

Gilthead seabream (*Sparus aurata*) – Current status of selective breeding in Europe

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Summary

This report describes the status of selective breeding of gilthead seabream (*Sparus aurata*) in European aquaculture. Surveys were conducted among the eight existing breeding companies to gain insight into the main characteristics of breeding companies and their juvenile production. The market share of breeding companies was estimated from the total juvenile production by breeding companies relative to the total European juvenile production. Most breeding companies performed family selection and the main traits in the breeding goal were growth performance, morphology and product quality. The number of selected generations varied between one and five. An average selection response on growth performance of 10-15% per generation can be expected, hence after an equal growing period the bodyweight of the fasted growing selected strains is expected to be 1.5-2 times larger than that of a wild strain. The market share of breeding companies in total juvenile production was 60-66% in 2012.

1. Introduction

With an annual production over 100 thousand tonnes gilthead seabream is one of the major aquaculture species in Europe (FEAP, 2014). In order to achieve this production over 400 million juveniles of 2-10g are stocked in sea cages each year (table 1), which are grown for approximately 1.5 years to a harvest weight of 300-600g. The majority of the European production of fish and juveniles takes place in Greece. France and Italy export a large part of their juvenile production. Males reach a reproductive age after two to three years and females after four to five years, hence an average generation interval around four years can be expected in practice. The survival from egg to juvenile is highly variable among different hatcheries, but also among different batches within the same hatchery. The industry average survival from egg to juvenile ready for sales or stocking is 10-15% (Anonymous, 2015).

Table 1. Gilthead seabream production volume and value in Europe in 2012

Country	Production volume ^a (tonnes)	Production volume ^b (tonnes)	Production value ^b (1000 €)	Juvenile production ^a (million)
Croatia	2 105	2 173	11 000	5.4
Cyprus	3 121	3 126	15 483	8
France	1 300	1 300	7 414	30.4
Greece	72 000	72 300	357 311	245
Italy	8 700	5 400	35 815	70
Malta		2 604	11 048	-
Portugal	1 000	895	4 755	0
Spain	19 430	16 607	77 594	55
Total	107 656	104 405	520 419	414

^a (FEAP, 2014)

^b (FAO, 2014)

Even though seabream aquaculture has developed into a large scale industry, it has a relatively short history. Up to the late 1970's aquaculture of gilthead seabream (*Sparus aurata*) relied entirely on the capture of wild larvae and juveniles. The development of large scale fry production technologies in the early 1980's allowed the rapid expansion of the industry (Moretti et al., 1999). Global seabream production increased rapidly from less than five thousand tonnes in 1990 to over 135 thousand tonnes in 2012 (FAO, 2014). The first trials on selective breeding of seabream were carried out in the

mid-1990's (Knibb et al., 1997 ; Knibb et al., 1998). It was only in the early 2000's that the first commercial breeding programs of seabream were initiated (Thorland et al., 2006 ; Brown, 2003). The convergence of production costs and revenues associated with a maturing industry pushed companies to produce more competitively (Knibb et al., 1998). This process may have promoted the use of selective breeding by the seabream farming industry. However it is unclear what part of the current production originates from breeding companies. Therefore this report aims to:

1. Describe the main characteristics of breeding companies.
2. Estimate the market share of breeding companies in Europe.

2. Materials and Methods

2.1. Characteristics of breeding companies

In a first survey conducted in collaboration with AQUATRACE¹, questionnaires were distributed among the eight breeding companies in Europe. This extensive questionnaire included questions related to the type of selection, the number of selected generations, selected traits, the application of genetic markers and genomic selection, the monitoring of inbreeding, protection strategies and the quantity of juveniles produced.

As not all companies completed the extensive questionnaire, a second survey was carried out involving a limited number of questions. The aim of this second survey was to identify whether a breeding company employed mass or family selection and how many juveniles it produced in 2012.

2.2. Market share of breeding companies

The market share is defined as a firm's sales relative to the total sales of all firms in the same industry (Ghosh, 2004). Here it is used as the total juvenile production of breeding companies relative to the national and relative to the total European juvenile production (table 1). Both surveys provided information on the quantity of juveniles produced per breeding company. The quantity of eggs sold by breeding companies was insignificant and therefore ignored. The juvenile production data were compared to national and European statistics in order to estimate market shares. On a national level the market share of breeding companies was determined by comparing the pooled juvenile production of breeding companies per country to the national juvenile production. On a European level the market share of breeding companies was determined by comparing the pooled juvenile production of breeding companies to the total European juvenile production.

3. Results

3.1. Characteristics of breeding companies

In 2012 eight companies were active in selective breeding of seabream. Six of these breeding companies completed the questionnaire of the first survey. Of these six companies, five performed family selection and one performed mass selection. The reported number of selected generations

¹ AQUATRACE - <https://aquatrace.eu/> - 7th Framework Programme for research (FP7)

were two times one generation, once three, once four and twice five generations. Most breeding companies performed selection on growth performance and morphology (table 2). Some of the companies that performed family selection also selected on traits related to product quality, disease resistance and feed efficiency. The rate of inbreeding was monitored in five of the companies. Two companies that performed family selection applied artificial fertilisation to create families, which were reared separately until large enough to be individually tagged. The other three companies reconstructed pedigrees with the use of genetic fingerprints. Three companies indicated to apply marker assisted selection and genomic selection was not applied. Over 90% of the juvenile production by breeding companies, was realized by breeding companies that performed family selection.

Table 2. Traits in selection of gilthead seabream breeding companies in Europe

Selected traits	Mass selection ^a	Family selection ^a
Growth performance	0	5
Processing yield	0	0
Product quality	0	3
Disease resistance	0	2
Reproduction (maturity, fecundity)	0	0
Morphology	1	4
Feed efficiency	0	2

^a Number of respondents that performed selection on a trait. Six companies completed the questionnaire, of which one applied mass selection and five applied family selection.

3.2. Market share of breeding companies

The juvenile production data of seven out of eight breeding companies were collected (figure 1). Together the breeding companies produced 248-275 million juveniles in 2012, hence the market share in the total European production (table 1) was 60-66%. The four Greek breeding companies were responsible for more than 80% of the juvenile production by breeding companies (figure 2).

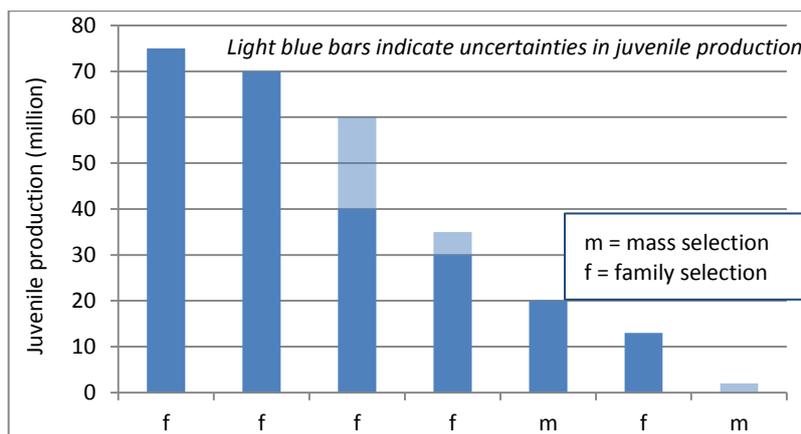


Figure 1. The juvenile production of seven gilthead seabream breeding companies in Europe in 2012.

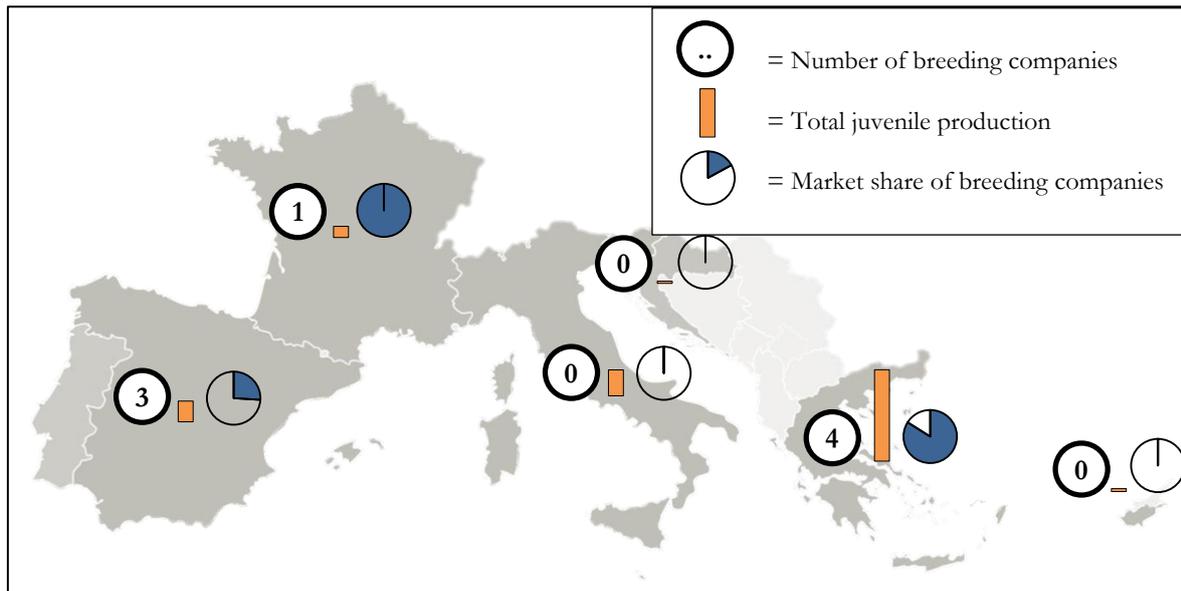


Figure 2. The distribution of gilthead seabream breeding companies across Europe, the juvenile production per country and the national market share of breeding companies in 2012.

4. Discussion

No juvenile production data could be obtained from one breeding company, however it is expected that this company was only a minor player in the industry and thereby had little effect on the estimated market share.

Only one breeding company operates a breeding program as its core activity. Most of the breeding programs are part of integrated companies which control the entire process from reproduction to harvest. Thereby deliveries of juveniles to other parties are generally limited.

The impact of selective breeding on seabream production depends on the market share of breeding companies as well as the genetic gain that has been achieved. A few studies have estimated the selection response in gilthead seabream breeding programs. Growth is selected on by all breeding companies (table 2) and may be most illustrative for the achieved genetic gain. Thorland et al. (2006) predicted a 15.6% increase in bodyweight at harvest after one generation of selection in a family selection program. Brown (2003) predicted a reduction in time to harvest in one round of selection of at least 60 days, corresponding to 10% of the seacage period. Knibb (2000) reported a 5-10% increase in growth rate per generation of seabream that was selected for up to three generations. Therefore an average selection response in bodyweight at harvest of 10-15% per generation may be expected, which is similar to other fish species (Gjedrem & Baranski, 2009). As the highest number of selected generations reported by breeding companies was five, this could theoretically have resulted in a 1.5-2 fold increase in bodyweight at harvest in the fasted growing strains currently produced compared to wild strains. In practice this is likely to have resulted in a combination of a reduced growing period and an increase in harvest weight.

5. Conclusion

1. In 2012 eight companies were active in selective breeding of seabream
2. Most breeding companies perform family selection, with commonly selected traits being growth performance, morphology, product quality, feed efficiency and disease resistance.
3. The number of selected generations ranges from one to five.
4. The market share of breeding companies in the total European juvenile production was 60-66% in 2012.
5. After an equal growing period the bodyweight of the fasted growing selected strains is expected to be 1.5-2 times larger than that of a wild strain.

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