Fish Culture Technical Bulletin
Best Management Practices

HUSBANDRY OF FISH DURING EARLY AND ADVANCED REARING[1]

INTRODUCTION

The definitions of early and advanced rearing are based on developmental stages of the fish, but are often confused due to the use of these names for specific areas of the fish hatchery. Early rearing is defined as the phase of development following hatching during which the fry feed endogenously (from the yolk sac) and includes the transition to exogenous (external) feed. Advanced rearing is defined as the phase following the switch from endogenous to exogenous phase, after swim-up and first feeding. Fish at all stages of development tend to have similar needs in regards to environmental and physical conditions, so the blurring of these definitions does not have a great effect on the overall care of the fish in the fish culture station.

EARLY REARING

Hatching and the sac fry stage

Eggs can be left in the incubator units to hatch. The main concerns with any type of incubator are to remove dead fry and egg shells to prevent fungal build up and maintain adequate water flow to prevent smothering. Once the eggs hatch, the fry are termed sac fry because they have an external yolk sac still attached. This is used for food until their digestive systems are developed enough to handle external feed.

The fry can be transferred to the early rearing units at one of two times; several days to a week after hatching when most of the yolk sac is absorbed, directly into the troughs, or two or three days pre-hatch into baskets (which float in the early rearing troughs). After eye-up eggs are transferred to hatching baskets which sit inside a hatching trough. Transfers should not occur during the actual hatching time because this will cause a decrease in survival rate of the fry. Some factors to consider when deciding when to transfer the fry include the following:

- the type and size of incubators available;
- water quality;
- the type and size of early rearing units available; and
- the size of the lot of fish.

The transfer should occur so that the fry are offered the best care possible. Whether the transfer occurs before or after hatching it is important to set up the early rearing units a few days before the transfer. Ensure that the standpipes and screens are installed and functioning properly. Sac fry are extremely fragile and easily damaged so handling should be reduced to the minimum.

Tips for proper care of sac fry

- disinfected feathers, fine-mesh disks and soft mesh scoops can be used to handle fry - feathers should be used to disperse clusters of fry to reduce smothering;
- high water quality with a dissolved oxygen content > 6ppm and total gas pressure not exceeding 100% saturation should be provided;
- water flows should be set so that metabolic wastes are removed but the fry are not required to expend energy fighting against the flow of water;
- exposure to light should be reduced as much as possible - incandescent lights are preferred;
- accumulated egg shells, debris, and algae should be removed from screens on a daily basis with the least amount of disturbance to the fry; and
- dead, moribund and abnormal fry must be removed, counted and recorded
- records should also be kept of water temperature, water volume and water flow.

Swim-up and first feeding

The most critical stage in the rearing of all fish species is the initial feeding. In salmonids this occurs as soon as the fry start to swim up. Once the yolk sac is almost absorbed, fry begin to be more active, swimming towards the surface of the water.

At this stage fry can start to be exposed to soft lighting. The process of transferring fry from endogenous to exogenous feed requires patience to reduce losses. Feeding should be done by hand so that proper control over the amount given to the fry can be exercised. It is important to feed the fry not the trough, spreading feed only over areas where the fry are located. In the early stages it is not only important that the proper amount of feed is given to the fry, but also that the highest quality feed is provided. Proper feeds and feeding techniques will result in uniform fish size in all units.

Feeding a few times a day should begin prior to complete absorption of the yolk sac to begin slowly introducing the fry to external food sources. A good guideline to follow is to begin the introduction when approximately 50% - 60% of the fry are swimming up. When first introducing feed to the fry, it is advisable to distribute slightly more feed than is eaten. This will ensure that all fry have an opportunity to sample the feed, but limits excess feed

accumulated on the bottom of the rearing unit. Once 90% of the fry have swum up a feeding schedule should be implemented, with fry being fed frequently throughout the day. When fry begin to show little feeding response, stop feeding. Wastage should always be avoided as it decreases water quality and may cause gill damage. When it is evident that the majority of fry are feeding, automatic feeders can be used to extend the hours of feeding, distributing small amounts of feed five or more times per hour. More frequent feeding results in more efficient feed utilization and greater uniformity in fish size.

ADVANCED REARING

A routine of care involving the following areas of concern will maximize growth and health of fish stocks in the hatchery. This will not only minimize stress to the fish, but it will ensure that all issues surrounding the care of the fish and facilities are attended to. A routine will also help in the maintenance of proper records, which is crucial for the effective management of a hatchery.

Facility Check

Check the following:

- lighting controls;
- water temperature recorders;
- oxygen monitoring systems;
- feeding equipment;
- screens and standpipes;
- water source and outflow structures;
- water filters;
- LOX systems;
- alarm systems and other security features;
- water flow to rearing units; and
- monitor effluent water.

Feeding

Observing the fish at the time of feeding is important as it can be determined whether the fish are being under- or overfed. Overfeeding can cause water quality problems, whereas underfeeding can lead to emaciation, fin nipping, eye picking and cannibalism. Ninety- five percent of the feed should be eaten in the first one to two minutes. Fingerlings and older fish reared in water temperatures below 5°C may not require regular feeding. Once daily feedings are adequate and a lack of food for several days at a time will not harm fish at

these low temperatures. Feeding frequency and amount must be modified for individual conditions; however a general rule is that smaller particle sizes are desirable for more frequent feedings and larger pellets for less frequent feedings. The following are some general guidelines to follow for the feeding of fish of various sizes.

Table 1. Suggested feeding regimes for various fish sizes.

Stock Type	**Feed Type**	**Feed Size (mm)**	**Feedings per day***	**Fish Size**
Broodstock	Grower Pellets	7 mm	0.5 - 2	>200-500 g
Production	Grower Pellets	5 mm	1 - 6	>200 g
Production	Grower Pellets	3 mm	1 - 6	<12-180 g
Production	Grower Pellets	2 mm	3 - 6	7.5 - 60 g
Production	Starter Pellets	2 mm	3 - 6	7.5 - 60 g
Production	Starter Pellets	1.5 mm	3 - 7	2 - 15 g
Production	Starter Pellets	1.2 mm	4 - 7	2 - 7.5 g
Production	Starter Granules	1.0 mm	5 - 8	0.6 - 3.5 g
Production	Starter Granules	0.5 mm	6 - 8	0.2 - 1.5 g
Production	Starter Granules	micro	7 - 12	<0.8 g

* The number of feedings per day will depend on the feeding method (i.e., by hand, demand feeders, automatic feeders etc.).

Water

- Check water levels in all units. Water flows should be checked on a regular schedule and records should be properly maintained of all flow levels and adjustments made. In raceways the exchange of water should be one to three times per hour, while hatching troughs should have higher exchanges, two to three times per hour.
- Check the water temperature. Water temperature should be recorded on a daily basis. Recording thermometers are ideal because they can provide a continuous record of water temperature. Ideal temperatures vary with species reared. For all salmon species, the temperature should be increased for the initial feeding and then returned to a regulated level. Table 2 illustrates optimum rearing ranges.

Table 2. Optimum water temperatures for the culture of various fish species[1,2,4].

Fish Type	Species	Temperature range
Coldwater	Atlantic salmon	12-15°C is optimal
	Brook trout	12-15°C
	Brown trout	12-15°C
	Chinook salmon	10-15°C (12°C is optimal)
	Coho salmon	12-17°C (15°C is optimal)
	Lake trout	9-12°C (11°C is optimal)
	Rainbow trout	14-19°C (16°C is optimal)
Coolwater	Lake whitefish	11-16°C (14°C is optimal)
	Muskellunge	16-21°C (21°C is ideal)
	Walleye	20-22°C (summer flgs); 18-20°C (fall flgs)

- Check dissolved oxygen concentrations. Measurements should be regularly taken from the same location at the same time of day so that they can be accurately compared.
- Observe water clarity to determine if overfeeding or silt is causing debris build- up.

Table 3. Diverse water parameters and their suggested optimum ranges for salmonid aquaculture.

Parameter	**Concentration** (ppm = parts per million)
Alkalinity	10-400 ppm as calcium carbonate
Ammonia-Nitrogen	<0.02 ppm; <0.005 ppm for salmonids
Cadmium	<0.0004 ppm in soft* water; <0.003 ppm in hard* water
Calcium	>5-160 ppm
Carbon dioxide	<2.0 ppm
Chlorine	<0.003 ppm
Chromium	<0.03 ppm
Copper	<0.006 ppm in soft* water; <0.03 ppm in hard* water
Dissolved nitrogen	<102% saturation
Dissolved oxygen	>6.0 ppm
Hydrogen sulphide	<0.002 ppm
Iron	<0.15 ppm
Lead	<0.03 ppm
Mercury	<0.0002 ppm
Nitrite-Nitrogen	<0.05 ppm
pH	6.5-8.0
Phthalate esters	<0.00030 ppm
Polychlorinated biphenyls (PCBs)	<0.002 ppm
Suspended solids	<80.0 ppm
Total dissolved solids	<400.0 ppm[5]
Zinc	<0.005 ppm

*Soft water is defined of water with an alkalinity of less than 100 ppm, while hard water is defined as water with an alkalinity greater than 100 ppm.

Fish

- Observe the condition and behaviour of the fish. Record any abnormal behaviour such as swimming at the surface, crowding at the inflow or outflow, flashing/spiralling, etc. Abnormal behaviour may be a sign of water quality problems, onset of fish diseases or predator problems.
- Remove, count and record all mortalities. Daily mortalities are normal. However, they should decline to low levels as the fish age with mortalities in broodstock being very rare. Remove the dead fish with nets or scoops, which should be disinfected before being used again. Each tank should have its own equipment in order to avoid spreading disease. Mortalities should be checked for any signs of disease or other abnormalities and disposed of accordingly.
- Tank crowding can cause unnecessary stress to the fish. A density of 30 kg of fish/m^3 is a good conservative rule of thumb. Higher densities may

- be supported depending on water quality, other environmental factors, rearing practices and species of fish.

Cleaning

Cleaning rearing units can be very labour intensive and stressful to the fish. However, regular cleaning is essential in units that are not self-cleaning. Methods of cleaning vary with the type of unit and the size of the fish. When fish are at the fry and fingerling stage, units should be cleaned regularly, at least once per day (i.e., first thing in the morning and/or last activity at the end of the day). As the fish grow, and rearing density increases, the fish will tend to move the waste along the unit and cleaning can be done less frequently.

There are several methods of cleaning rearing units. Vacuums and siphons can be used without lowering the water level. Brushing with a feather or soft-bristled brush requires the lowering of the water level and can be stressful to fish. Some precautions must be taken to reduce the risk of mortalities when cleaning this way.

- Direct the waste to the outflow of the tank.
- Avoid lowering the water too rapidly, or too much, because this will increase the stress to the fish. If the water becomes too low before the cleaning is complete, allow it to refill and finish cleaning later.
- Avoid too vigorous brushing, this will stress the fish and break up the solids making them more difficult to remove.
- Be sure to replace the standpipe or switch the control valves back to the regular effluent line.

Each unit should have its own cleaning equipment to avoid transfer of diseases. If this is not possible, at least each lot should have its own equipment. Sections of the rearing units that are not submerged, such as the outside and tops of the sides should also be regularly cleaned.

Shade

Most fish are sensitive to bright light and will seek shelter. Lights should be switched on gradually over indoor units. Incandescent light is preferred. Fish will crowd in the shadows of the corners of the units if light is not properly controlled. Crowding will cause an increase in mortality and reduction in growth.

Cover should be provided for all fish raised outdoors. This will provide some protection from the bright sunlight as well as from predators, and will reduce the stress caused by human activity around the units.

[1] Adapted from: Handbook of Fish Culture. OMNR, 1981. George K. Iwama, C. Young Cho and Julian D. Hynes.

[2] From: Fish Culture Course 1999 Manual. OMNR, 1999. Fish Culture Section.

[3] From 2000-2001 Provincial Fish Culture Station Strategy Documents. OMNR. Fish Culture Section.

[4] Glenn Hooper. 2004. White Lake Fish Culture Station. Personal Communication.

[5] Dube, P. and E. Mason. 1995. Trout culture in Atlantic Canada. *In* A.D. Boghen (ed.) Cold-Water Aquaculture in Atlantic Canada. 2nd Edition. Canadian Institute for Research on Regional Development. Moncton, New Brunswick.