included in the selection program from January 2014.**

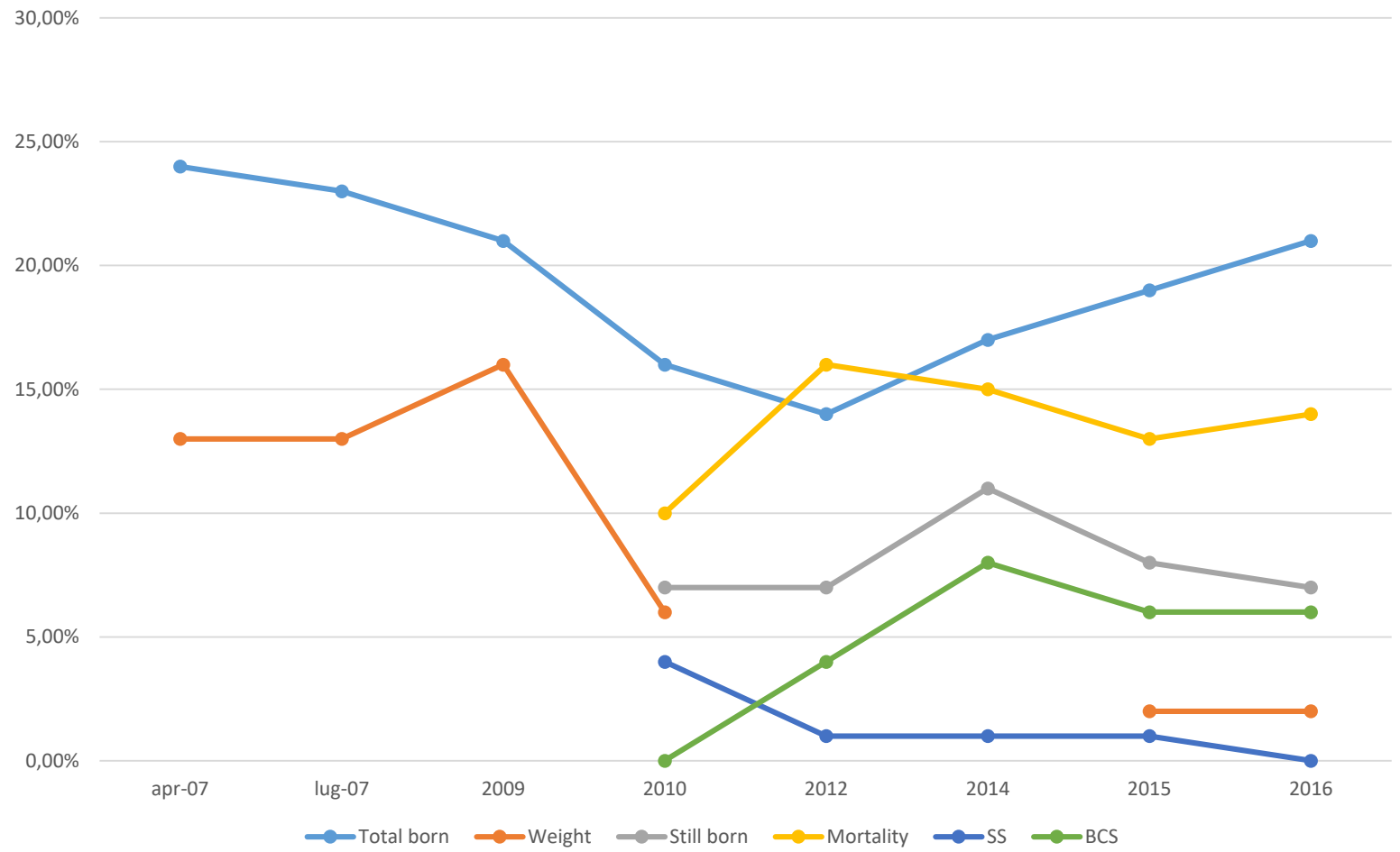
The traits included in the study	Year:
A1: Total born, no	1987/1992
A2: Number of stillborn piglets	2007
A3: Mortality at 3 weeks, no	2010
(- : Number of weaned piglets)	-
B1: Weight at 3 weeks, kg	2007
B2: Variance in weight at 3 weeks, kg	-
C : Shoulder sore, score 1-4	2010
D: Body condition score, 1-5, with half points (see figure)	2010



The weighting of litter size and other maternal traits from 1978 to 2016



The weighting of maternal traits from 2007 to 2016

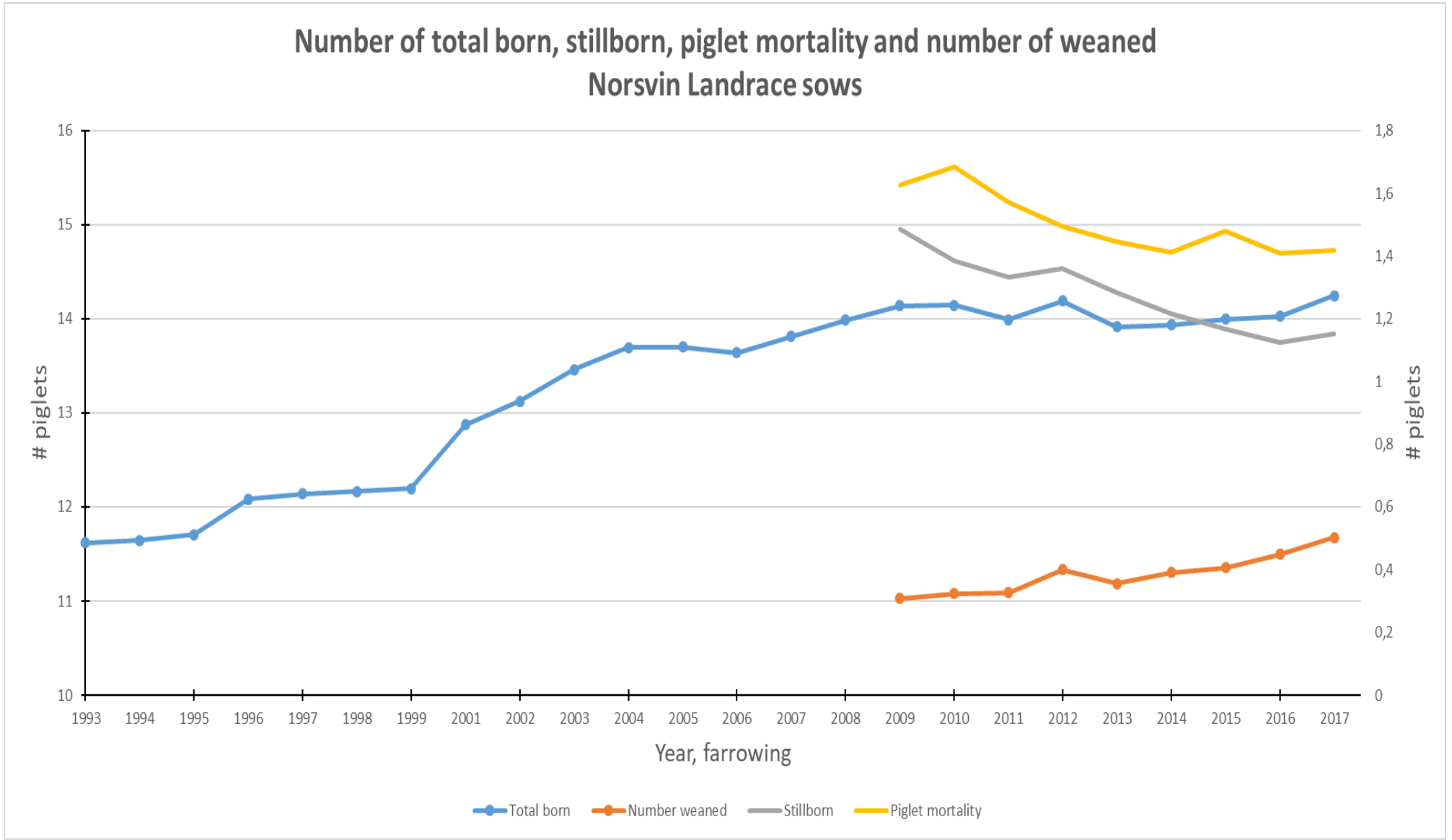


THE DATASET:
Number of observations for each trait from 1991 to 2017

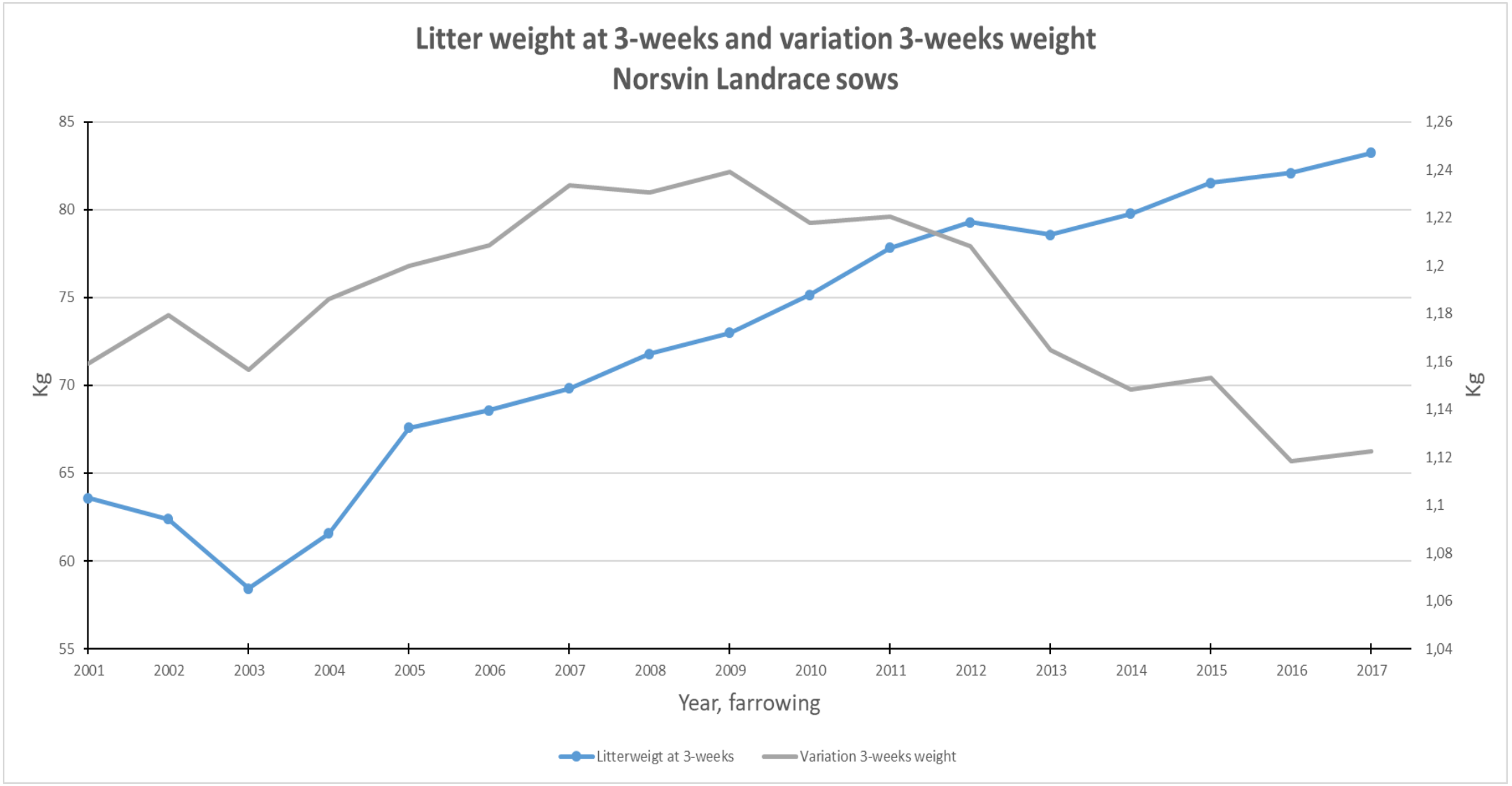
Trait	No. of observations
Total born	395 217
Stillborn	395 239
Mortality at 3 weeks	149 394
Weight at 3 weeks	221 038
Variance at 3 weeks	210 907
Shoulder sore	149 717
BCS	147 015

- The relationship matrix included 936000 animals, oldest animals from 1. Jan. 1990.
- 40053 of these had been genotyped and included in the H^{-1} .

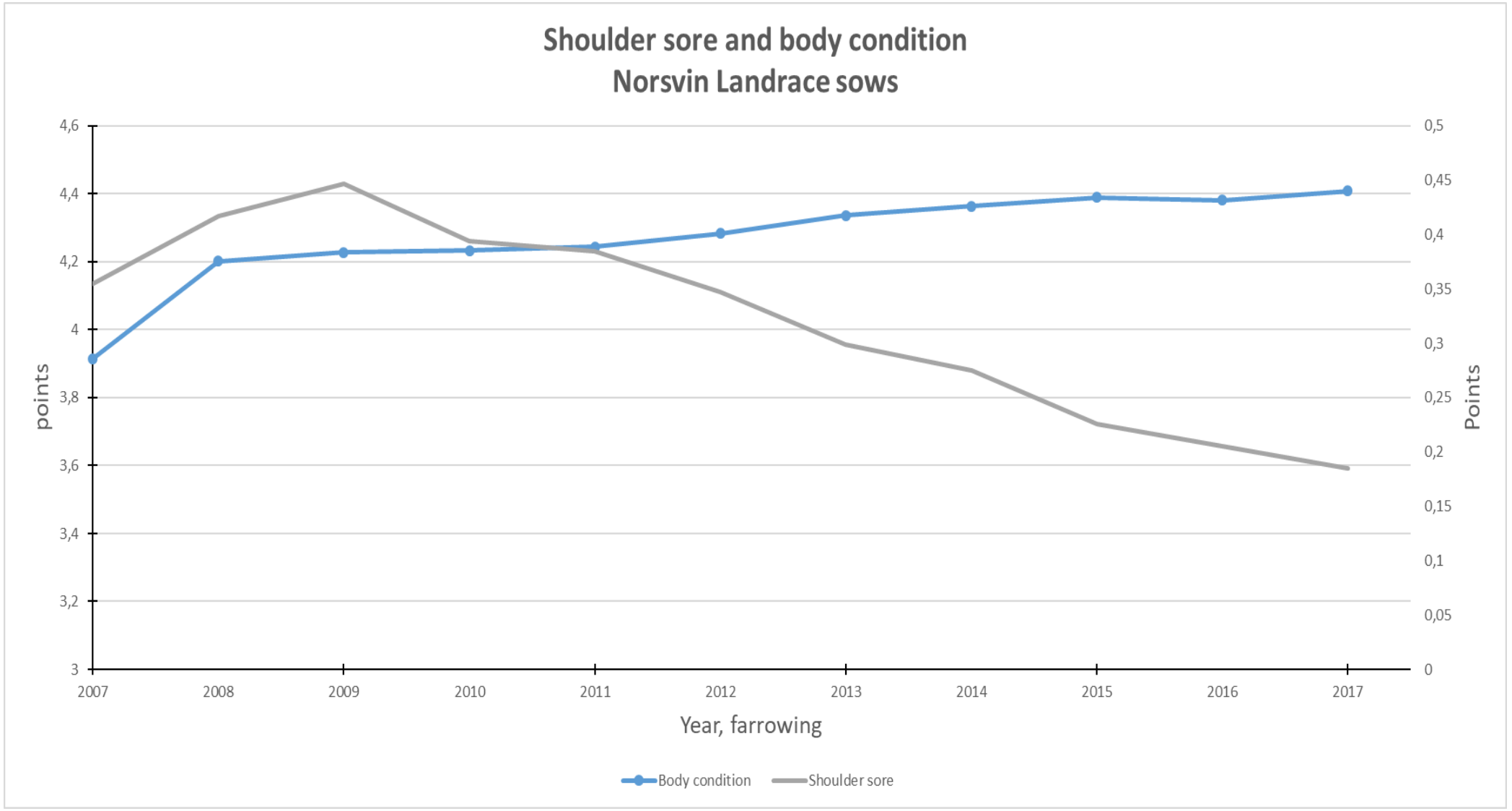
Phenotypic trends in the different traits; A1, A2 and A3, plus number of weaned piglets



Phenotypic trends in the different traits; B1 and B2



Phenotypic trends in the different traits; C and D



The variables utilized in the analysis

Variable	Description
Individ	Random effect, individual, utilised twice – once as animal effect and once as a permanent environment effect
Kull	Random effect, litter
M_kullnr	Fixed effect, litter number of mother
Kullnr	Fixed effect, litter number of offspring
Hy	Fixed effect, herd + year
Ses	Fixed effect, season
Raseaar	Fixed effect, breed + year (breed of piglets)
Veide	Fixed effect, number of weighed piglets (weighed between 17-25 days of age)
Avv	Fixed effect, weaning
Veide_b	Fixed effect, number weighed piglets regardless of age
Alderk	Fixed regression, age of litter
Alderk2	Fixed regression, age of litter^2
Alderm	Fixed regression, age of mother
Alderm2	Fixed regression, age of mother
Aldera	Fixed regression, age at weaning
Aldera2	Fixed regression, age at weaning^2

The different fixed effects that are included in the model for each trait

	Litter no. mother	Litter no.	Herd/year	Season	Breed/year	Weighed	Weighed_b	Weaning	Age weaning	Age weaning^2	Age_m	Age_m^2
Total born	X	X	X	X	X						X	X
Still born	X	X	X	X	X						X	X
Mort 3w	X	X	X	X	X						X	X
Weight 3w	X	X	X	X	X	X					X	X
Var 3w	X	X	X	X	X		X				X	X
BCS	X	X	X	X	X			X	X	X	X	X
SS	X	X	X	X	X			X	X	X	X	X

Heritabilities for the traits studied, and used in the breeding value estimations

Trait	h^2
Total born	0.09
Stillborn	0.07
Mortality at 3 weeks	0.06
Weight at 3 weeks	0.14
Variance in weight at 3 weeks	0.07* Not included in breeding goal
Shoulder sore	0.14
Body cond. score	0.13

The genetic correlations between the seven maternal traits

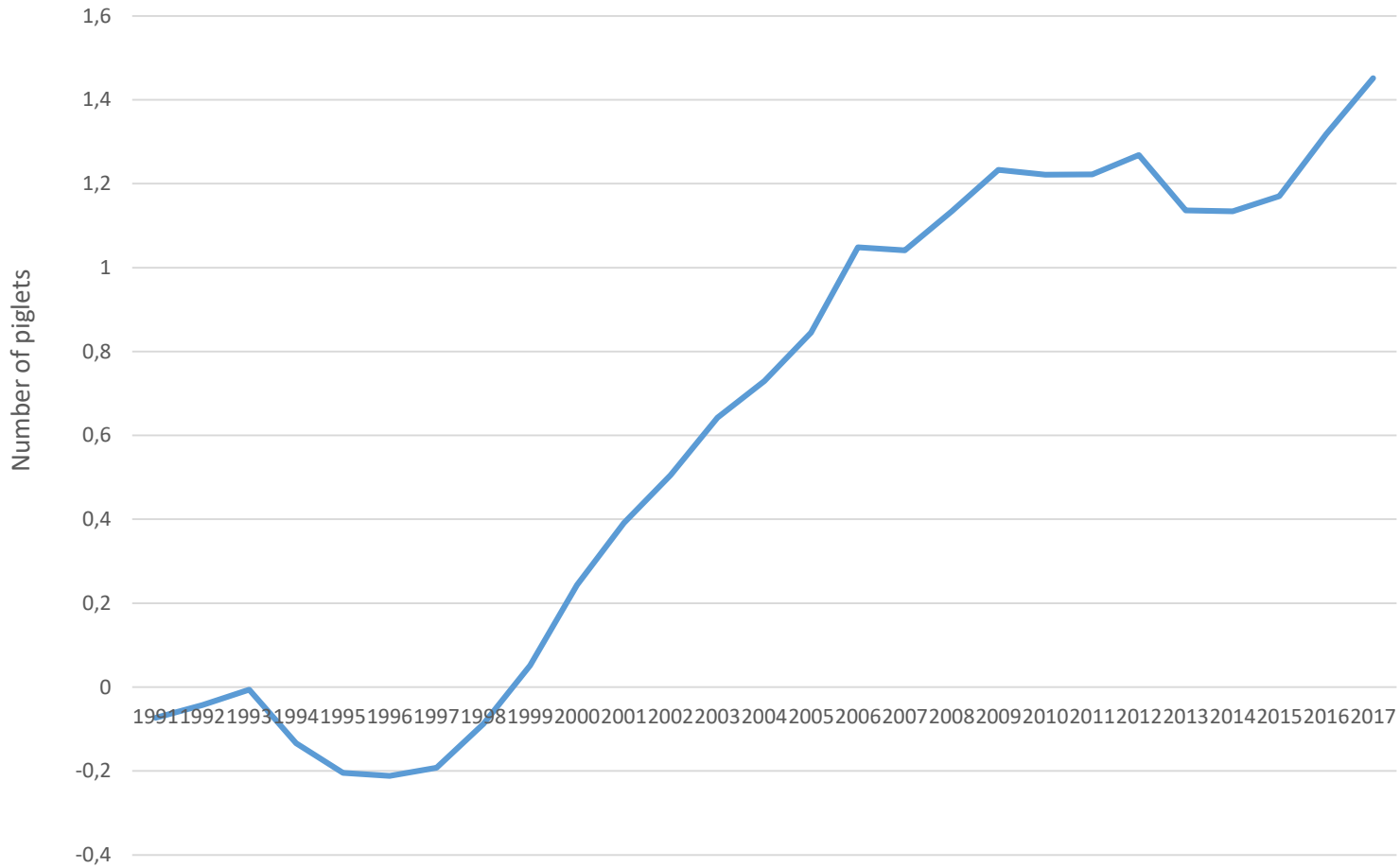
	Total born	Still born	Mort 3w	Weight 3w	Var 3w	SS	BCS
Totalborn	1						
Stillborn	0.46	1					
Mort3w	0.66	0.26	1				
Weight3w	-0.34	-0.004	-0.48	1			
Var3w	0.06	0.30	0.12	0.48	1		
SS	-0.05	0.22	-0.03	0.04	0.18	1	
BCS	-0.17	-0.24	0.06	-0.25	-0.26	-0.58	1

Genetic parameters

- **Genetic parameters were estimated by DMU**
- **The heritabilities varied from 6 to 14 percent, highest for weights, shoulder sore and body condition score.**
- **The genetic correlations were from zero to moderate high. The highest unwanted was between total born and mortality to 3 weeks (0.66) and the highest wanted between shoulder sore and body condition score (-0.58).**
- **A high body condition score is advanteousy for low no stillborn and for a low variance at 3 weeks, but disadvanteous for litter size and weights at 3 weeks**

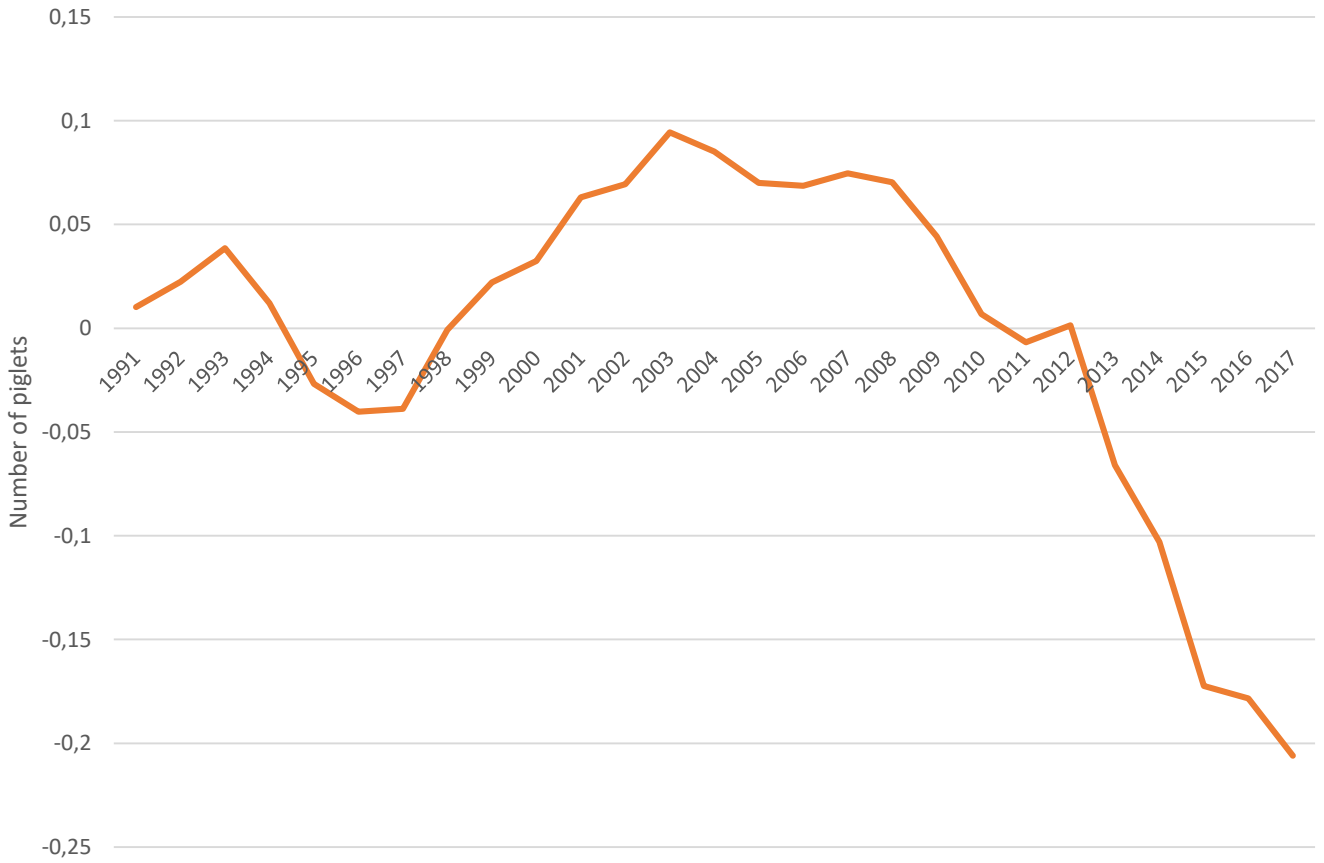
Genetic changes in the trait A1. Total born.

Litter size, total born



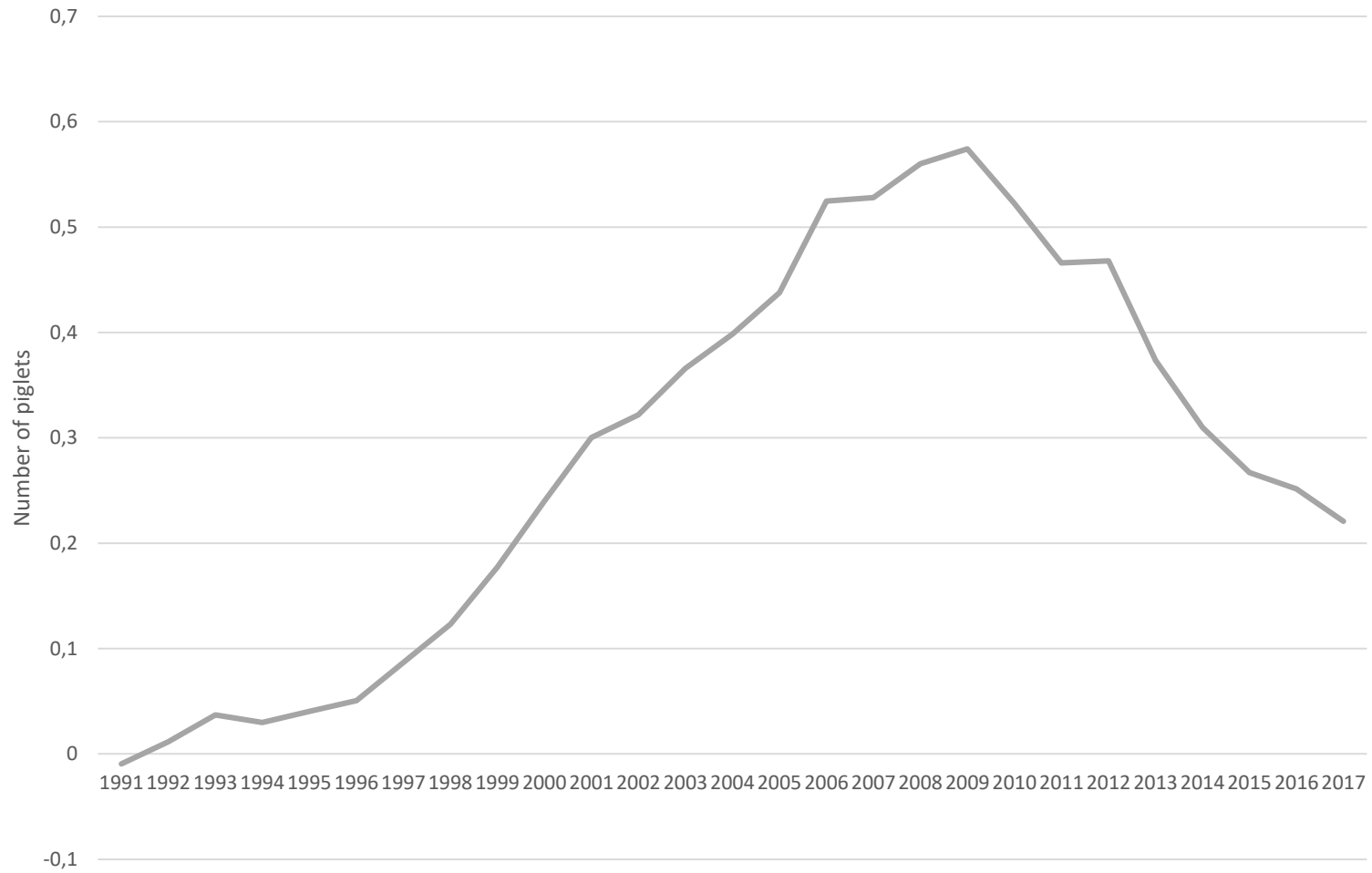
Genetic changes in A2. No stillborn piglets

No. stillborn piglets



Genetic changes in the trait A3. Mortality to 3 weeks

Mortality to 3 weeks

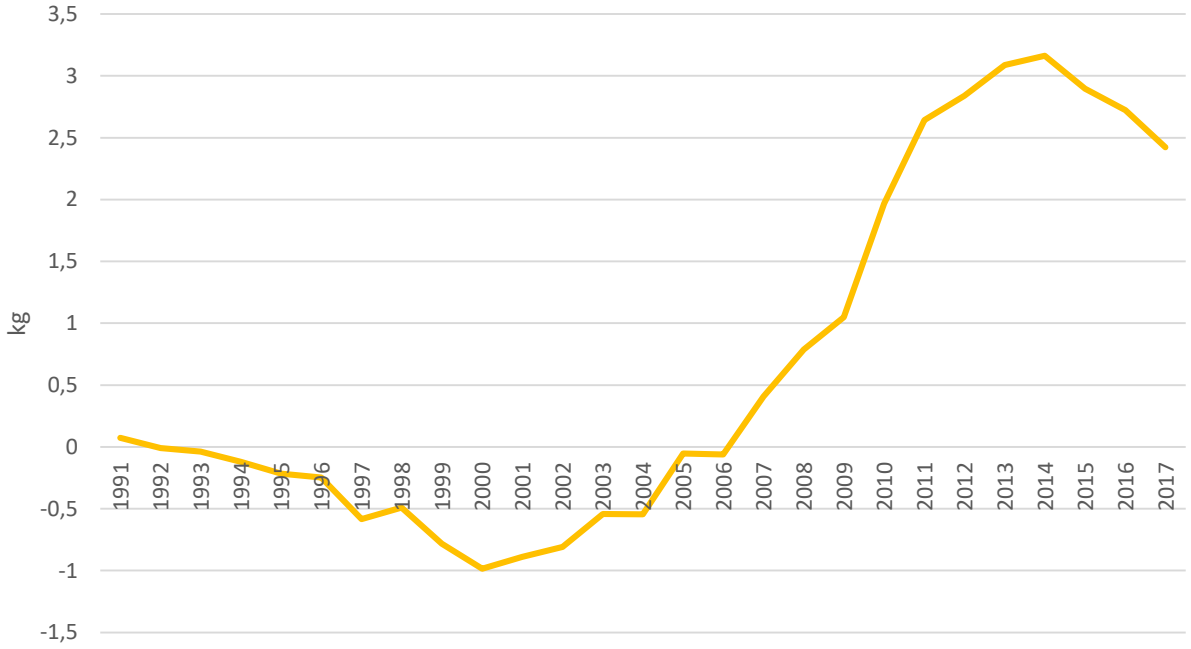


Genetic changes in litter size and mortality (total born, stillborn, mortality to 3 weeks)

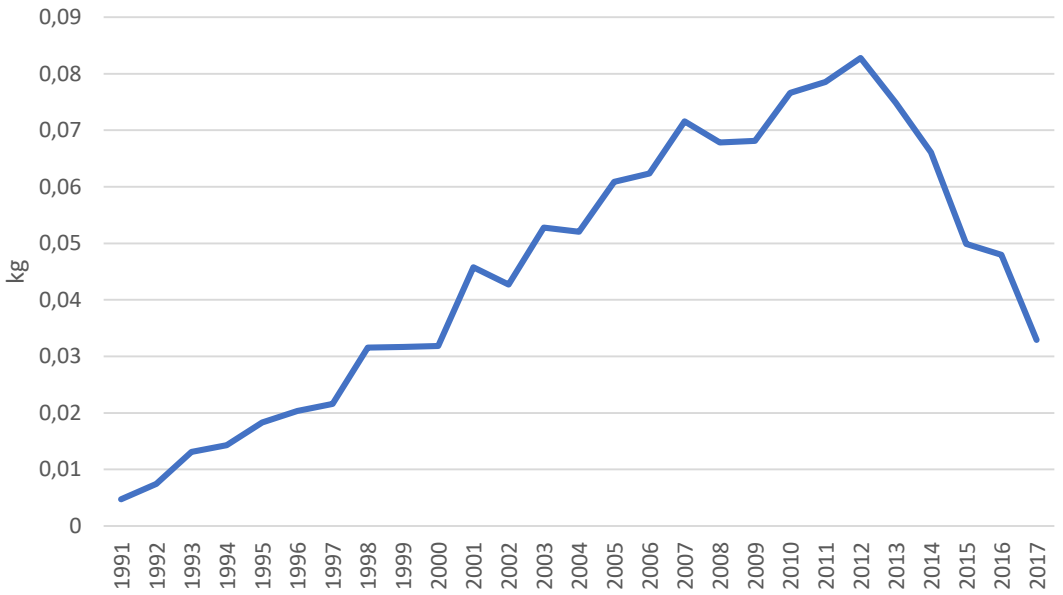
- **No genetic changes in litter size though the years 1993-1996. When increasing the economic weighting , the response increased to 0.12 piglets/year until 2009.**
- **For some years thereafter there were no genetic development, as mortality was included in 2007 and slowed the progress in litter size.**
- **However, the last years the response is back to its earlier increase. These changes has to be seen in view of the introduction shoulder score and body condition score from 2010, traits that improved the health and maternal potential of sows.**
- **It is also shown that no. stillborn was increasing as long as breeding goal was only total born, while since it was introduced in the breeding goal, it has been reduced with between 0.01 and 0.04 piglets per year.**
- **Mortality increased with increase in litter size until 2009 with 0.04 piglets/year. From 2009 to 2017 mortality has dropped with 0.05 piglets/year, as a result of being included in the breeding goal from 2007.**

The genetic changes in the traits
B1. Litter weight and B2. Variance of litter weight at 3 weeks (kg)

B1.Litter weight



B2. Variance in litter weight

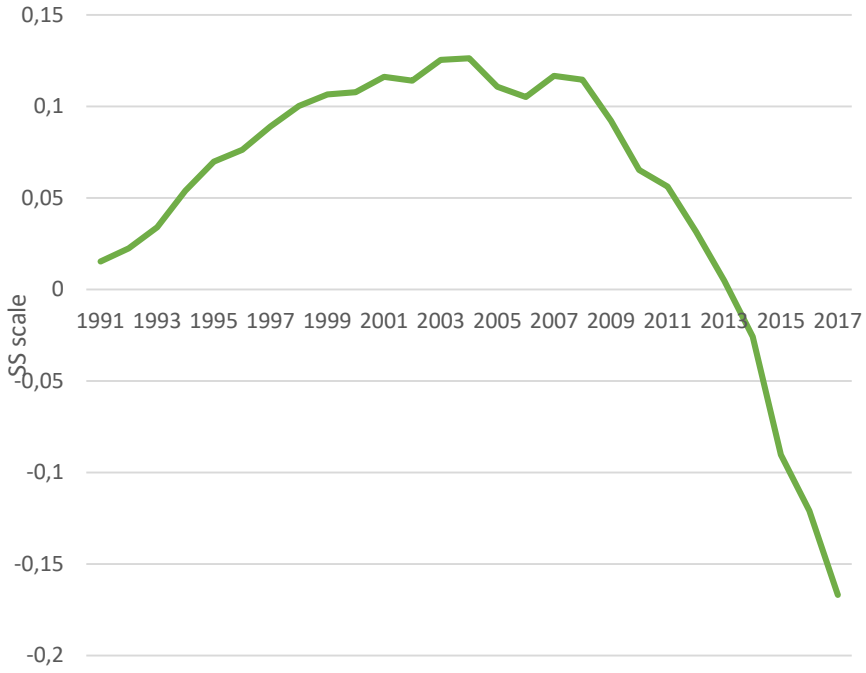


Genetic changes in weight at 3 weeks and variance of the same trait

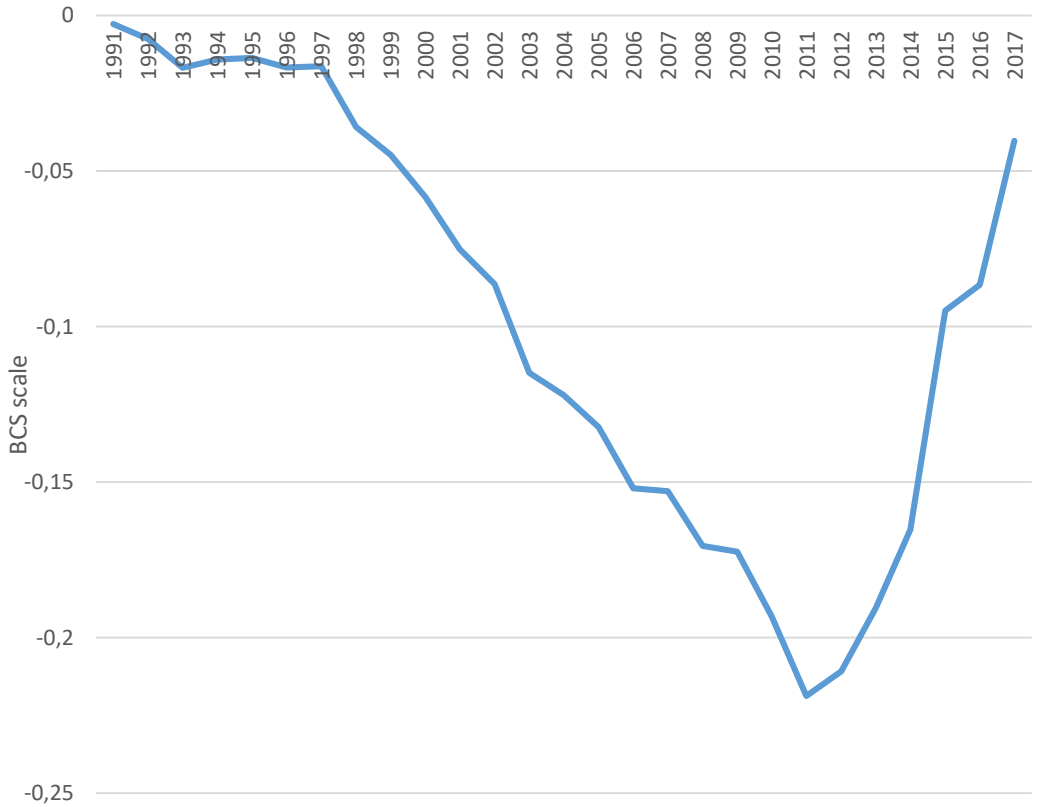
- **The weight at 3 weeks (sum of individual weight of piglets alive at 3 weeks) showed a slight decrease from 1991 to year 2000. Thereafter there was a high increase from 2000 to 2014 with from 0.19 to 0.44 kg per year. From 2014 there has been a decrease with around 0.24 kg per year.**
- **The inclusion of more maternal traits from 2010 is the main reason why the increase in litter weights have stopped and even decreased.**
- **The variance in litter weights at 3 weeks as increasing steadily to 2011. Even if never included in the breeding goal, the variation deceased steadily from 2012, due to the inclusion of the new maternal traits from 2010.**

Genetic changes in the traits
C. Shoulder sore and D. Body condition score

Shoulder sore



Body condition score

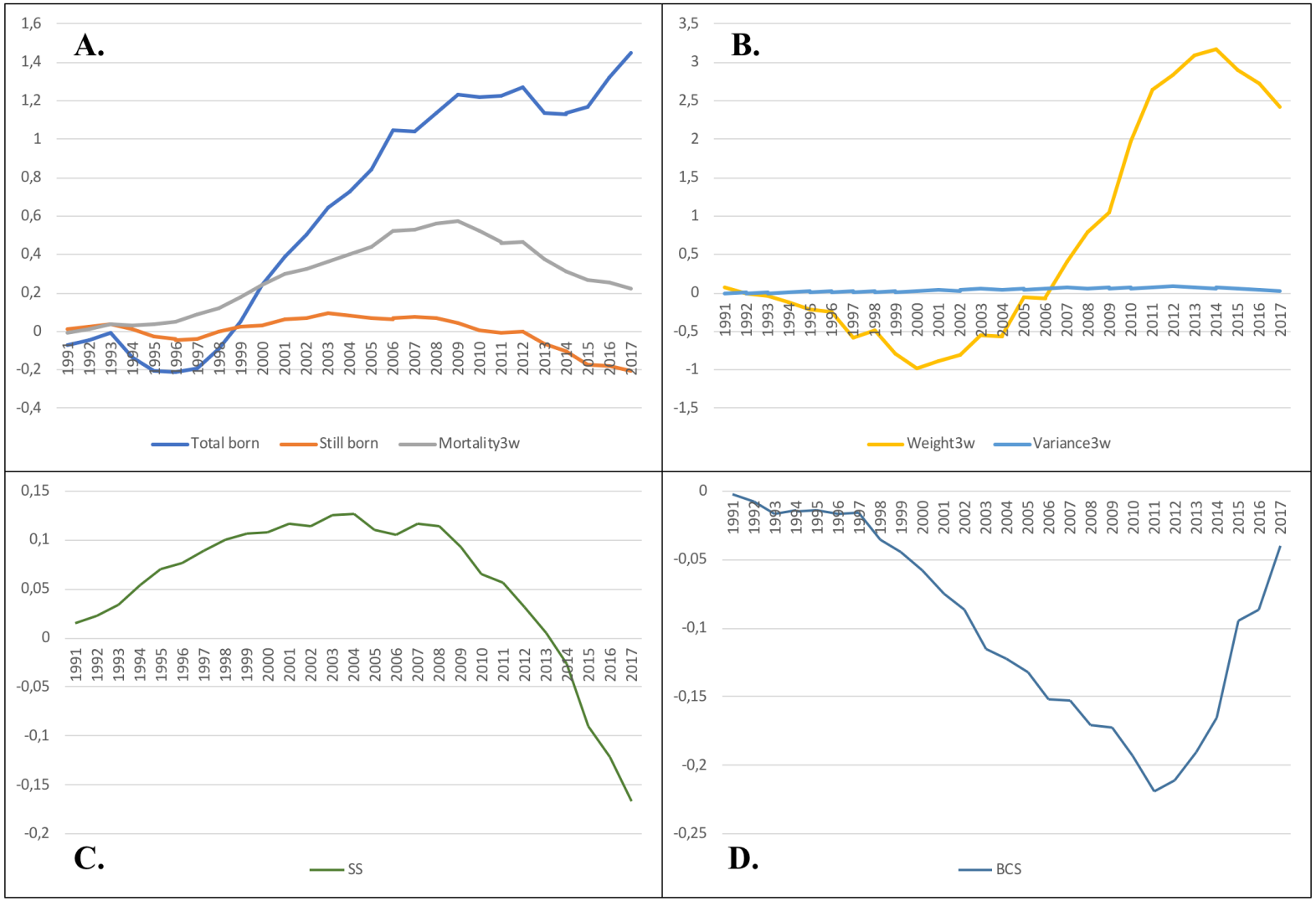


Genetic changes in shoulder sore and body condition score

- **The genetic change in shoulder sore showed increasing trends until around 2003, from when it started to decline. The last period 2011-2017 the decrease has been almost 0.04 score units per year.**
- **The genetic changes in body condition score show the same genetic developments as for shoulder sore (remember opposite development in values favourable); body condition score got worse during the period from 1991 til 2011, thereafter a more positive development (higher values). The last period 2011-2017 the increase has been around 0.03 score units per year.**

Comparing the genetic changes in the traits with the same units: A. Total born, stillborn and mortality at 3 weeks (number of piglets) B. Weight and variance at 3 weeks (kg) C. Shoulder sore (specified scale) D. Body condition score (specified scale)

SUMMARIZING:



Genetic changes in maternal traits

- **It is obvious that inclusion of more maternal traits than litter size has improved the sore situation in the sows. However the change in this type of trait cannot be seen independent from the general trend in breeding goal development; more emphasis on maternal traits in the breed, and less focus on growth, efficiency and leanness.**
- **It is obvious that inclusion of more maternal traits than litter size has improved other maternal ability and sow welfare traits. However the change in this type of trait cannot be seen independent from the general trend in the TOTAL BREEDING GOAL DEVELOPMENT; more emphasis on maternal traits in the breed, and less focus on growth, efficiency and leanness.**

CONCLUSIONS

- **The genetic improvements in total born piglets has been positive in the whole period, however increased over time**
- **The correlated responses in the other maternal traits were negative(unwanted) until shoulder sore(SS) and body condition score (BCS) were included in the breeding objectives. Then these traits showed a positive (wanted) genetic change. It even gave less genetic variation in 3 week weights.**
- **The detailed results in all traits showed that it is possible to obtain sustainable developments in all these low heritable traits related to fertility and mothering ability, if there are reliable records available and the traits are given relevant economic weighting in he breeding goal.**
- **However, there must be a willingness to invest in recording of relevant phenotypes, even if costly, in order to breed more biologically balanced sows for the future.**

"I AM THE FUTURE"

THANK YOU FOR YOUR ATTENTION