Inbreeding in the Golden Retriever

Jack J. Windig, Sabrina v.d. Kraats, Kor Oldenbroek

WUR, Livestock Research, Centre Genetic Resources The Netherlands (CGN)

WAGENINGEN UR
For quality of life

Inbreeding and genetic defects common in pedigreed dogs

- Dutch project (2011-2012)
- Two parts
  - Book and lectures to develop knowledge among breeders, kennel clubs etc.
  - Software for monitoring and management of inbreeding and relatedness
- This talk: software put into practice for the Golden Retriever

“Traffic light” inbreeding rate

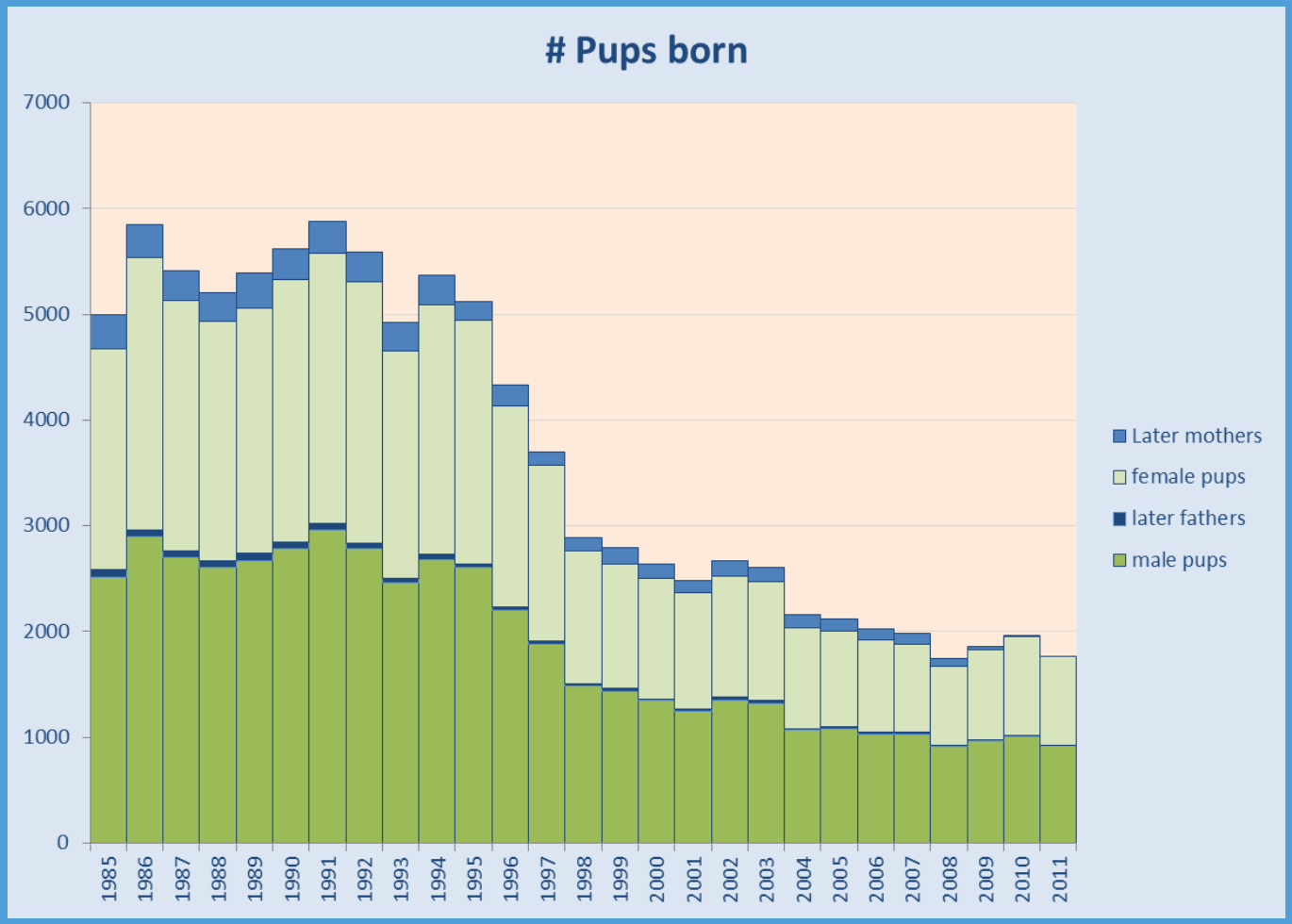
Inbreeding rate	Risk assesment	Effective population size
>1%	Extinction by accumulation of genetic defects possible	<50
0,5% - 1%	Genetic defects likely to occur	50-100
0,25% - 0,5%	Possibility of genetic defects	100-200
< 0,25%	Small chance on genetic defects	>200




Software for monitoring inbreeding in pedigreed dogs

- What is the population structure relevant for inbreeding
  - # of pups born per year
  - # of pups selected for breeding
  - # offspring per father/mother
    - Mean and Variation
  - Age of breeding animals
  - Etc.
- What is the inbreeding rate?

Population data: size population



- >5000 pups/year before 1996
- Around 2000 pups/year after 2004
- Small % of pups selected for breeding

Population parameters

Population size	1985-1994	2003-2012
Total # pups born / year	5436	2011
Pups later father	2.1%	2.0% (2003-2008)
Pups / father / life	66 (Max. 1335)	39 (Max. 93) (2002-2006)
Age fathers	4.2	4.6
ΔF	0.82%	0.27%

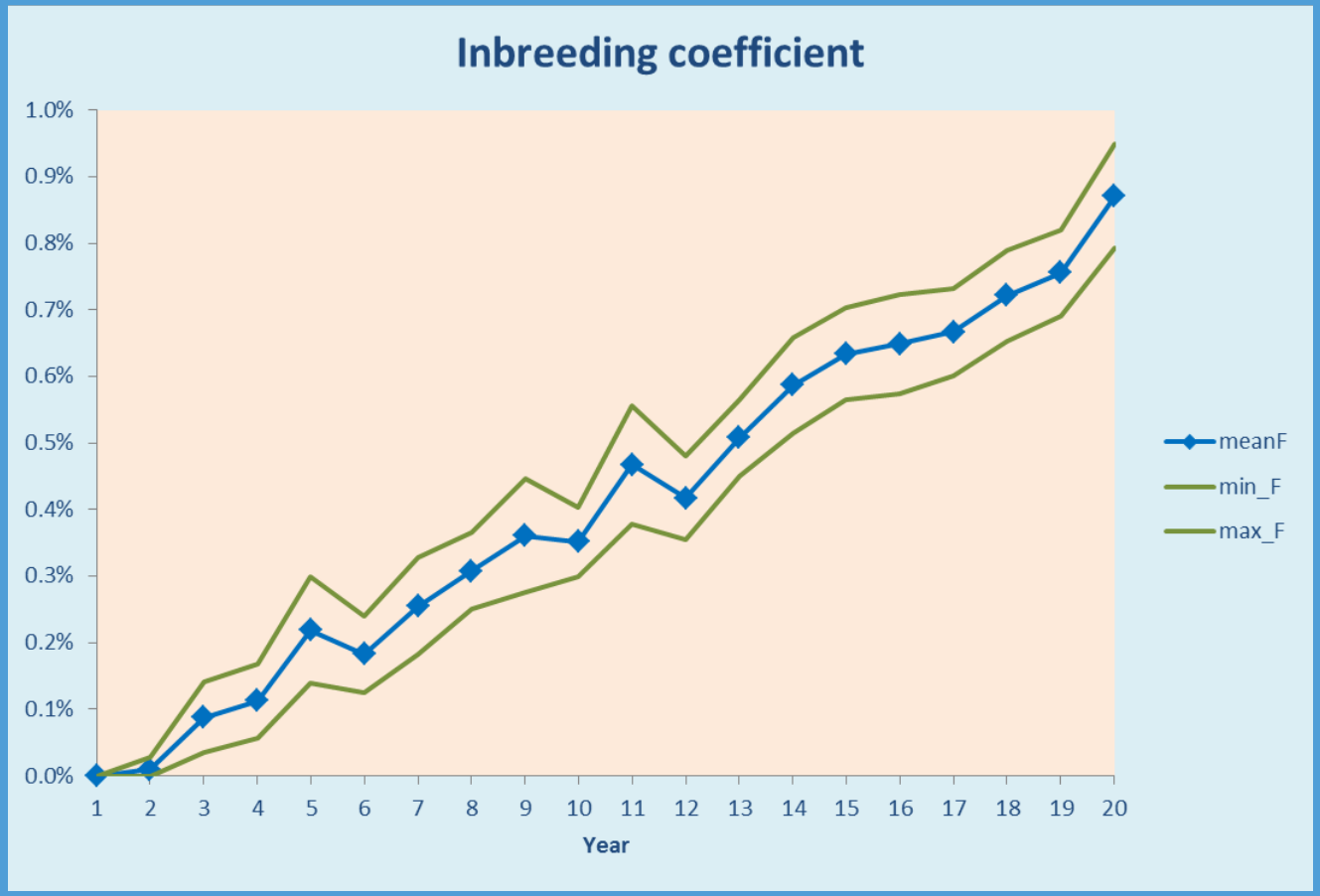
Managing inbreeding software program

- To decide on breeding policy you need to know what the effect is of different measures to control inbreeding
- Software simulates breed and estimates inbreeding in future generations
- User provides data on
  - Population structure
  - Biology
  - Breeding policy
  - Program estimates inbreeding rate

Standard population

- Based on 2005-2011 population
  - 150 breeding males; 600 breeding females
  - 300 nest per year, nest size 6.7 (2 – 13)
  - Age parents 4.5 years (1 – 12)
  - 5 ‘top’ dogs sire 75 nests
    - 50% of top dogs replaced by sons
  - No breeding restrictions
- Inbreeding / relatedness starts at 0
- Simulated for 20 years
- 10 replicates

Inbreeding standard population



- $\Delta F_{simulated} = 0.41\%$

Changing population structure

Population size	ΔF	Generation interval
Standard	0.41%	3.6
300 instead of 150 breeding males	0.39%	3.6
Top 5 sires 12.5% instead of 25%	0.26%	3.7

- Limiting contribution of top dogs more effective than increasing number of breeding males

Breeding restrictions

Restrictions	Per year		Per life	
	ΔF	Age	ΔF	Age
Standard no restrictions (up to 28 nests per father per year)	0.41%	3.6	0.41%	3.6
20 nests/father	0.45%	3.6		
10 nests/father	0.27%	3.8	0.42%	3.6
5 nests/father	0.18%	3.7	0.26%	2.6
2 nests/father	0.16%	3.8	0.13%	2.4
1 nest/father	0.19%	3.8	0.12%	2.5

- Restricting nests/father/year more effective

Restricting relatedness

- Between parents
  - Each breeding female is mated with the least related male in the population
  - Inbreeding in offspring is minimised
  - Already practised on a limited (?) scale in the breed
- Breed wide
  - For each animal the average relatedness with all other animals in the population is estimated
  - Animals with a higher than average relatedness with the rest of the breed are excluded from breeding

Restricting relatedness

Restrictions	Year 0-20		Year 50-70	
	ΔF	Age	ΔF	Age
Standard no restrictions	0.41%	3.6	0.40%	3.6
Minimise f Parents	0.04%	4.2	0.39%	4.6
Breed wide f above average excluded	0.12%	3.9	0.14%	3.8

- In the long run restricting breed wide relatedness more effective
  - Using a small number of (or a single) unrelated fathers decreases inbreeding of offspring, but increases their relatedness

Rate	2003-2012
ΔF	0.27%
Δf	0.41%

Conclusion

- History of strong inbreeding
- Limited number of pups selected for breeding
- Software helps to determine effective management of inbreeding
  - Breed restrictions per dog per year
  - Restricting breed wide relatedness