No signs of decline in genetic variation in racing performance traits in Swedish standardbred

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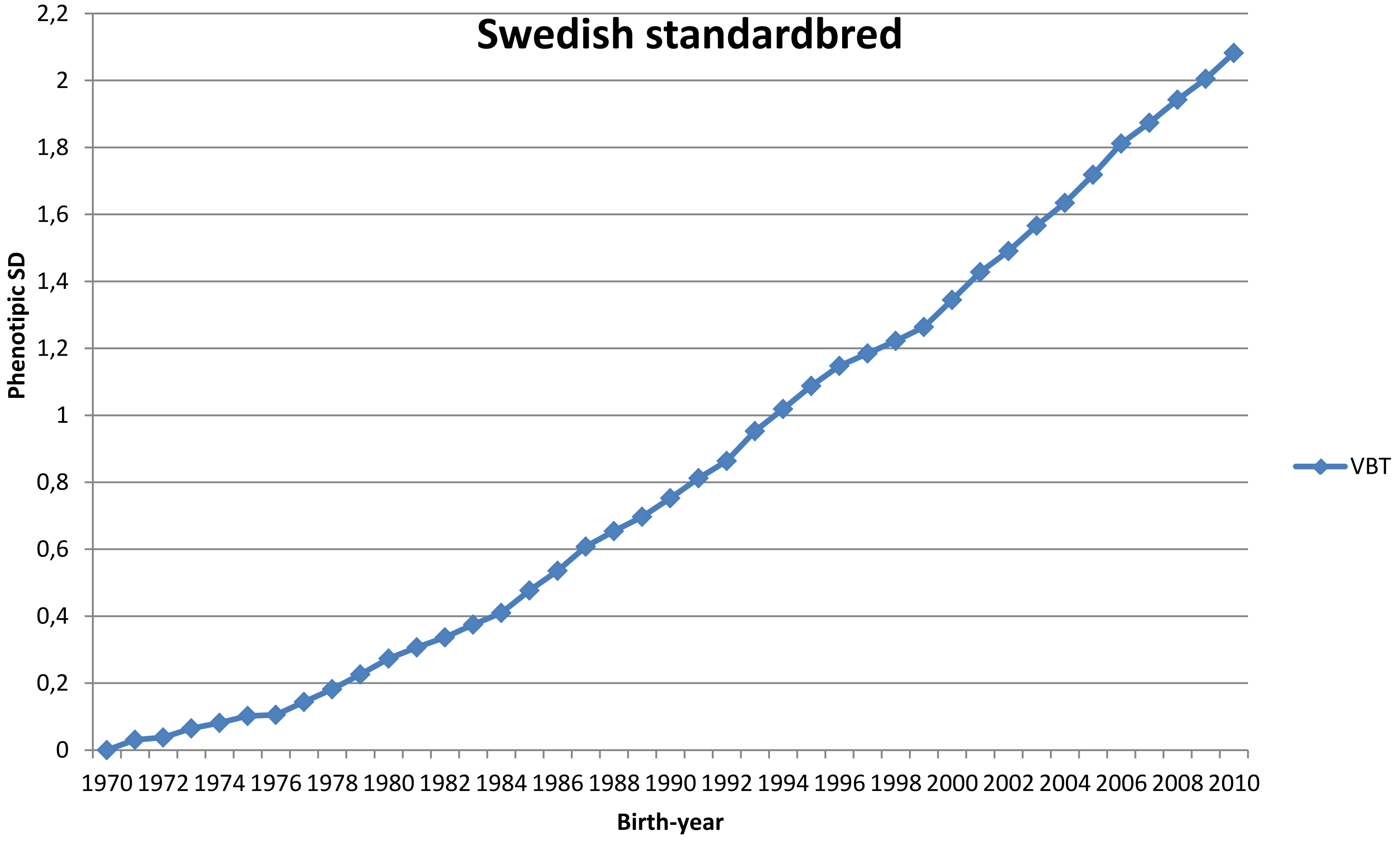
Background

- **Breeding Goal:** *fast, sound, sustainable, well tempered trotter of international standard with regular gaits and strong ability to win races*
- **Gene pool:** 94% American Standardbred, 6% French trotter
- **EBVs:** SireM-BLUP 1984-1991, AM-BLUP since 1992

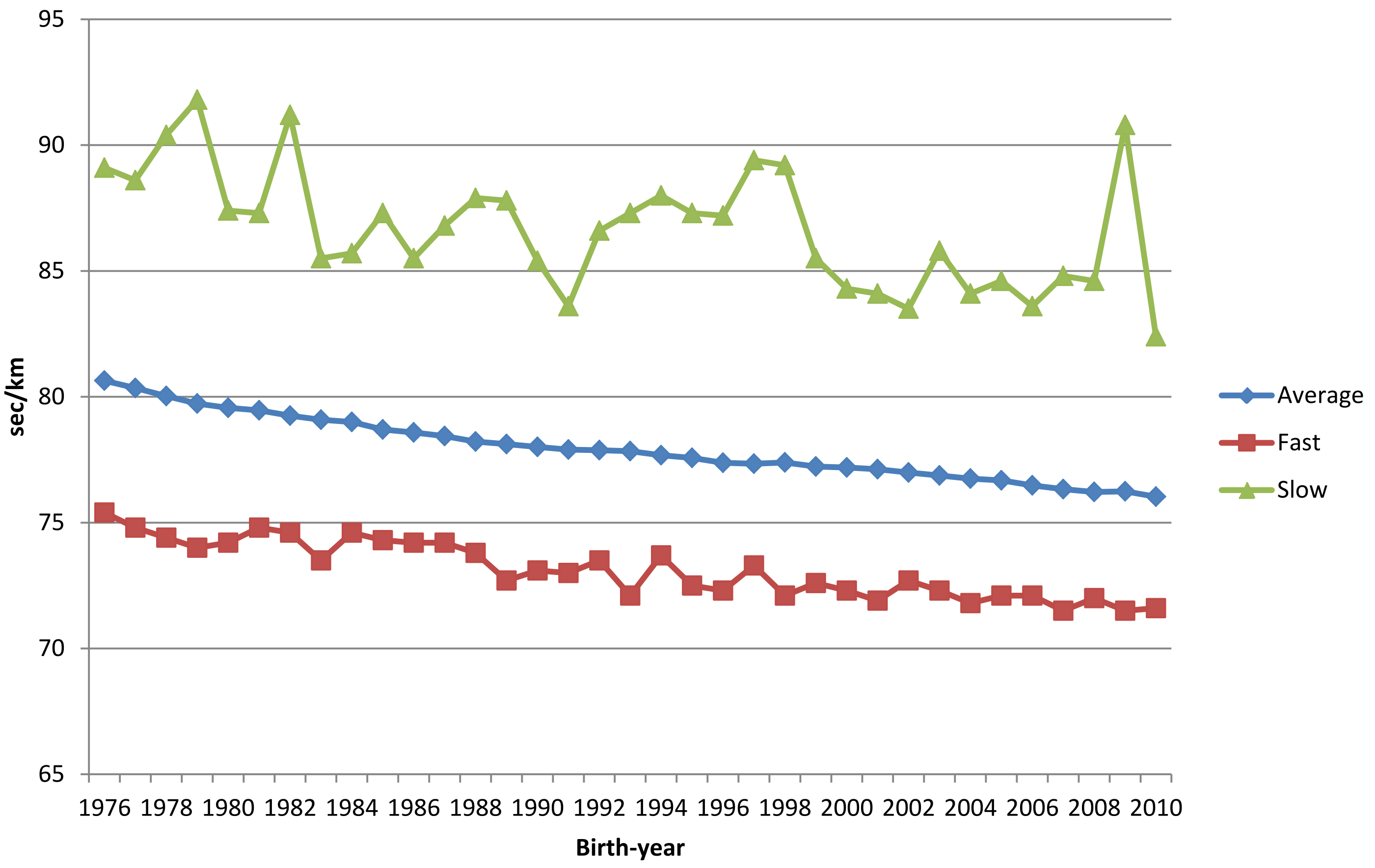
Racing performance traits

- **Accumulated 2-5 year-old-results (transformed):**
- Ln(Earnings + 1000 SEK)
- Ln((Earnings + 1000 SEK)/(number of races))
- Ln(Best racing time(sec/km) – 68.2)

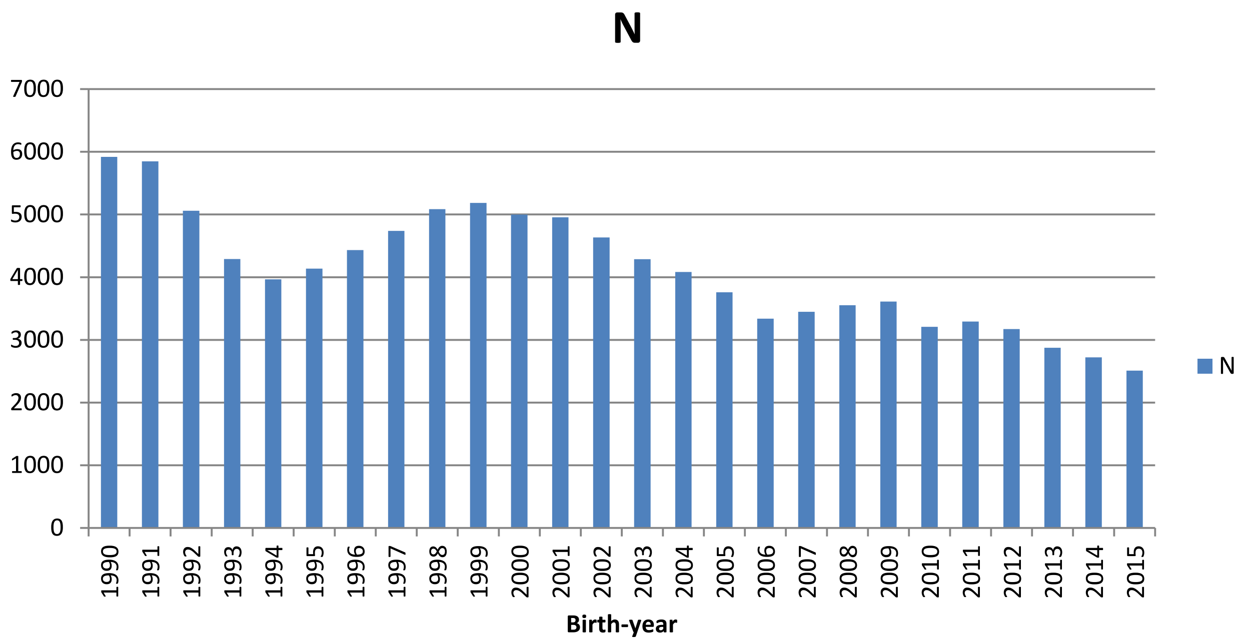
Genetic progress in racing performance



Trend in racing times (males)



Actual population size (foals registered)



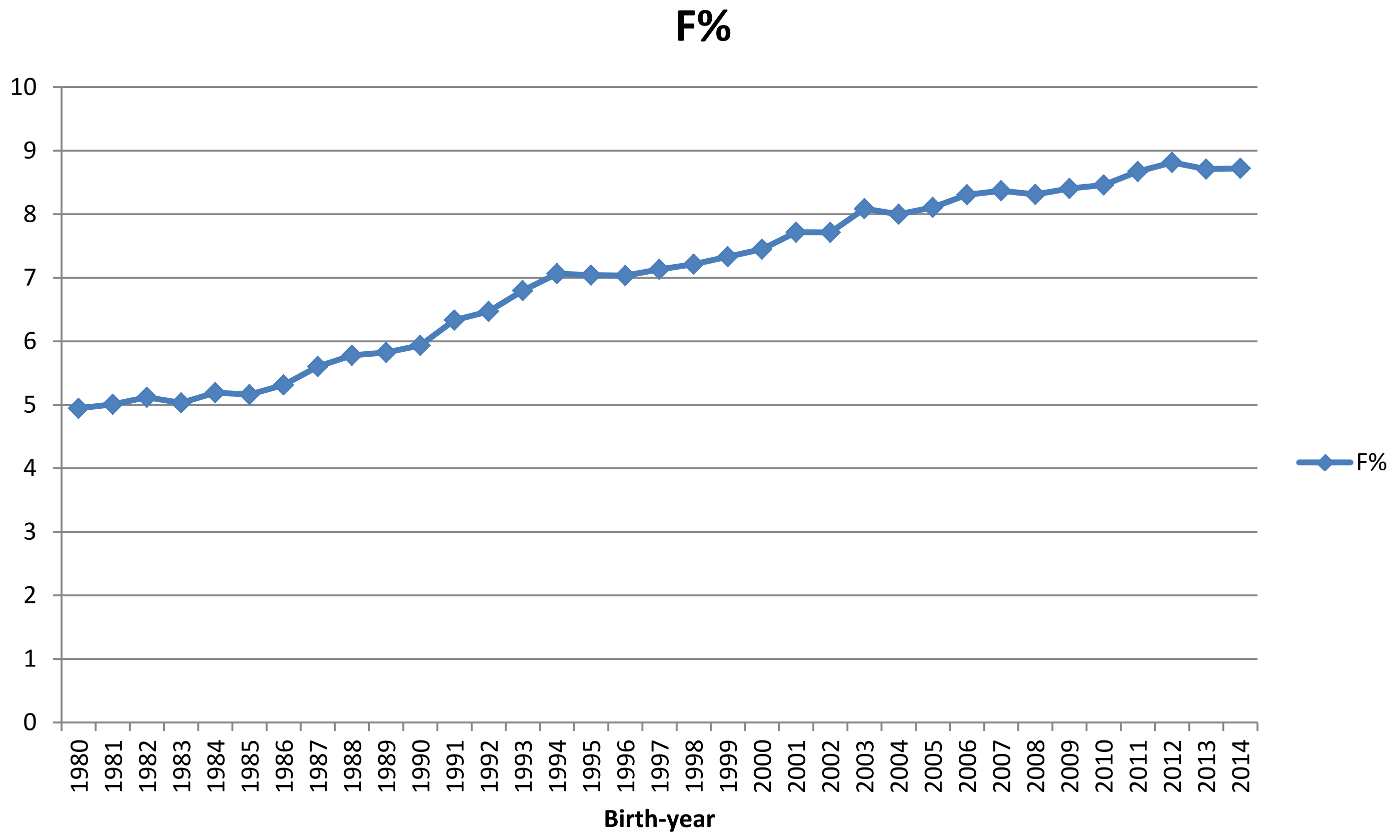
Paternal and maternal linage

Paternal linage founders of the current generation (2000-2009) :

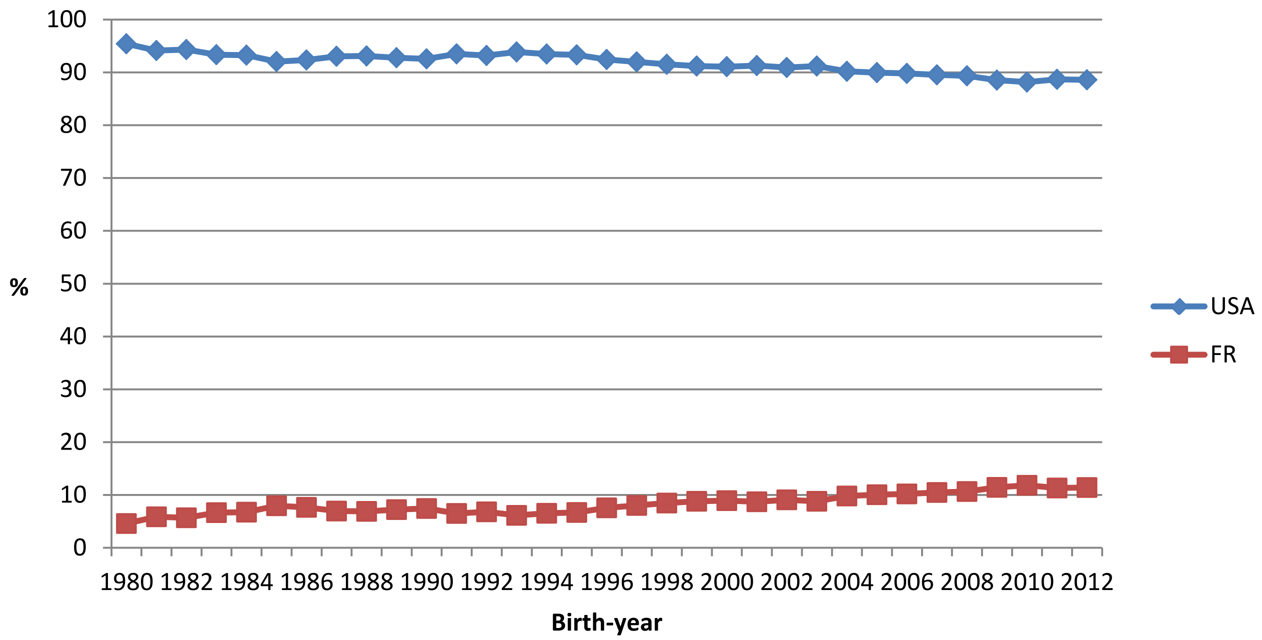
Stallion	Country	Birth-year	%
Happy Medium	USA	1863	92,5
Fuschia	France	1883	1,8
Axtell	USA	1886	1,7
McKinney	USA	1887	1,2
Beaumanour	France	1901	2,8

Maternal linage founders of the current generation (2000-2009) :
781 maternal lines in total; 495 maternal lines with ≥ 5 direct decendants in the current generation; 87 maternal lines with ≥ 100 direct decendants in the current generation

Inbreeding


F%
10
9
8
7
6
5
4
3
2
1
0
1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Birth-year
F%

Influence of French genes



Effect of inbreeding and genetic progress in racing performance

- Rate of inbreeding: $\Delta F=0.0132 \approx 1,3\%$ *per* generation
- **N_e = 35-40 animals**
- Inbreeding depression : ca 0,5% of σ_P/yr
- Genetic progress: ca 7% of σ_P/yr
- -> **Adjusted genetic progress: 6,5% of σ_P/yr**
- **Has genetic variance reduced over time?**

Material

Time period	No records (FR>0 excluded)	Pedigree file (5 generations)	Base average
A. 1978-1990	33,099 (24,233)	54,467	1932.6
B. 1991-2000	28,753 (17,879)	54,919	1942.8
C. 2001-2009	21,994 (10,818)	47,822	1953.8

Time period	No records	Pedigree file (2 generations)	Base average
A. 1978-1990	33,099	44,348	1970.9
B. 1991-2000	28,753	41,368	1982.4
C. 2001-2009	21,994	33,027	1992.1

Methods

- AI-REML, DMU
- Model: y = sex/birth-year (fixed) + animal + e
- Single trait analysis
- Sire model tested
- Inclusion of maternal linage (fixed or random effect) in the animal model was tested

Results (AM 5 generations traced, (FR>0 excluded))

Trait	Period	h^2	Var(A)	Var(P)
Earnings	A	**0.34 (0.35)**	**0.7888 (0.7756)**	2.2896 (2.2240)
	B	0.37 (0.37)	0.9796 (0.9402)	2.6590 (2.5476)
	C	**0.37 (0.38)**	**0.9782 (0.9729)**	2.6577 (2.5776)
Earnings per race	A	**0.46 (0.46)**	**0.3737 (0.3543)**	0.8118 (0.7773)
	B	0.46 (0.47)	0.4851 (0.4703)	1.0453 (0.9902)
	C	**0.48 (0.50)**	**0.5123 (0.5247)**	1.0761 (1.0446)
Racing time	A	**0.30 (0.30)**	**0.0110 (0.0110)**	0.0368 (0.0363)
	B	0.34 (0.35)	0.0129 (0.0129)	0.0381 (0.0369)
	C	**0.34 (0.35)**	**0.0161 (0.0163)**	0.0479 (0.0472)

Results (AM 2 generations traced)

Trait	Period	h^2	Var(A)	Var(P)
Earnings	A	**0.33**	**0.7411**	2.2486
	B	0.36	0.9440	2.6177
	C	**0.35**	**0.9148**	2.5962
Earnings per race	A	**0.44**	**0.3474**	0.7905
	B	0.45	0.4632	1.0227
	C	**0.45**	**0.4692**	1.0399
Racing time	A	**0.29**	**0.0101**	0.0362
	B	0.33	0.0125	0.0375
	C	**0.32**	**0.0151**	0.0469

Results (Sire model)

Trait	Period	t	Var(S)	Var(P)
Earnings	A	**0.132**	**0.3115**	2.3642
	B	0.120	0.3222	2.6740
	C	**0.122**	**0.3180**	2.6169
Earnings per race	A	**0.192**	**0.1649**	0.8580
	B	0.160	0.1680	1.0507
	C	**0.163**	**0.1716**	1.0506
Racing time	A	**0.129**	**0.0050**	0.0385
	B	0.110	0.0042	0.0382
	C	**0.105**	**0.0050**	0.0480

Conclusions

- No decline in h^2 or in genetic variance observed over time
- Estimated heritability of racing performance traits in Swedish standardbred trotters is high (0.3 to 0.48). I.e. 30-50% of the phenotypic variation is controlled by nuclear DNA!
- Inclusion of maternal linage analyses indicated that variation in mitochondrial DNA contributed very little (0 to 0.5% of σ^2_P) to the variance in racing performance in Swedish standardbred

Implications and questions

- Creation of new genetic variation in the racing performance traits seems to balance loss due to inbreeding!
- Migration – DMRT3?
- Is there a critical actual population size?
- ”Steady state” and Bulmer effect?

Acknowledgements

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