Response to selection for harvest weight in a family based selection program of Githead seabream (*Sparus aurata*)

I. Thorland[1], L. Kottaras[2], T. Refstie[1], A. Dimitroglou[2],
L. Papaharisis[2] and M. Rye[1]

[1]Akvaforsk Genetics Center AS, Sunndalsøra, Norway
[2]Nireus Aquaculture SA, Koropi, Greece

Nireus' family based breeding program for Gilthead seabream

- **Broodstock collected from commercial stocks and wild origin**
- **2002: First batch of full- and maternal half-sib families of sea bream made *by artificial stripping.***
- **Nested mating design, 1 female mated to ~2 (range 1-13) males.**
- **40-90 families have been produced annually in individual batches during 13 years.**
- **Seabream:**
    - **Hermaphrodite**
    - **Males/females mature at different age**
    - **Batch spawner**
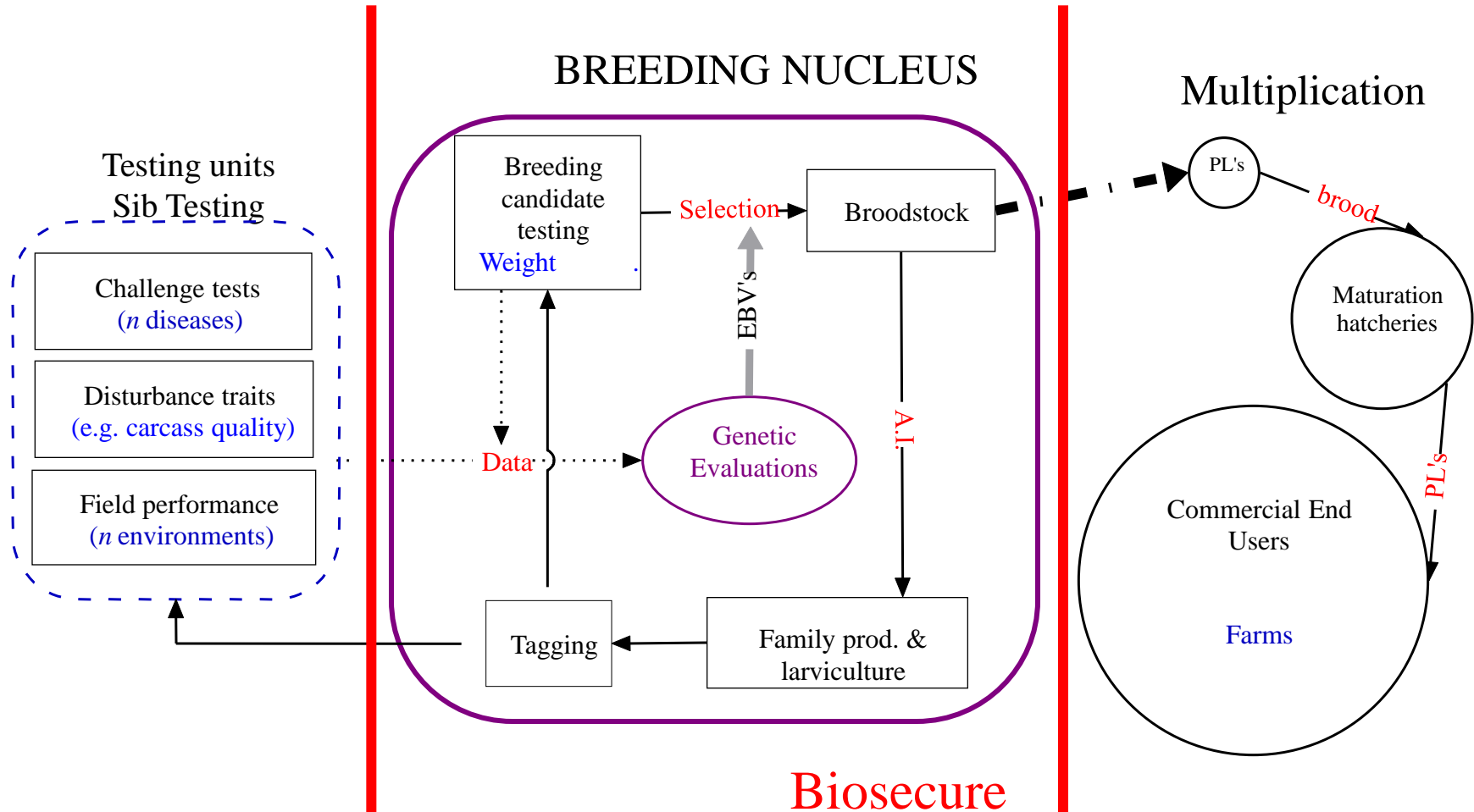
Genetic ties between batches:
- **Repeated use of some broodstock**
- **Overlapping generations**

→ Genetic trend analysis of total population → Selection according to comparable EBVs from all batches

Location:

- **Full-sib families incubated and reared separately to approx. 10-15 grams average body weight.**

- **Tagged individually, pooled, and transferred to cages at commercial farms**
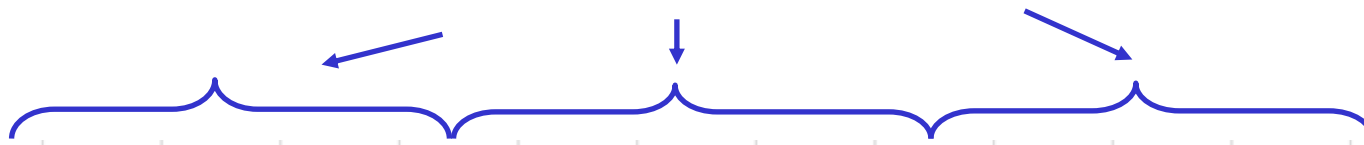
- **Recorded individually at market (harvest) size**

Family based breeding program

Testing units
Sib Testing

Challenge tests
(*n* diseases)

Disturbance traits
(e.g. carcass quality)

Field performance
(*n* environments)

BREEDING NUCLEUS

Breeding candidate testing
Weight

Selection

Broodstock

EBV's

Genetic Evaluations

Data

A.I.

Tagging

Family prod. & larviculture

Multiplication

PL's

brood

Maturation hatcheries

Commercial End Users

Farms

PL's

Biosecure

Nucleus

4 years generation interval

Sea bream	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
F0	Batch01	Batch02												
'F½'			Batch03	Batch04										
F1					Batch05									
F1.3						Batch06								
F1.6							Batch07							
F1.8								Batch08						
F2									Batch09					
F2.3										Batch10				
F2.6											Batch11			
F2.8												Batch12		
F3.2														Batch13

#Fam/ batch	50			→	92		90
	F0		F1		F2		F(3.2)

Commercial broodstock mass selected for growth have been introduced also in recent batches

Traits/ Selection goals

- **Body weight (Growth – corr to FCR)**
  - **at harvest size ~400g**
  - **juveniles when tagging, g**
- **Exterior, score 1-4**
- **Deformities: - jaw malformations, score 0/1**

  - spinal malformations

  - others
- **Cage survival**
- **Disease resistance**
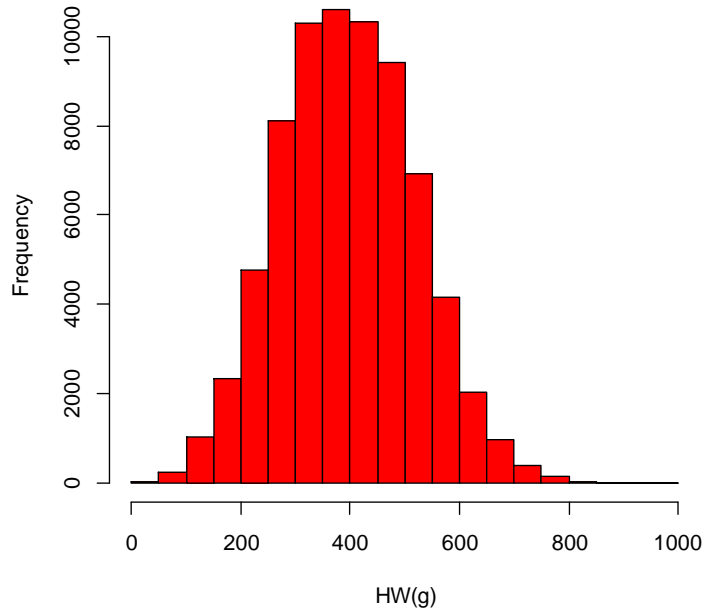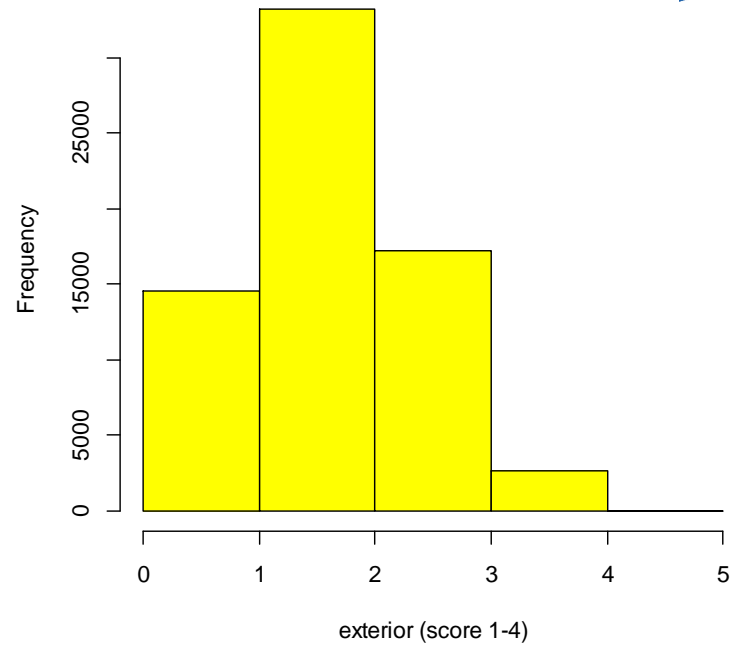- **Shape**
- **Carcass quality**

Material

trait	N batch	N fish	N fam	N sire	N dams
Harvest weight	12	71756	713	637	364
Exterior	12	67499	713	637	364
Jaw deformity$_{detailed ex.}$	7	57253	493	452	259
Cage survival$_{subopt env.}$	3	8766	248	218	132

Data individuals:

Harvest weight: mean 398g, sd 122g

Exterior: mean 2.1, sd 0.8

AKVAFORSK
Genetics Center AS

Family data:

trait	N fam	mean	sd	min	max
Harvest weight, g	713	399	102	152	682
Exterior, score 1-4	713	2.1	0.5	1.0	3.5
Jaw deformity$_{detailed ex.}$, %	493	23.4	16.2	0.0	81.4
Cage survival$_{subopt env.}$, %	248	67.0	20.7	0.0	100.0

Statistical analysis
Genetic trend analysis batch01 – batch12

$harvest\_wt^*_{ilm} = subclass1_i + \beta(age_m | subclass1_i) + tank_l + animal_m + e_{ilm}$

Subclass1= combination of batch, cage and transfer class

* Adjusted for heterogenity of variance

$External\_col_{jlm} = subclass2_j + tank_l + animal_m + e_{jlm}$

Subclass2= combination of batch, cage and deformity status

$Survival_{klm} = subclass3_k + tank_l + animal_m + e_{klm}$

$Jaw_{klm} = subclass3_k + tank_l + animal_m + e_{klm}$

Subclass3= combination of batch and cage

Genetic parameters

| Trait	h^2	c^2
Body weight at harvest*	0.37 ± 0.03	0.06 ± 0.01
Exterior	0.15 ± 0.02	0.03 ± 0.00
Jaw deformity	0.16 ± 0.02	0.03 ± 0.01
Cage survival	0.13 ± 0.03	0.01 ± 0.01

Selection is done according to a combined index with main focus on improved growth.
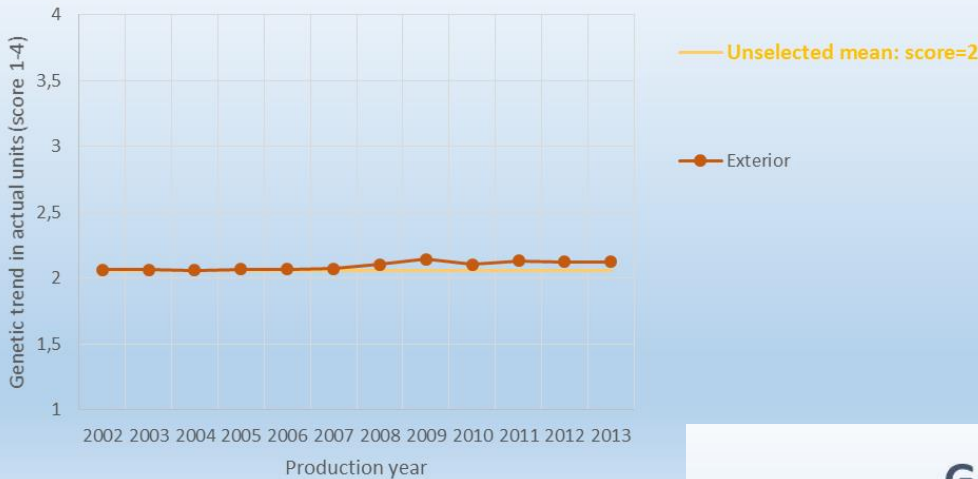
Genetic trend expressed as mean EBV + average solution for fixed effects

Response to selection

Genetic trend harvest weight (%)

35% total improvement achieved in 2013
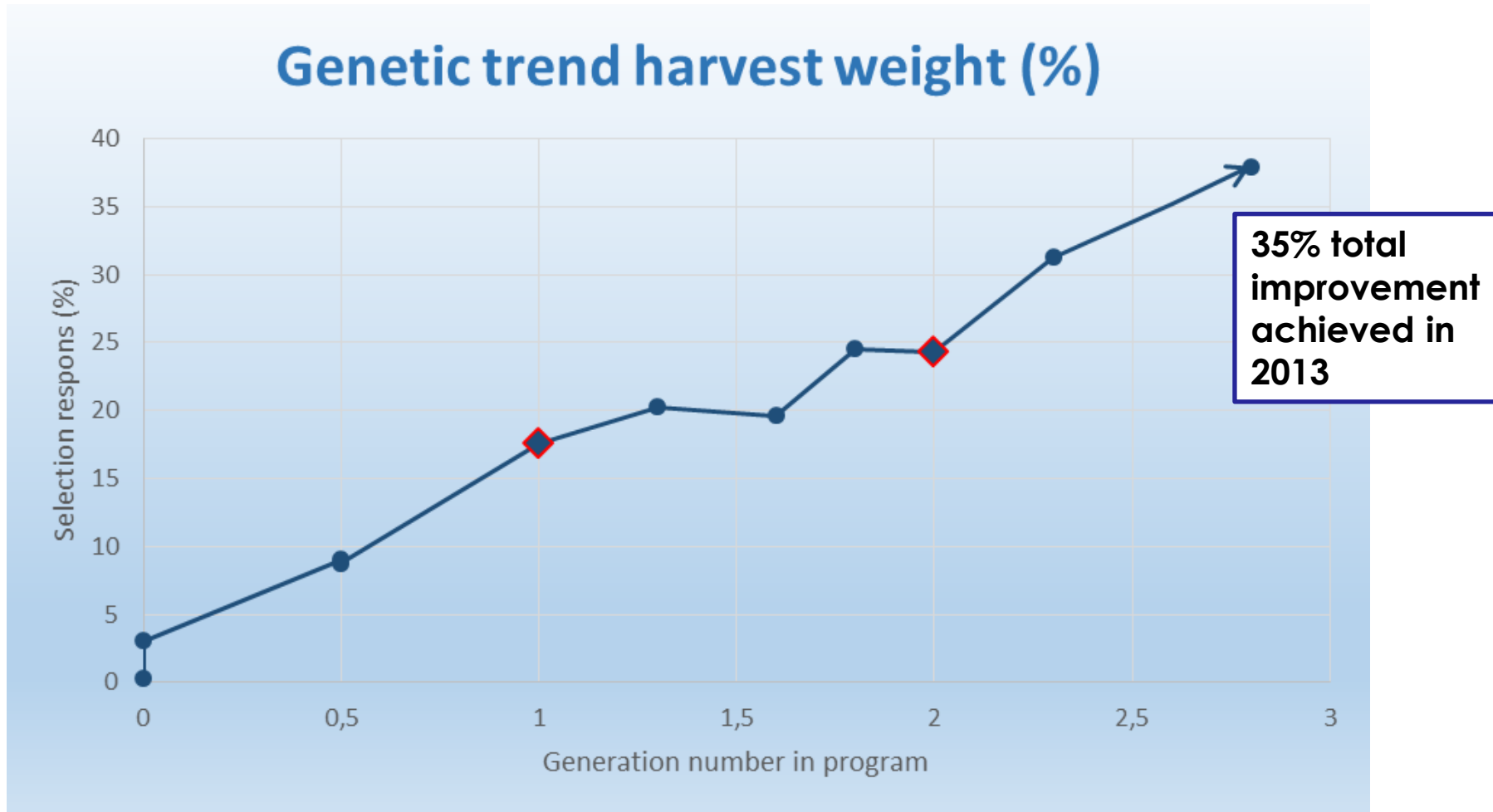
Response in % having average solutions of fixed effects as reference

Genetic trend exterior (score1-4)

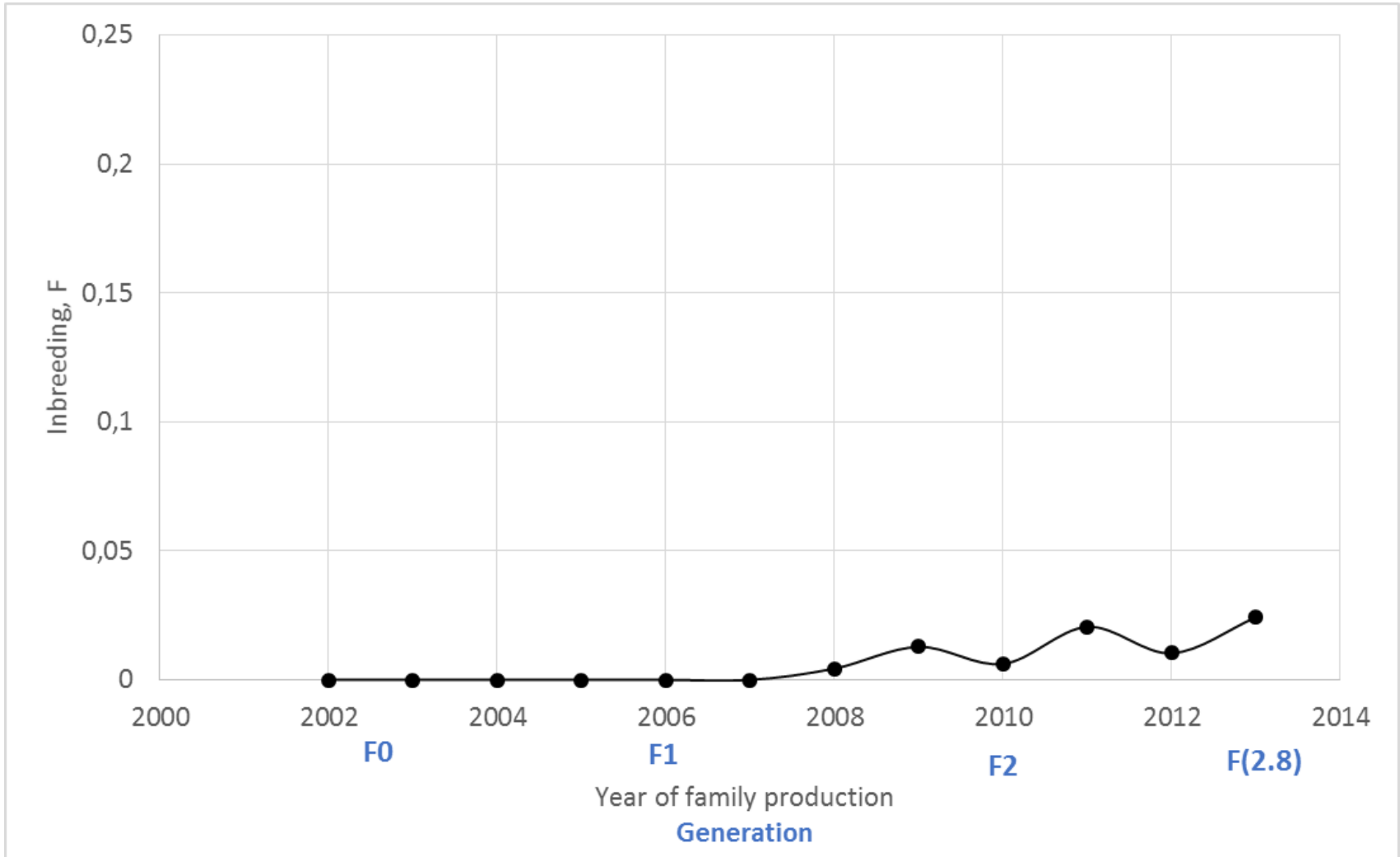**Genetic trend robustness traits**

Monitoring and control to avoid undesirable changes

Only very small responses to selection has been achieved for exterior and cage survival

Genetic trend expressed as mean EBV + average solution for fixed effects

Accumulated inbreeding

Conclusion and status

- **Results demonstrates totally 35% improvement in growth (harvest weight) in generation F(2.8) → average selection response of 12.5% / generation.**

- **Accumulated inbreeding are kept on a low level, below 3% in present population.**

- **Low heritability and selection response is calculated for external appareance.**

- **Additive genetic variation also shown for robustness traits (against developing jaw deformities, survival in sub-optimal environment). These traits are under selection control to avoid possible undesired responses.**

- **Selection program for Gilthead seabream is well established in Greece. Further responses to selection is expected in comming years. Expected the selection goals to be broadened (disease resistance, general robustness)**