14. Automatic feeders & Transportation systems

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Transport equipment

By far and large the most common way to transport fry is by means of open containers, with or without lid and insulation, installed on trucks. These containers are attached to other equipment, more or less complicated, such as aeration-oxygenation systems, cooling systems, automatic DO and temperature monitoring. Another way to transport fry, not frequently used anymore, is in PE bags, which are filled with 1/3 seawater and 2/3 pure oxygen. Bags are placed into insulated (polystyrene) cardboard boxes to keep the temperature at an optimal low level during transport. This method works well, but it is not practical when large amounts of fry are involved because packaging is quite expensive and time-consuming. It is typically adopted for air transport of valuable and not bulky biological material, such as shrimp post-larvae, tropical fish or fish eggs.

Vehicles

The use of trucks is the main way of transporting live fish. Conventional light trucks equipped with 2-3 round open tanks are commonly utilised over short distances and for small quantities of fry. To deliver large quantities and for long journeys, dedicated heavy truck-trailer units equipped with several rectangular closed tanks are used.

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Tanks

Reinforced fibreglass is the preferred material to build strong, lightweight and easy to clean tanks for live fish transport. For relatively short distances (covered within 2 to 4 hours) and for limited amounts of fry (max 15 kg of biomass per cubic meter), the commonest and simplest design is the round, flat bottom tank with open top. With a volume up to 1.5 m^3, it has neither insulation nor lateral outlets. The smooth inner sides are painted in white and are gel-coated to offer the best visibility of transported fish and to prevent skin damages. A floating wooden cross with size smaller than the tank diameter is a simple device used to reduce water splashing during transport without affecting fish. A light truck can carry two to three such containers.

Over longer distances and for bulk transport, the round tanks are replaced by closed rectangular tanks with a capacity ranging from 1 600 to 2 400 l to make better use of the space available on the chassis, allowing up to13 tanks on a long vehicle, and up to 6 on a normal truck. This type of tank has white gel coated internal surfaces and has smoothed corners, a large square trapdoor on the top, closed by a screen (to prevent fish from jumping out when the lid is open) and a lid. They also have a large lateral sluice gate with a removable gutter for unloading the fish, and a bottom valve for complete drainage and a vent hole with a valve or an air scoop on the top to prevent the accumulation of toxic gases as carbon dioxide and ammonia. Insulation is provided by styrofoam or polyurethane injected in the between the walls of the tank.

Oxygenation systems

Large volumes of oxygen will be consumed due to the high fish load and to their high oxygen requirements, which are also increased by the stress induced by the transport and the build up of ammonia due to the absence of water renewal. Additional supply of oxygen has to be foreseen in both tank models, either by aeration or by pure oxygen injection. Aeration requires the installation of an air blower driven by the lorry engine. It provides filtered air through a frame of air diffusers fixed to the tank bottom. Because of their lower efficiency and shorter life span, air stones and ceramic diffusers are being frequently replaced by new textile flat hoses which provide finer bubbling, which minimise water turbulence and that last longer. Diffuser's output is controlled via a valve placed on the tank cover. Being a less efficient system to add oxygen to water, aeration is considered a sort of emergency solution to replace the more effective oxygenation system, widely adopted in fry transport, should it break down.

Ammonia

When fish are transported in tanks without water renewal, their metabolic products accumulate in the water. Ammonia, which is excreted through the gills, is their main metabolic product. In water it exists in chemical equilibrium between the un-ionised form NH_3, and the ionised ammonium (NH_4^+). The un-ionised form is very toxic to fish, even at very low concentrations. While in closed rearing systems it is eliminated by biological filtration, which oxidises ammonia to non toxic nitrites and nitrates, in the case of transport containers this problem is addressed in the following ways:

- fish are not fed at least 24 to 48 hours prior transport to reduce their excretion rate, provided that their cannibalistic behaviour is kept under control;
- water is partially or totally renewed each 24 hours during long distance deliveries;
- temperature is kept as low as possible to reduce metabolism without affecting fish, and to reduce the percentage of the toxic un-ionised ammonia;
- the transport tank lid or the vent are left partially open to prevent the build-up of ammonia (and carbon dioxide) inside the tank.

Carbon dioxide

Produced by respiration, carbon dioxide is dangerous because it reduces the oxygen carrying capacity of fish blood, even in presence of an adequate oxygen level. It is removed by water aeration and tank ventilation: the gas leaves through a vent or an air scoop. Sealed tanks can produce a dangerous build-up of carbon dioxide. The presence of foam at the water surface also reduces the water-air gas exchange (see below).

Turbidity

The removal of suspended solids and other agents causing turbidity allows a better view of the fish and reduces the risk of gill clogging, oxygen depletion and bacterial build-up. Transport tanks should therefore be filled (or refilled) with clean, filtered water.

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Stocking density for transport

During the transport fry require more space and consume more oxygen than similar weight of adult fish. Moreover, marine species are far more fragile than their freshwater counterparts and as a consequence, fry stocking density for transport is lower. The optimum fish density in transport containers is influenced by a number of factors, which are usually learned and calibrated by practical experience. Seabass and gilthead seabream stocking for long trips up to 2-3 days does not usually exceed 20-25 kg/m^3, while shorter deliveries (24 hours or less) allow a 50% increase, up to 30-35 kg/m^3.

As a reference, according to professionals involved in fry transport in Northern Italy, the stocking density of 2 g seabass fry should not usually exceed 30 kg/m^3 for a transport of 12-13 hours with a salinity of 25 ppt and a temperature of 20°C. If water can be renewed one or two times during transportation, this transport time can be safely doubled.

Fig.72.01 High density of gilthead seabream fry in a transportation tank (photo STM Aquatrade)

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Fry handling

To prevent excessive stress, the precautions previously mentioned for fry handling indicated in the weaning section are also valid for transport operations. Due to the prolonged time of a transport, from some hours to a few days, the precautions to be adopted should be strictly adhered to.

Transport conditions

It is advisable to fill the transport containers with water of similar quality of that present in the hatchery. Often, when loading is completed, water is totally renewed in the transport tanks to remove the load of contaminants (dirty, foam, mucus, faeces) that entered the tank with the fry. Again care should be taken to use only well oxygenated water. For transport over long distances, lasting more than 24 hours, at least a complete water change is recommended. It is usually done at well-known sites where good quality seawater is easily accessible and can be pumped using equipment available in the truck.

A working protocol for water change during fry transport does not exist because, again, too many variables are to be considered. A simple rule of the thumb based on practical experience foresees at least a 50% water change every 12 hours for transports with a fry density as high as 30 kg/m^3. In absence of marine water, pure freshwater can be added to the containers in replacement of an equal volume of original medium, provided that the resulting drop in salinity does not exceed 5 ppt per hour. The addition of ice bars can also be considered when a lower temperature is desired.

Loading

Fish to be transferred must be in good health, should be well accustomed to their rearing tanks, should be free from diseases and any possible treatment for parasites must be done well in advance. Injured or weak fish, which are easily recognisable by their dark colour, slow or irregular swimming and altered behaviour, should be removed prior to loading. If their numbers are high in the stock to be transported, this is an alarming sign indicating that something has gone wrong with that population and therefore no transport should be possible before its complete recovery.

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Controls during transport

During transport the crew periodically monitors the oxygen supply and the presence of foam and dead animals at the water surface. Other parameters are seldom considered because too often nothing can be done to fix a possible problem during the journey, in particular when it takes place far from the coast. It is however highly recommended to control water temperature, DO, pH and salinity when new water is added along the journey to avoid abrupt changes in these parameters.

A first stop is usually done soon after departure (about half an hour), to control fish behaviour and calibrate the aeration/oxygenation flow meters. Then, frequent checks made at regular intervals are strongly advisable. The use of reliable automatic DO monitoring devices saves time and provides an early warning in presence of unexpected oxygenation failures.

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Unloading and precautions at point of arrival

A logical precaution at arrival is to make sure that the transport water matches as much as possible the salinity and temperature levels of that of the receiving stocking facilities. If necessary, add slowly an increasing volume of the receiving water by using buckets or pumps to acclimatise fish to the receiving water salinity and temperature values before unloading. It is very important that fry are not exposed to abrupt shocks of temperature and salinity. In case fish are badly suffering from poor transport conditions, the faster they are moved to the receiving facilities, the better.

The discharge operations are related to the type of containers utilised for transport. Fry transported in round, open tanks are harvested by means of a small seine net, and then transferred in buckets or tubs to the receiving facilities. Fish stocked in closed tanks for long distance transport cannot be fished from the top trapdoor. In this case fry are unloaded through the lateral opening where a gutter has been placed. Flexible, non-collapsible hoses may be connected to the gutter to discharge fry into facilities placed in a position that cannot be reached by the truck. To reduce the discharge speed, the water level is lowered through the screened draining valve or by a screened siphon. In this phase, the oxygen flow must be maintained to avoid critical low levels due to the temporary overcrowding.

Upon stocking, long starved fry should be immediately fed with dry feed to prevent the appearance of cannibalism. Dead fish should be carefully removed, as well as moribund specimens. Mortality has to be controlled carefully and dead fish must be counted and noted on a daily basis. Administering antibiotics for prevention purposes is no longer recommended for the possibility to create drug resistant bacterial strains. Their use should be limited to cure actual disease outbreaks, always possible in weakened or stressed populations.

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Fry counting

During weaning the number of fry has to be assessed several times to calculate their total biomass, as well as their survival rate, and to adjust feeding rations accordingly. Their number is also needed to plan sales and consequent truck loading. Both manual and automatic methods are utilised to assess the number of fish fry. Manual counting can be done in three different ways:

1. the individual count, where the whole fish population is counted one by one;

2. the estimated count, where the fish population is assessed by counting only some well chosen sub-samples;

3. the count by weight, based on the total weight divided by the unit weight obtained through sub-samples.

For its large subjectivity, visual estimation of quantities is almost completely abandoned, while automatic counter devices are being increasingly adopted by large fish farms for the opposite reason.

Individual counting

This method is reserved to fry such as gilthead seabream and to those batches of fry where there is no agreement between seller and buyer about their estimated counting. It has the advantage to be very precise, but it takes time and personnel, usually three to five counters for each tank plus a supervisor who takes note of the count.

Fry are counted during transfer to the receiving facility or prior to their loading into the transport tanks. The equipment required is a small seine net for fishing (2 mm in size, stretched mesh), white small containers (large tea cups work well), markers for every 50 or 100 fry and aeration or oxygenation equipment of the stocking containers (more frequent water change is also required).

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Counting by weight

When counting large amounts of relatively large fry (individual body weight above one gram), the counting by weight is preferable. Its advantages are the rapidity of the operation and the limitation of stress, but its precision is adversely influenced by the practical impossibility to eliminate the water coming with the scooped fry (which induces a water weight error). Of course, the more homogeneous the size of fry, the better the final result will be.

This method calculates the total number of the fry population by dividing the weight the whole population by the average individual weight measured from a sample. This can be easily done during the grading operation. Proceed as follows:

1. tare the balance with a bucket half filled with seawater to a pre-set weight, say 5 Kg;

2. harvest fry by means of a seine net (see transfer procedures above), or directly from the floating cages if already graded (see below), the latter method giving a more precise counting;

3. transfer with a hand-net a small lot of fish into the pre-weighed bucket and record the net weight displayed by the calibrated balance; try to keep the water in the hand net to a minimum;

4. repeat the previous steps until no fish is left and sum all the weights;

5. obtain the average weight by counting the fish of three hand net hauls:

6. calculate the total number of fry of each size class by dividing the total weight by the average individual weight.

Remarks

- however carefully done, this method remains only a good estimate of the actual figure, its error being inversely proportional to the size of fish; its accuracy is considered overestimated by no more than 10%;
- for a greater accuracy, the amount of water trapped in the hand-net can be pre-determined and then subtracted from the final weight;
- when counting small fry an electronic balance with 0.1-gram division and automatic tare switch is strongly recommended to better match size variability.

Automatic counting

The increasing production of fry of valuable species has motivated the development of faster and more accurate counting systems and as a result reliable automatic counters for fish fry are available in the market. They are based on a photocell that counts the fish passing in front of it. They are designed to keep fry always in water, swimming along a mild water current to the counter where patented nozzles separate the fingerlings to minimise counting errors. Their counting capacity is of about 30-35 000 fry/hour within a size range of 0.5 to 6 g.

Some models of automatic counting devices can also be linked to an automatic grader, and the combination permits a complete automatic selection process. The advantages of such equipment are fairly good accuracy (98-100%), rapidity and reduced disturbance and damage to fish. The personnel required to operate the counting machine is also less than that required for the more traditional counting sessions. Their rather high cost can be justified when large amounts of fry have to be counted.

Fig.74.01 Digital counter with over 100 000 fry per hour of capacity (photo STM Aquatrade)

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