Effect of the number of sibs measured in commercial conditions on the response to selection for body weight in turbot

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Background

Aquaculture production

- Has experienced exponential growth in recent decades, surpassing fishing in the supply of aquatic products
- **Turbot** is one of the most relevant species due to its commercial value

- Well-established selective breeding programs in turbot

Selection for body weight based on phenotypes of fish in the selection nucleus

BUT in terms of commercial performance, the focus should be on weight under production conditions (**commercial weight**, CW) rather than on weight in the nucleus (NW)

Background

Selection for weight in turbot

- Differences between nucleus and commercial environments

Genotype by environment interaction (G x E)

→ Ranking can differ between environments

- To effectively improve CW, EBVs for this trait for fish in the nucleus are needed

➡ Records of relatives (e.g. sibs) raised in commercial conditions

- As **CW** is measured in the relatives, **genomic selection** would be useful to exploit within-family component

Optimal no. sibs measured and genotyped is unknown

Objective

Determine the **optimal number** of **measured and genotyped sibs under commercial conditions** to ensure accurate estimates of breeding values for CW in the selection candidates of the nucleus

Using computer simulations

https://www.nuevapescanova.com/que-hacemos-3/cultivamos/

Material and Methods

- Genotypes for ~ 5,600 fish from real data from INSUIÑA

  → Low-density 5K SNP chip (Affymetrix)

- Turbot map: SNPs distributed 22 chromosomes

  Genome total size of ~600 Mb

- Mimic the linkage disequilibrium

Expanded population: ~ 22,400 simulated fish

Each replicate ↓ Random sample

200 fish (half of each sex) → Single pair matings

100 full-sib families

Base Population

Material and Methods

- Two traits simulated :
  - Body weight in the nucleus (**NW**)
  - Body weight in commercial conditions (**CW**)

➡ Controlled by the same 200 additive loci (QTLs)

QTLs sampled at random from the 5K SNPs

h^2 = 0.3 for both traits

ρ_g **= 0.5**

Material and Methods

Breeding programs simulated


100 ♀ x 
100 ♂

Single pair matings

100 full-sib families

Nucleus

20 sibs per family

Nucleus body weight (**NW**)

Commercial

0, 10, 20, 30, 40, 50 or 60 sibs per family

Commercial body weight (**CW**)

Selection candidates

200 (half of each sex)

Selected based on their (G)EBVs for CW

- All fish measured and genotyped
- All records used in the genetic evaluation
- 5 generations of selection

Material and Methods

Evaluation method

- **Genomic Evaluation (GBLUP)** → GEBVs
- **Standard BLUP** → EBVs

Phenotypes (**NW** or **CW**)
candidates and all relatives
from current and previous generations

Two-trait mixed model

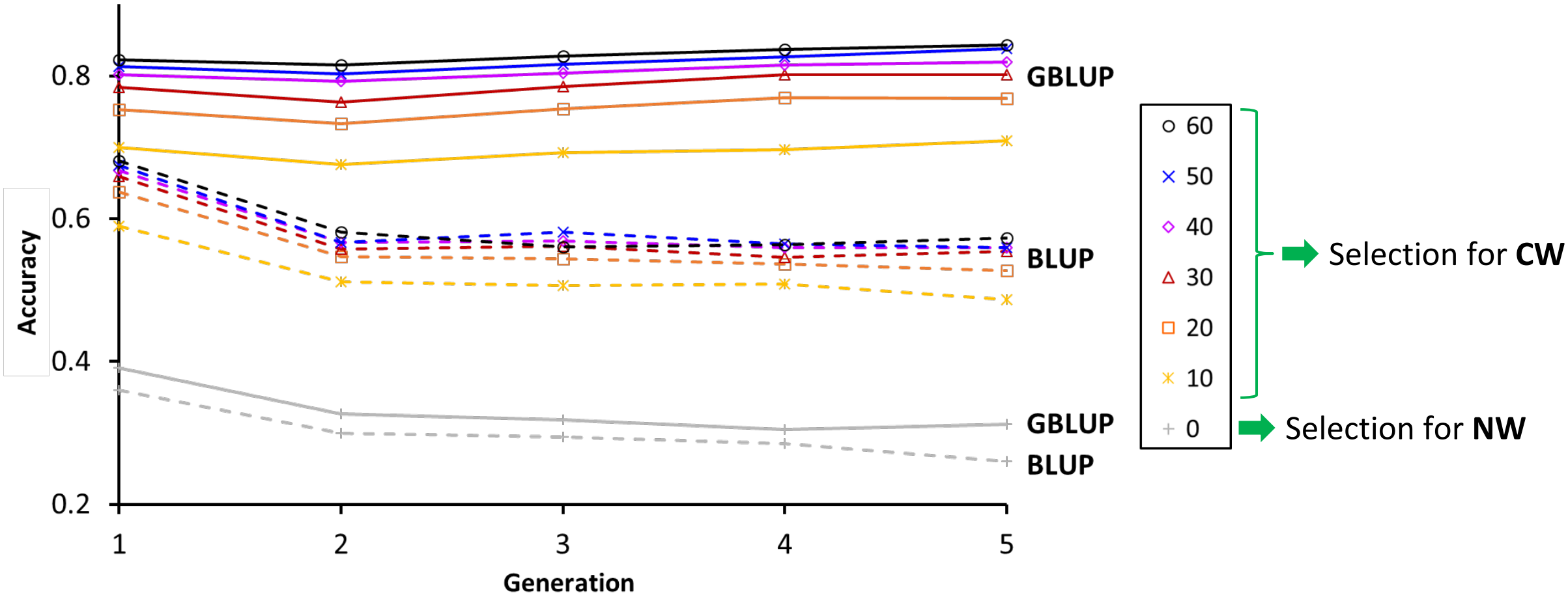
$$\mathbf{y} = \boldsymbol{\mu} + \mathbf{Zu} + \mathbf{e}$$

- (G)EBVs obtained for **NW** and **CW**

→ Candidates selected based on EBVs for **CW**

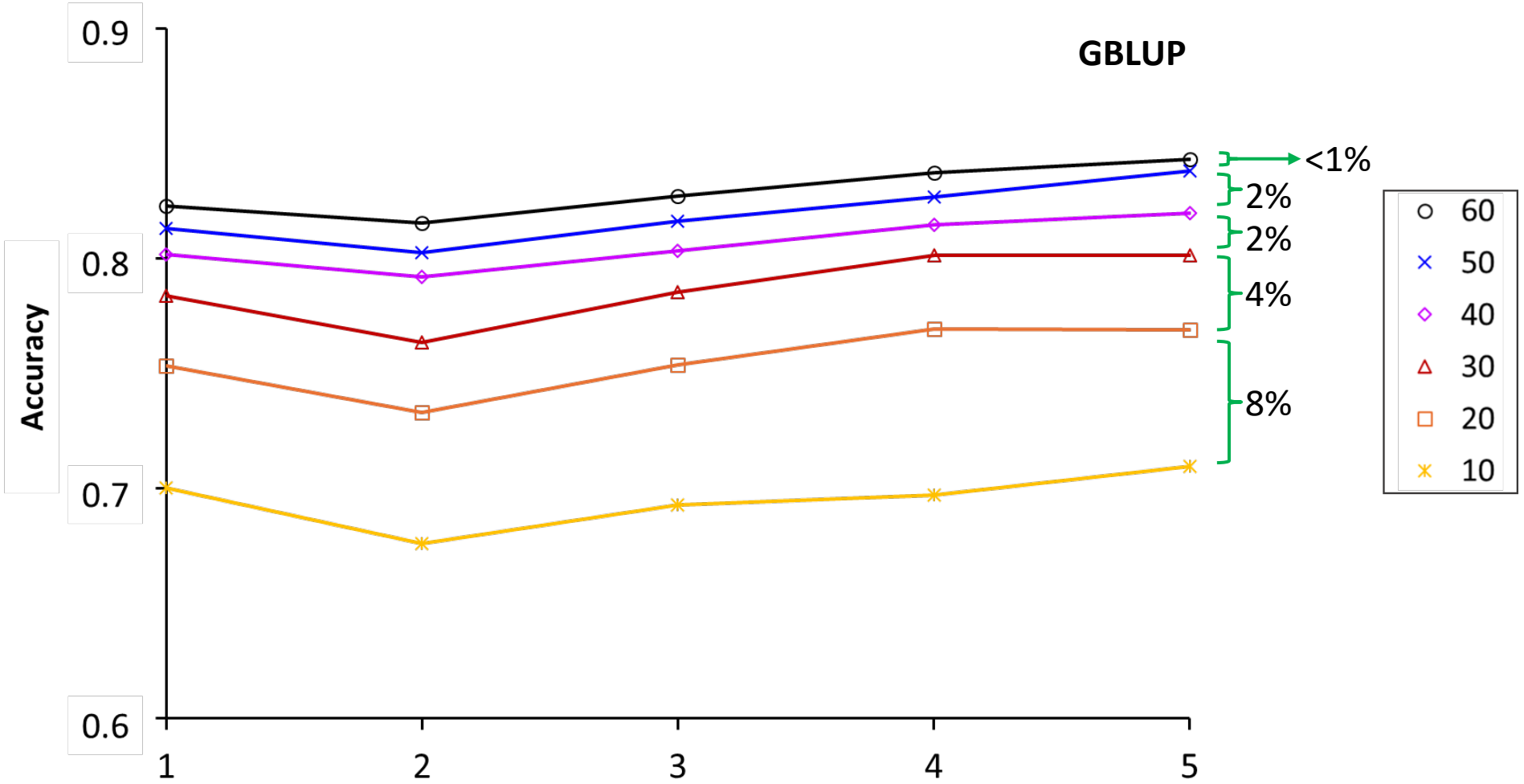
Accuracy for CW

Correlation between (G)EBVs and TBVs



Results

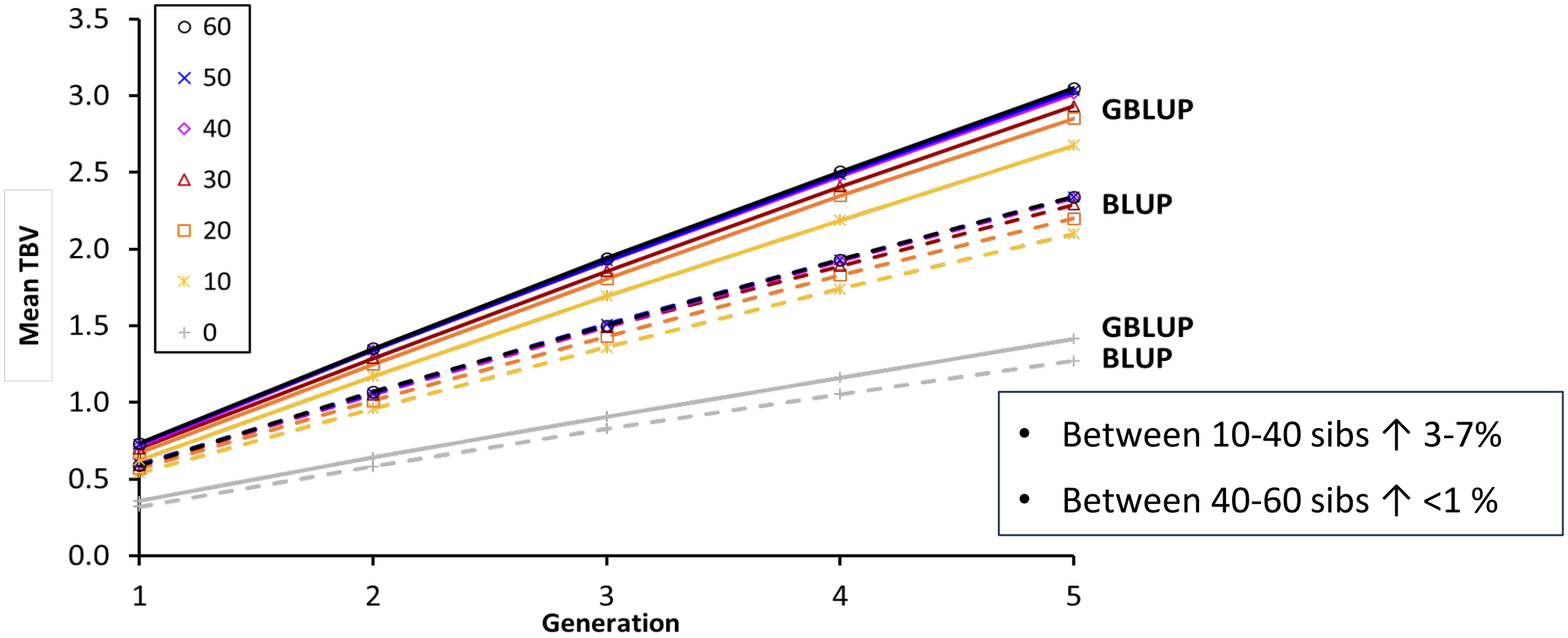
Accuracy for CW



Results

Genetic gain for CW

Results for accuracy translate into equivalent results for genetic gain



- Between 10-40 sibs ↑ 3-7%
- Between 40-60 sibs ↑ <1 %

Beyond 40 sibs, the increase in gain becomes minimal as the no. of sibs increases

Results

Genealogical Inbreeding at $t = 5$

No Sibs	GBLUP	BLUP
0	0.051	0.090
10	0.064	0.159
20	0.054	0.151
30	0.052	0.140
40	0.048	0.141
50	0.046	0.134
60	0.044	0.133

Inbreeding is higher with BLUP than with GBLUP

As the number of sibs increases, inbreeding decreases

Conclusions

For both GBLUP and BLUP

- High increase in accuracy and in genetic gain when using information of sibs raised under commercial conditions

- Increasing the number of sibs measured and genotyped under commercial conditions leads to higher accuracy and genetic gain and lower inbreeding

- However, beyond 40 sibs, the increase in genetic gain is minimal

➡ Beyond 40 sibs, the increasing in the number of sibs may not compensate the extra costs

Acknowledgements

Thank you for your attention!!