11. Selective fish breeding

Establishing the broodstock

To work properly and with adequate safety margins, any hatchery should secure a reliable and sufficient supply of good quality fish eggs. With this aim in mind, most Mediterranean hatcheries have established their own broodstock units, where breeders of different age groups of the species involved are kept under long term stocking conditions.

However, timing, amount and quality of the eggs produced by these units do not always fit hatchery requirements, resulting sometimes in poor final outputs in terms of viable fry.

The importance of a properly dimensioned and managed broodstock unit is now fully acknowledged and its relatively high running costs are fully justified.

In the management of a fish broodstock unit the main issues to be considered refer essentially to:

- stock dimensioning;
- stock collection;
- adaptation to captivity and long-term stocking conditions;
- sexual maturation and spawning according to the production schedule;
- renewal of the old breeders.

Stock dimensioning

To properly determine the dimension of the broodstock unit, different parameters have to be taken into consideration. First, the seasonal production target for the hatchery has to be set. In particular the desired number of fry, their size and species and delivery timing should be planned. To this purpose, it is important to set the average survival rate from larva to weaned fry. Second, the reproductive characteristics of the species, such as sexual cycle pattern, egg productivity and latency period (see Table 3.1) play a key role in stock dimensioning. A third important aspect is represented by the possibility to introduce a year-round supply of eggs, which requires the manipulation of photoperiod and temperature to obtain out-of-season maturation and spawning.

As described in Part 2 of the manual, both seabass and gilthead seabream are seasonal breeders spawning in winter and early spring, with some differences in timing according to the specific location and the species. But whereas seabass is a synchronous gonochoric species, gilthead seabream is a proterandrous hermafroditic species where males undergo sex reversal to became females. They also differ from seabass females in being sequential spawners, i.e. they can lay 20,000-80,000 eggs every day for a period of up to four months, moreover, in captivity sex reversal is conditioned by social and hormonal factors which may lead to unfavourable sex ratio if not properly considered in establishing groups of broodstock.

Table 3.1 - Conservative propagation parameters under hatchery conditions for seabass and gilthead seabream

Species	Egg productivity as No. eggs per kg b.w.	Egg productivity as % of b.w.	Fertilization rate (%)	Hatching rate (%)	Viable larvae (No. Per kg per yr)[1/]	Latency (months)[2/]
Seabass	300,000	20-25	90-95	75-85	220,000	6
Gilthead seabream	800,000	50-80	90-95	70-80	560,000	12

[1/]Average number of viable two days old larvae that can be expected yearly per kilogram of healthy female

[2/]Time between the introduction of brood fish in the hatchery and their first spawning.

Table 3.2 Size at first sexual maturity and optimal size for spawning

Species	Sex	Size at first maturity		Optimal size and age		Reform
		L or W	age	wild	farmed	
		(years)		kg (years)	kg (years)	kg (years)
seabass	M	23-26 cm	2-3 1/	0.6 (2-4)	0.7 (3-4)	> 1.5 (6)
		28-30 cm	2 2/			
	F	31-33 cm	4 - 5 1/	1-1.5 (5-8)	1.5-2 (6-8)	> 3 (9)
		37-40 cm	3 2/			
gilthead seabream	M	100-300 g	1-2	0.3-0.5 (1-2)	0.3-0.5 (2-3)	
	F	> 600 g	> 3	0.8-1 (3-5)	1-1.5 (4-6)	>2 (8)

1/ Tunisia

2/ Mediterranean France

The main selection criteria to identify adult fish as suitable breeders are not scientifically stated, but follow the common sense. With the advance of genetic studies, more specific criteria will probably become available related to faster growth rate and stronger disease resistance. For the time being, the following empirical selection criteria for breeders have a proven record to work for hatchery purposes:

- normal body shape and colour;
- absence of skeletal deformities;
- overall healthy status (absence of large wounds, haemorrhages, infections, parasites and necroses);
- normal behaviour such as a quick response to food distribution, fast swimming, controlled buoyancy, etc.;
- the largest size within its age group;
- the best growth and food conversion rate within its age group.

To spare additional and potentially fatal stress to recently caught fish, the temporary holding and transport containers should have the following characteristics:

- be heat insulated;
- be filled with sea water coming From where the fish have been caught;
- be round in shape or square with rounded corners to avoid skin abrasions and mechanical shocks;
- be large enough to allow the fish a fair degree of movement.

Additional precautions are:

- keep fish density inversely proportional to transport time and water temperature;
- maintain oxygen saturation around 100%;
- take the animals to the hatchery as soon as possible: speed and care are always recommended when handling gilthead seabream and seabass breeders.

For fish transport in which oxygen is provided, consider the following:

- for short transport under favourable climatic conditions, fish density should not exceed 30 kg/m^3;
- for long transport, limit density to 1.0-15 kg/m^3 and use anaesthetics (at a level of sedation only);
- always monitor dissolved oxygen saturation levels during transport; safe values ranging from 85 to 120%.

Selection and quarantine treatment

Upon arrival at the hatchery, fish are anaesthetised and checked using the selection criteria mentioned above. Selected fish are then weighed, their sex is checked and they are immediately transferred to already prepared “quarantine tanks” to receive their first prophylactic treatment, as indicated in the quarantine protocol (Annex 1). The treatment is given as soon as fish enter the hatchery facilities: this limits the risk of introducing parasites or bacterial diseases and facilitates their recovery from handling stress. Fish not selected are discarded or sold.

The most commonly used anaesthetics for fish are: MS 222 (@20-50 ppm), 2-phenoxyethanol (@200-300 ppm) and quinaldine dissolved in acetone (@3-5 ppm). Excessive manipulation and sudden changes in water temperature and salinity have to be avoided.. Always operate gently when getting hold of brood fish, raising the fish with both hands palms up from the lower body (one below the head, the other below the anus). Never touch them with dirty or dry hands, wash them and dip them in the holding container water to have your skin well wet prior to touch the fish. The use of cotton gloves to handle fish is recommended.

The quarantine protocol (Annex 1) is designed to eliminate possible external parasites, as well as to seal wounds and abrasions caused by fishing, handling and the parasites themselves. The treatment usually followed in hatcheries is a sequence of medicated baths: first formalin (water solution with 37-40% by weight of formaldehyde, HCHO) and malachite green (zinc free oxalate or aniline green), followed by a second quick immersion in fresh water to end with a third bath in furanic antibiotics. This treatment is repeated four times every three other days. The entire procedure takes a couple of weeks. No additional specific treatment is required as fish are assumed to be healthy.

Quarantine tanks should have a flow-through water circulation, round or rounded shape, small size (4 to 6 m^3) and a smooth inner surface to allow for rapid cleaning, easier harvesting and reduced use of chemicals for treatment baths. The recommended building materials are: FRP, PVC, PE or plastic-lined concrete tanks.

Stocking facilities

After quarantine, parent fish are moved either into larger tanks where they remain for a couple of months until full recovery, or directly into the long-term holding facilities. Lowering salinity down to 20 ppt for a few days helps the recovery of weak animals. In any case, the weight of each female fish is recorded to estimate its potential egg output (see Table 3.1). For gilthead seabream weight gives also an acceptable estimate of the broodstock sex ratio (see Table 3.2).

Long term stocking facilities exist in a variety of designs and capacities. When land area is not a constrain, earthen ponds stocked at low density (up to 0,5 kg/m^3) represent a reliable and easy to manage solution. They usually measure up to 500 m^2 in size with an average water depth of 1.5 m and have a rational water exchange with inlet and outlet systems through loosely screened monks to allow small fish and crustaceans, which may represent an additional source of food, to enter the pond. The outlet offers the possibility to empty the pond by gravity. During the hottest months, a shelter should cover at least 10% of the pond area to provide some protection against the sun and a quiet place to rest. If necessary, protection against fish-eating birds should also be contemplated. Another cheap solution to stock broodstock is given by floating cages, provided that suitable sheltered coves are available. Fish control is however less easy than in land-based facilities.

Feeding broodstock

Although studies on the effects of diets on the reproductive capacity of seabass and gilthead seabream are far from being complete, it is generally acknowledged that a diet rich in vitamins, poly-unsaturated fatty acids (n-3 PUFA) and other micro-nutrients is essential in obtaining viable eggs and larvae.

For practical purposes, two distinct feeding regimes are applied: a maintenance diet after spawning till the onset of the next ovogenesis period, some three to four months before the next spawning season, and a boosted diet thereafter to provide the essential nutritional requirements for proper gametogenesis (Annex 3).

Maintenance diet

The maintenance diet should keep spent fish or new fish breeders in good health until the onset of the gametogenesis. It should therefore be rich and varied both in quality and quantity, and should be assessed by regular controls. It should preferably be as close as possible to the fish natural diet, including fatty and lean fish, crustaceans and molluscs. According to availability from the local fishery and suppliers, trash fish may represent a cheap solution, paying due attention to the increased pollution load in the stocking facilities. To keep their original quality, trash fish should be purchased fresh and then cleaned, minced and deep frozen immediately. This process also lowers the risk of parasitic infection.

It is advisable to get broodstock used to pelletized dry feed in order to have an alternative to fresh food at hand in case of shortage. Moreover, dry feed is useful when drugs or other feed integrators have to be supplied to the fish. The use of automatic feeders is only possible with dry pellets.

Even if the choice between fresh food and dry feed depends on several factors such as their availability, cost, use of feeding equipment and management, it is advisable to use both feed types in order to benefit from a broader range of possibilities. A practical solution envisages the distribution of pellets 6 days a week supplemented with moist food twice a week, and with no feeding one day a week, typically on Sunday. This pattern reduces the workload to manageable proportions, and still provides fish with a proper diet. The daily feeding rate usually ranges between 0.7% and 1.4% of body weight in seabass and 1 to 1.5% in gilthead seabream, both adjusted in line with water temperature and physiological status of the fish (Annex 3).

From a management point of view, a feeding schedule should be prepared at regular intervals based on periodical controls of fish weight. Feeding by hand is recommended because it would be possible to prevent food leftovers, which may rapidly deteriorate water quality, and to observe the behaviour of broodfish. Food is usually given once a day, early morning or late afternoon. Water renewal in the tank is adjusted to keep DO levels at saturation and ammonium nitrogen below 1 ppm. Pollution caused by feeding fresh food can be controlled by using a flow-through water system and frequent cleaning. When broodstock is kept in a system using water recirculation, a mechanical filter to remove suspended solids is frequently added to improve the performance of the biofilter.