Demonstration of inbreeding control

Theo Meuwissen

Norwegian Univ. Life Sciences

Ås, Norway

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Introduction

- Why control of inbreeding (F)?
  - Control the loss of genetic variation
  - Loss of future selection opportunities
  - Control of inbreeding depression on functional traits
  - Towards: sustainable breeding schemes
- How: Optimal Contribution (OC) selection
  - Proven optimal
  - How much ΔG does it costs: none
    - can achieve >30% more gain at equal ΔF
  - Endangered breeds: essential to manage F

However, OC has still limited uptake:

- Technically complicated: need trained staff
- Results in fraction of matings per candidate
- Not well adapted to practical circumstances
  - Multi-tier selection
  - Multi-stage selection
  - Restrictions on number of matings: 0, 1, 2,..
  - How to control no. of matings at local farms?

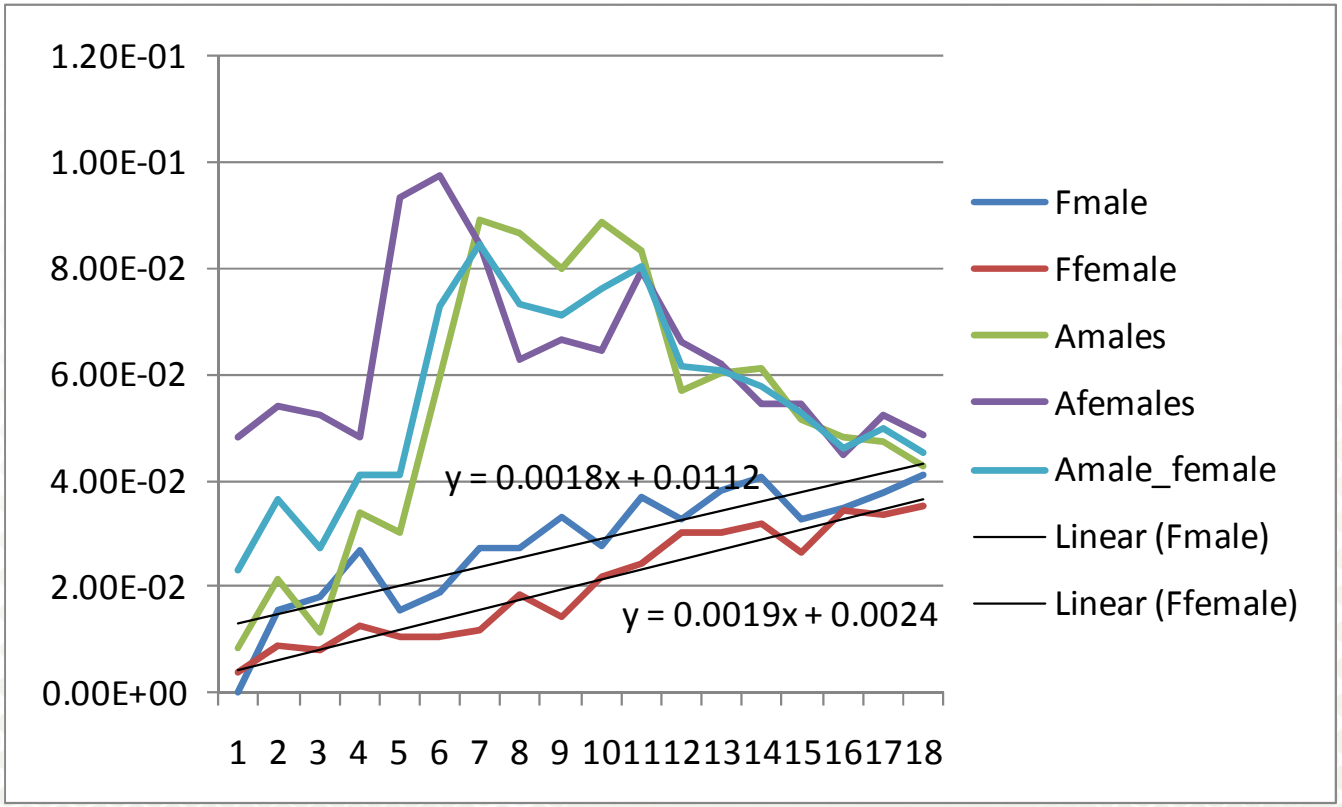
AIM:

- To demonstrate the use of OC in the practical case of Eastern Finn Cattle (EFC)
- EFC is endangered breed:
  - main aim: minimise ΔF
  - Also: maximise ΔG while controlling ΔF
- Using GENCONT software
  - Freely available: jack.windig@wur.nl

EFC data:

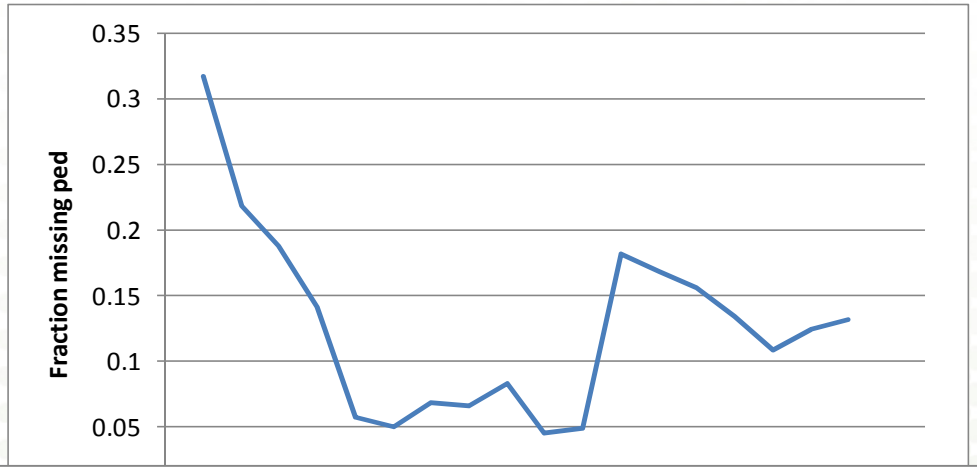
- Received from Asko Maki-Tanila
- 9913 animals in pedigree (back to 1940)
- 2575 animals were available for selection
- 2480 were younger than 14 yrs
  - Data set being used
- Current population size ~600 breeding cows
  - Need to select ~300 cows to breed replacements

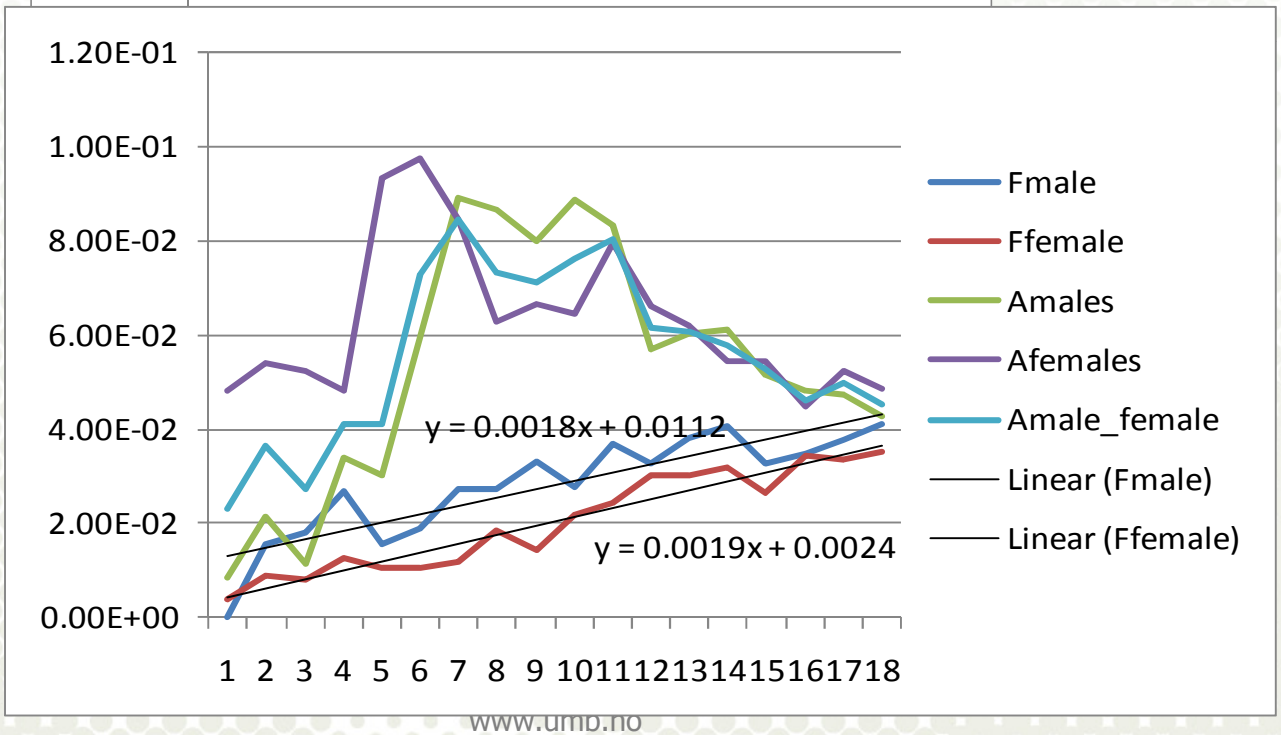
History: relationship and F of EFC



- ΔF=0.18%/yr

Missing pedigree





Missing Pedigree

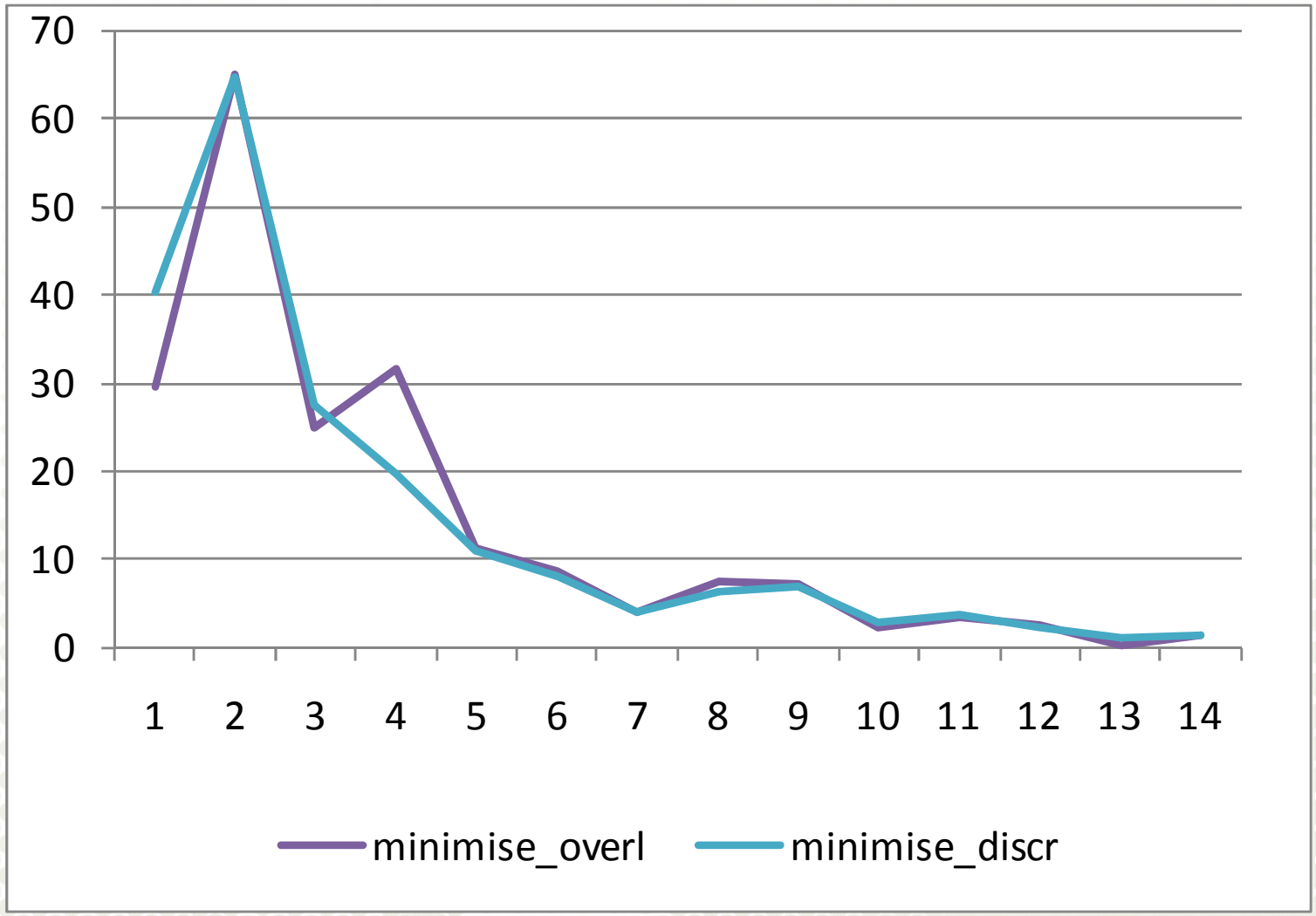
- Important to account for it:
  - Assume unknown parents are a sample from contempories
  - Instead of assuming they are unrelated founders
  - However: GENCONT assumes the latter

Minimisation of A (and F)

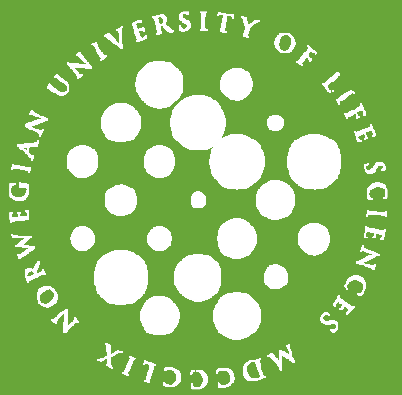
Generations:	discrete	overlapp
Average A (%)	1.2	1.8
Nsires	134	36
Ndams	300	300

- Average A:
  - Discrete: average relat. of newborns
  - Overlap: average relat. of 'breeding pop.' incl. newborns
- Discrete & overlap give different answers

Distrib. of contributions over age



Maximise ΔG whilst restricting ΔF



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Option in GENCONT 'constraint deltaF':

- Sets constraint_A = $\overline{A} + (2 - \overline{A})\Delta F \approx \overline{A} + 2\Delta F$
- ΔF = desired rate of inbreeding
- Gencont calculates $\overline{A}$ of candidates
  - Candidates often more related than population
  - Family structure often very uneven
    - $\overline{A}$ >> A_{min}
    - Here: $\overline{A}$ = 4.4% ; A_{min}= 1.8%

Solution : use 'constraint relationship'

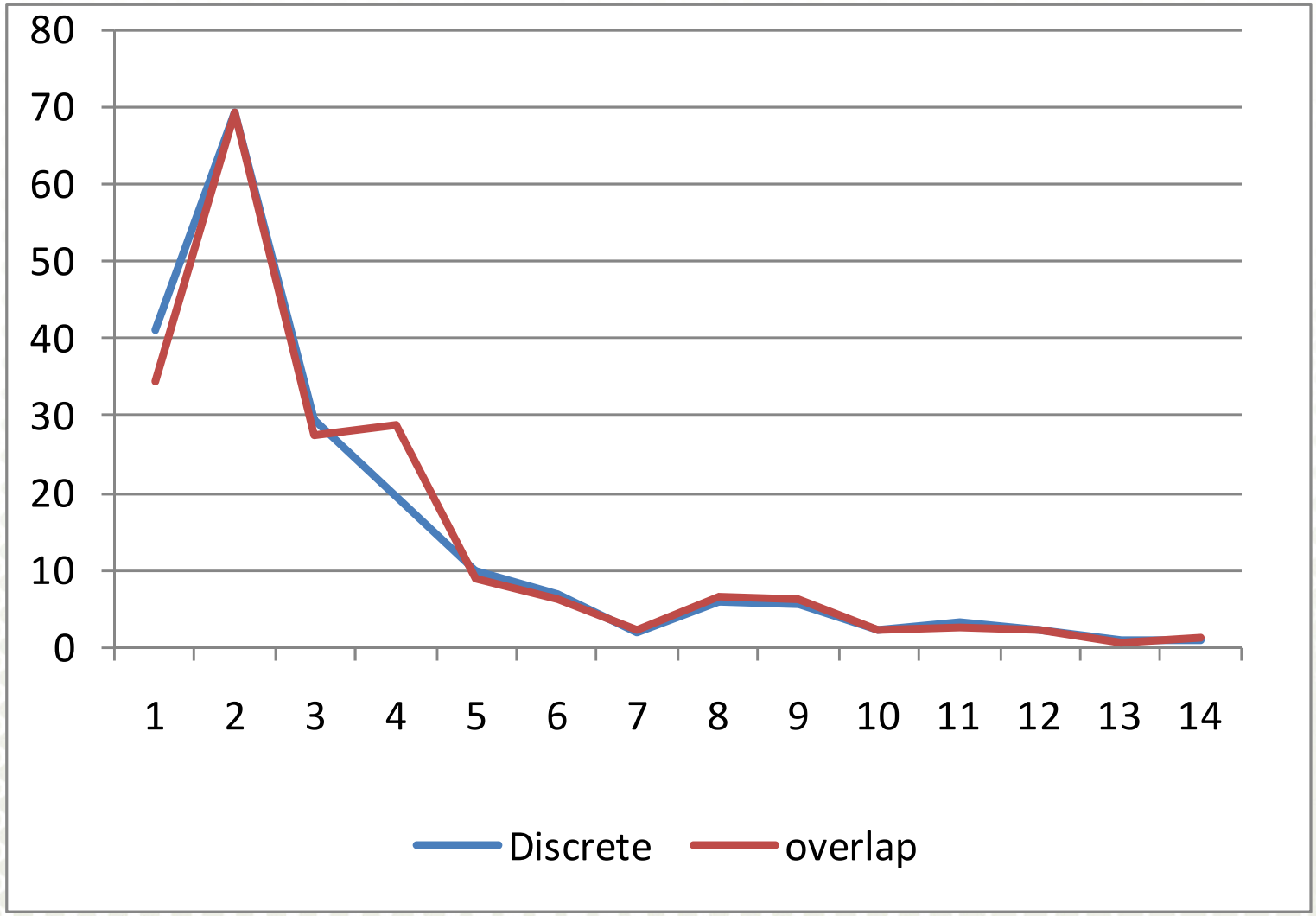
- Calculate minimum A using Gencont (1.8%)
- Set constraint to 0.0184+2*ΔF/L =2.12%
  - ΔF = 0.01 (desired rate of F per generation)
  - L = 7 years (generation interval)
- Note: in ongoing opt. contrib. selection:
  - the base A (1.8%) equals the constraint used in the previous year
  - Thus: chosing base A is only a startup problem

Results:

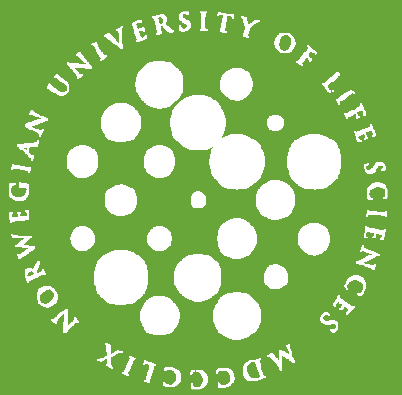
Generations:	discrete	overlapp
Average EBV	1.67	1.67
Average A (%)	1.2	1.8
Nsires	128	38
Ndams	300	300

- AverageA(solution) < constraint on A
  - Due to discrete number of dams required
- Solution is similar to minimise solution
  - Here: many EBV unknown & set to 0 (= popul. mean)

Distrib. of contributions over age



Set up semen bank



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Aim of semen bank

- Store a back-up population that conserves ancestral variation as much as possible
- In GENCONT language:
  - Consider only males as candidates
  - Minimise A of stored semen
  - Add to existing contributions of males to bank
    - Adapt current contribution to existing bank
  - No overlapping generations: set up one back-up population

Add/adapt to existing semen bank

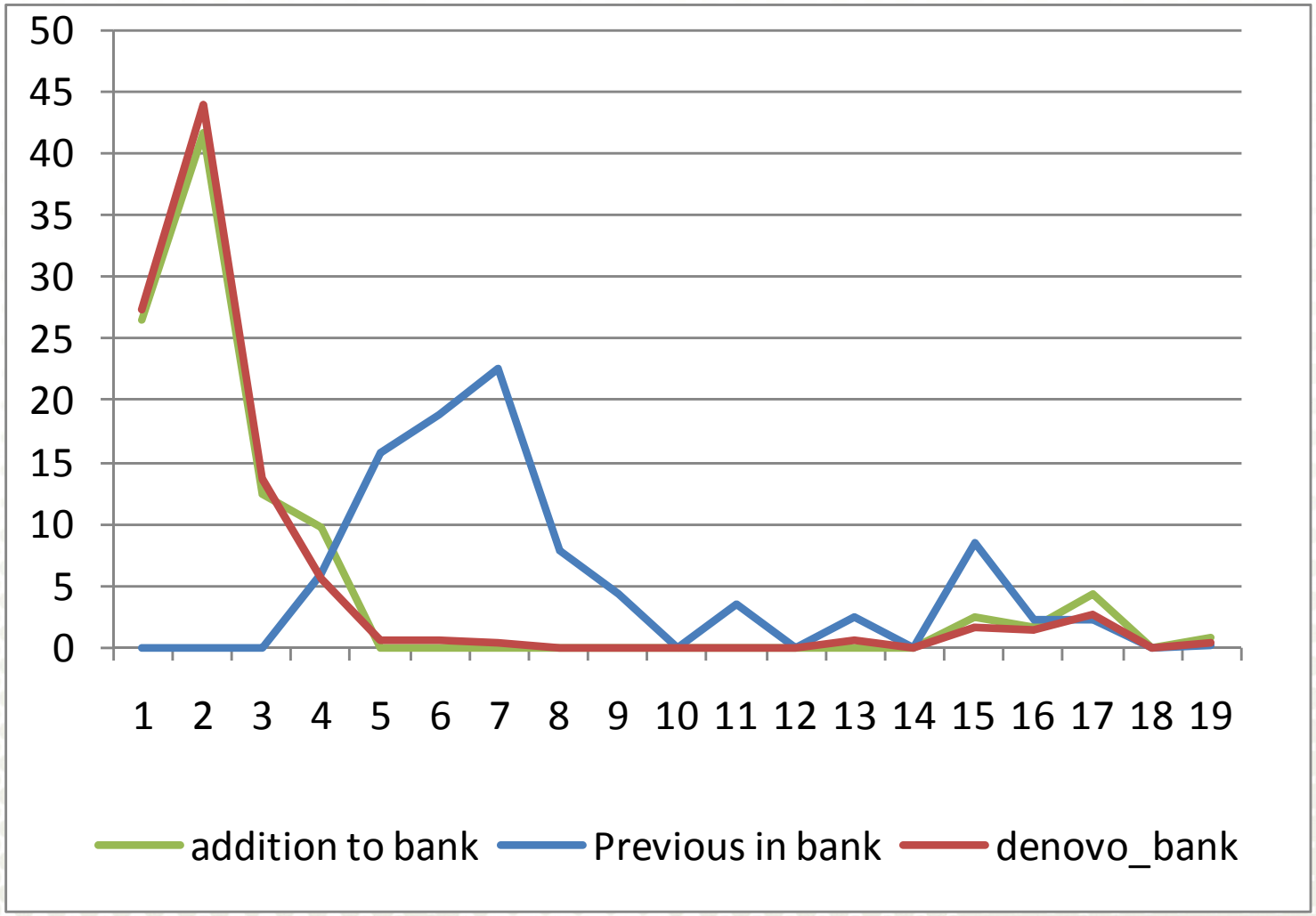
- Currently stored semen doses were provided by Asko
  - 61,654 straws
- Assumed that we want to add 38,346 straws
  - Total: 100,000 straws
  - So new contribution = 38 % of total bank
- Use 'Cprev' option in Gencont:
  - defines for every sire his previous contribution to the bank

Results

Set-up bank:	de-novo	add
Average A (%)	1.2	4.5
Nsires	255	74

- Although 'additional' contribution high (38%): averageA is much increased
- De-novo set up requires sampling of 3-4 times more bulls

Distrib. of contributions over age



Conclusions

- Gencont seemed able to optimise contrib's
  - Minimise ΔF
  - Maximise ΔG and constrain ΔF
  - Optim. contributions to (existing) gene bank
  - Given the imposed restrictions (select 300 dams)
  - missing pedigree: assumed unrelated founders
    - might have affected the results presented
  - Don't use 'constrain deltaF' – option
    - Directly set constrain on relationships

Conclusions (2)

- Have to account for overlap. generations:
  - Solutions differ
  - Overlap: somewhat longer generation interval
- Here: min. A and max. G solution similar
  - Probably due to many EBV=0
  - possible to find solutions with little ΔF and ΔG
- Setting up semen bank:
  - De-novo may give considerably lower relationsh.
  - Use of existing bank: considerably less sampling