Hatchery Equipment Operation
INSTRUCTIONS
For nurseries having an independent water supply

In order to create the optimal conditions for rearing the fry in the hatchery and obtaining young salmon that is physiologically most prepared for life in natural bodies of water, the biotechnical norms and rules for handling young salmon must be observed.

THE BEGINNING OF THE FREE-SWIMMING LIFE STAGE.

The beginning of the free-swimming life stage of the young salmon must be timed to coincide with the period when the temperature remains continuously above 4 °C, since at lower temperatures the feeding activity of the young salmon decreases and feeding the fish with granulated fish food becomes less effective.
The free-swimming stage for young salmon is initiated as follows:

1. The darkening mode is discontinued and lighting is gradually increased.

The black film is removed from the nursery channels, and electric lighting is turned on. On overcast days, curtains may be opened only on the north (non-lit) side, since bright sunlight upsets the young salmon and creates additional stress. Young salmon that has not yet adapted to bright light will stay close to the bottom, collecting in mass concentrations, which can lead to increased mortality among the weaker fry. Lighting in the nursery during initiation of the free-swimming stage and the beginning of feeding must be diffuse.

2. Increased water level in the nursery channels.

The minimum depth of water to allow feeding of the young salmon must be no less than 25 cm. This level is achieved by using shutter panels 10 cm in height (2 pcs.) and 6 cm (1 pc.).
It must be remembered that a mesh panel has to be installed in the first shutter slot (before the shutter panels) in order to prevent the escape of the young salmon. The time that the mesh needs to be installed is determined from the time that the fry begins to passively move to the lower portion of the channel, or alternatively the mesh can be installed immediately following the completion of hatching of the free embryos and removal of the trays. The shutter panel sets are installed in the second slot. For convenience in cleaning the channels, the narrow shutter panel should be mounted on top. If necessary, the shutter panels should be fastened down with wedges.

3. Water flow.

In light of the increased oxygen consumption by actively swimming and feeding fingerlings, the water supply needs to be especially attentively regulated.
During the time when the substrata is lifted, after the water level has been raised, the water supply has to be adjusted so as to retain the former rate of flow in the channel, equal to the flow rate during the free embryo holding period.
Example:

Knowing the volume of the channel: Y = 2.0 * 19.0 * 0.25 = 9.5 cubic m = 9500 liters and the flow rate: V = 0.5 cm/sec,
we can find the time for a full change of water in the channel:

$$t = \frac{\text{L (length of the channel)}}{\text{V (flow rate)}} = \frac{1900 \text{ cm}}{0.5 \text{ cm/sec}} = 3800 \text{ sec}$$

From the result, we can find the water amount needed to establish that flow rate in the one channel:

$$Q = \frac{\text{Y (volume of the channel)}}{\text{t (time for a full water change)}} = \frac{9500 \text{ liters}}{3800 \text{ sec}} = 2.5 \text{ liters/sec}$$

Thus, in order to maintain the initial flow rate (0.5 cm/sec) when the water level is raised to 25 cm, 2.5 liters/sec of water needs to be supplied to the channel.

4. Substrata lifting.

After the water level has been raised and the water supply adjusted, the process of removing the substrata begins. Two workers simultaneously lift the substrata from both sides of the channel using metal hooks.
During the process of lifting the substrata, the following actions are prohibited:

- walking along the bottom of the nursery channel;
- lifting sheets (mats) of tubular substrata filled with young salmon out of the water (without first sharply shaking them under the water to get the fry out of the tubes);
- leaving dead fish in the channels for more than a day during the holding period.
- Lifting the mats by only one edge.

If the fry begins its free-swimming period non-simultaneously, when a portion of the fish press close to the channel bottom, a small number of the mats should be left in the channel for a few days until the young salmon have fully adapted to the new lighting and feeding modes. The substrata should be raised beginning at the head portion of the channel to avoid injuring the young salmon concentrated in the water flow area.

5. Nursery channel cleaning.

After the substrata has been lifted, a dip net is used to collect the holding casualties (fish with developmental defects or injuries) and count them. Then the nursery channel is cleaned of dirt and detritus that has entered the channel through the water, and the screen at the water discharge area is thoroughly cleaned. It must be remembered that nurseries that lack a lower slot for a mesh shutter panel need to have a sealing material fastened to the lower edge of the mesh to prevent the escape of fish (in particular, porolon 2.0 – 3.0 cm thick). The integrity and seating of the sealing material must be checked every day, and any defects must be eliminated quickly.
The extracted substrata is immediately washed out thoroughly using special washing machines or brushes and soapy water, and is then rinsed off, disinfected and stacked on a flat horizontal surface to prevent its deformation.

FEEDING OF THE YOUNG SALMON

1. Water supply.

If there is inadequate oxygen and the water is being supplied in great quantities, the young salmon will form large concentrations in the head portion of the channels, at the water supply areas. In order to achieve a more even distribution of the young salmon throughout the channel, a portion of the water is supplied at the central portion of the channel using perforated pipes (40 mm in diameter, 5 – 10 meters in length). In order to prevent the fry from congregating under the pipes and being injured by them during channel cleaning, the aeration system should be mounted above the concrete walkways.

2. Calculation of nursery channel water supply during the period of intensive feeding

During the period of intensive feeding, the fry's requirement of dissolved oxygen (DO) increases, and oxygen is also consumed through oxidation of organic residue (excrement and un-consumed food), therefore the supply of water in the channel must be regulated based on the content of DO. A decrease in DO due to the life activity of the fry and oxidation reactions should not exceed 50%, i.e., should not cause the oxygen content at the outflow to drop below 50% of the amount of DO at the inflow. The lower limit of DO at the outflow is 3.5 – 4.0 mg/liter.

The required water supply may be calculated using the following formula:

$$Q = \frac{N * K}{0.72 * (C2 - C1)}$$

where

Q – water supply, liters/min

N – mass of the fry, kg (weight of each fish * number of fish)

K – consumption of DO by the fry (K = 4 ml/kg/min) - const

C2 – DO at the water inflow, mg/liter

C1 – DO at the water outflow, mg/liter

0.72 – conversion factor for mg/liter to ml/liter

We present figures below for water flow calculated using this formula in liters/sec that provide optimal rearing conditions at a density of 15,000 fry/sq. m in each nursery channel. The amount of dissolved oxygen contained in the water at the inflow is 8 – 10 mg/liter, and at the outflow (arbitrarily accepted as the minimum possible) it is 50% of the content in the water initially entering the channel. Under such abiatic conditions, table data may be used as a starting point for adjusting water flow. Under greater amounts of DO at the outflow, the amount of water supplied may be reduced, with the physiological condition of the young fish and the amount of food consumed daily serving as a guide.

Table of water consumption per nursery channel during rearing

T C of the water	300	400	500	600	700	800	900	1000
4 – 5	2.0	2.5-3.0	3.5-4.0	4.0-4.5	5.0-5.5	5.5-6	6.5-7	7-7.5
6 – 7	2.5	3.0-3.5	4.0-4.5	4.5-5.0	5.5-6.0	6-6.5	7-7.5	8.0

In order to prevent die-off of the young salmon under extreme conditions (such as inadequate water supply), until their normal reactivity to external stimulation has been restored, feeding must be curtailed and the water supply increased, while taking care to avoid a situation where the fry is beat against the screen, since under unfavorable conditions the weaker fry tend to accumulate at the outflow.

3. Nursery channel cleaning.

During the period of intensive fry feeding, the nursery channels must be cleaned of excrement and food residue every day in order to maintain the optimum hydrochemical composition of the water.

Before the first feeding, the excrement that has accumulated during the night is driven to the mesh shutter using dip nets and brushes, and then forced out using a strong stream of water. The strong water stream is created by raising the two upper shutters at the outflow, taking care not to injure the fry at the mesh. Under the constantly repeating forced exercise of their swimming abilities, the fry are able to easily overcome the strong flow of water, which replicates its departure into the rapid stream current in nature.

Cleaning of the bottom of the nursery section may also be accomplished using a siphon or special set-up using a low-power electric pump and brushes retrieved from a domestic vacuum cleaner.

If necessary, cleaning can be done at night, using a more merciful approach (considering that feeding fish is more susceptible to stress and recovers from it with more difficulty). The organic residue is driven carefully to the mesh using dip nets and removed from the nursery channel. The mesh shutter at the outflow is cleaned regularly during the course of the day.

4. Nursery lighting schedule.

During the intensive feeding period, the nursery is lit to the maximum extent possible – all windows must be opened and internal lighting turned on. The length of the lighting day may be increased using artificial lights, thus creating the most favorable conditions for feeding the young salmon and ensuring that it will consume all of its daily ration of food.

Methodology for feeding young salmon with dry granulated fish food of Japanese manufacture.

A significant reserve for elevating the operational efficiency of the salmon hatcheries lies in the release of physiologically healthy and large salmon young once the optimal conditions have become established in the coastal waters, and this may be achieved through a properly organized and rational feeding program.

In recent years, the salmon hatcheries of Sakhalin have been using dry granulated fish food of Japanese, Finnish and Danish manufacture to feed their fish. In content of the main components of nourishment, these types of fish food fully satisfy the needs of the young salmon at the first stages of exogenic feeding.

It must be remembered that the Japanese product is high-temperature granulated fish food, and is not well digested by the young fish at low water temperatures (below 40°C). When the water temperature is below 40°C, the Danish and Finnish fish foods are more effective.

In order that the young salmon turns out to be of better quality and even size, feeding should be initiated after the yolk sac has been absorbed or there is no more than 10% of it left compared to its initial weight.

At each salmon hatchery, a development schedule should be planned and maintained for the young salmon at the hatchery that provides for timing the inception of the fry free-swimming stage to coincide specifically with the onset of optimal conditions for beginning their feeding.

The food requirement of the young salmon varies depending upon the temperature and quality of the water, the weather conditions and its feeling of well-being. Feeding methodologies and amounts have now been developed by the manufacturers for each type of fish food.

During the feeding stage, the condition of the young salmon and its feeding activity must be monitored attentively, providing food to the fish in such a manner as to ensure that it is available to all of the individual fish, and that there is no food left over that can degrade the condition of the water in which they live.