Streamside Incubation

SALMONID HABITAT RESTORATION

How-To-Guide for Washington State

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STREAMSIDE INCUBATION

Improving habitat can only go so far toward restoring salmon stocks. Increasing the population of native fish through remote streamside incubators, or egg boxes, is a proven method of improving regional salmon returns in future years once a healthy habitat has been re-established.

This is one in a series of Salmonid Habitat Restoration How-To-Guides for projects in Washington State. It was written to help groups and individuals undertaking similar projects and presumes some knowledge of salmon, habitats and project planning.

Other guides in the series:

- Rearing Pens
- Culvert Replacement
- Nutrient Enhancement
- Live Plants
- Habitat Restoration
- Permitting
- Project Funding
- Streamside Incubation

Before beginning:

- Check with the appropriate local and federal agencies to ensure egg boxes are permitted in the area and in the particular stream being considered. Certain permits may be required as well. For more information on obtaining permits see the *"Salmonid Habitat Restoration Projects in Washington State How-to Guide: Permitting."*
- Identify a qualified hydrologist and fisheries biologist to plan and supervise the project. Streamside incubation is a complicated process, and must be done under the supervision of qualified personnel. Such projects should also be coordinated with local fish hatcheries.
- Identify property owners if the streamside incubators will be installed on private property, and secure permission both for the physical installation and for regular access to the incubator.

This guide is meant to be an overview for projects in Washington State, and uses Coho salmon, or silvers, as an example throughout. Requirements and specifics for similar projects in other states and involving other species of salmon will vary.

AN OVERVIEW

Before undertaking an egg box project, it's helpful to understand how and why streamside incubation works, and the natural process it both parallels and substitutes for. Following is an overview of the process of spawning as it occurs in nature, and how streamside incubation mimics it.

Spawning in Nature

BEFORE THE HATCH

In nature, a female salmon takes on much of the responsibility of the spawn. First she identifies appropriate spawning ground, looking for gravel beds with an upwelling of water through the gravel. The gravel acts as a natural filter, and the moving water both oxygenates and flushes. Then she'll clean the area, called a redd, by sweeping the gravel with her tail.

Once the redd is prepared, she releases her eggs—between 2,400 and 4,500 of them—at the same time that the chosen male releases milt. Fertilization occurs in the water as the eggs drift down into the gravel.

When the eggs have settled, the female again sweeps the river bottom with her tail—this time to cover the egg nest with clean gravel. With silvers, the eggs will develop during the winter and hatch in early spring, 30 to 90 days after they are fertilized—or more, depending on water temperature.

Adult Pacific salmon die after spawning. Their decomposing bodies provide nutrients critical to the survival of the eggs and young salmon.

AFTER THE HATCH

After they have hatched, embryos remain in the gravel feeding off the yolk sac of their egg. When they emerge in May or June, they'll occupy shallow stream margins and expand their territory as they grow.

They live in ponds, lakes, and pools in streams and rivers, usually among submerged woody debris-quiet areas free of current-from which they dart out to seize drifting insects. Some types of salmon will migrate to the ocean in a matter of weeks after hatching from their gravel birthplace. Others may stay in the freshwater environment of the river for one to two years before migrating to the ocean.

During the fall after they are born, juvenile Coho may travel miles before finding the habitat where they'll pass the winter. Some fish leave fresh water in the spring and rear in brackish estuarine ponds and then migrate back into fresh water in the fall. They spend one to three winters in streams before migrating to the sea.

Spawning in Egg Boxes

Remote streamside incubators, or egg boxes, mimic the natural spawning grounds where salmon eggs are hatched and incubated. Egg boxes are essentially finite spawning grounds self-contained within a barrel or similar tank installed alongside a stream and fed with stream water.

BEFORE THE HATCH

Stream water enters the egg boxes through an intake at the bottom, and exits through an outtake at the top. The constant flow of new water provides for oxygenation. It percolates up through three layers:

- Natural gravel, for filtering.
- Artificial gravel, called substrate, in which the newly hatched salmon will settle.
- A basket filled with fertilized eggs.

AFTER THE HATCH

Newly hatched salmon with their egg sacs still attached—called *alevin*—filter through the egg basket and settle into the substrate where they'll remain for the next month, feeding on the yolk. When they're ready, they'll come out from the gravel—they're now called *fry*—and get carried out the outtake into the river.

At this point, the process for both wild and artificially hatched salmon becomes the same. Fry imprint on the water where they are born. This enables them to return to the same spot to spawn as adults.

During the first year of their life they'll stay close to the area where they were born, preparing for a life at sea by learning to evade predators and foraging for food—primarily nutrients in the water. Once in the river, many of these fry will also become food for salmon from the previous year's hatch. They eat the weakest and the slowest, culling the population to help provide for the survival of the species.

They'll rear there for a year or more before *smolting*—the physiological process by which they become adapted to the salinity of seawater—and beginning their migration to the ocean. Feeding at this stage is critical. The year-old salmon are supercharging their energy reserves, as the next part of their voyage—leaving freshwater for the sea—is the most difficult they'll face. Only about 30 percent of hatchery salmon survive this stage.

EGG BOX SETUP AND INSTALLATION

This section covers the basic steps for setting up streamside incubators. For more detailed instructions, please refer to documentation provided by the manufacturer with specific egg box models. Again, projects such as these should not be undertaken without the supervision of a hydrologist or fisheries biologist.

Topics covered in this section include:

- Location and setup
- Inside the egg box
- Seasons: Time of year
- Preparations
- A note on eggs

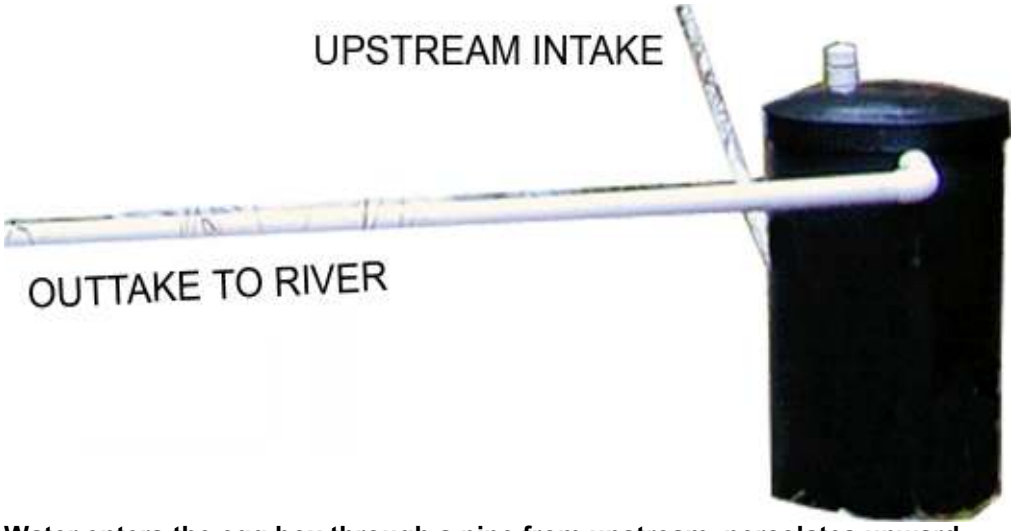
Location and Setup

Manufacturers make different models of egg boxes in a variety of sizes. A typical egg box used for Coho by Fish-First is a 55-gallon barrel made of rubberized plastic, with water inlets on both ends. Different models are more appropriate for some species than others, and the size of the egg box is dependent upon the stream where it will be used. A manufacturer can help you determine which is appropriate for your project.

Barrels are installed on the bank alongside the target stream. In a proper setup, stream water flows into the barrel at the bottom water inlet, rises through the egg box and flows out the outtake. In order for the stream water to fill the egg box, proper positioning is critical.

PVC piping used for water intake should be upstream of the egg box to take advantage of natural water flow, and must be higher in elevation than the intake inlet for gravity flow. In some situations, a tributary or feeder stream can better meet the intake requirements than the target stream.

A second section of PVC piping directs the water from the outtake downstream from the egg box.



Water enters the egg box through a pipe from upstream, percolates upward through the box and returns to the stream through an outtake, as shown here.

Stainless steel mesh screens filter the water at both the upstream point where it enters the PVC intake and the downstream outtake. These screens keep the pipe from clogging with debris.

Additional stainless steel screens should be positioned where the pipe enters and exits the egg box. Manufacturer instructions provided with the egg box should specify what size screen to use, but 1/16th of inch mesh is a useful guide number.

Inside the Egg Box

To best mimic natural spawning redds, materials inside the egg box are layered. The bottom layer should be clean gravel the same size as the natural spawning gravel in the target stream. Sizes range from ¾ of an inch down to sand. The gravel acts as a natural filter for the water entering the egg box as it does in nature.

The second layer is called substrate, and is made of bulky, injection-molded pieces of plastic with holes running through them. Substrate provides places for alevins to "hide" once they've hatched, as they would take shelter in stream gravel. It's bigger and less-tightly packed than natural gravel, because the eggs, in contrast, are more densely packed than in nature. When salmon deposit eggs in a stream, the newly hatched fry can spread out more than they can in a confined egg box.

Above the substrate is a plastic mesh "basket," or egg cage—essentially a plastic pan with a net on the bottom. This will actually contain the eggs prior to their hatching. The basket should be the appropriate size for the species of fish.

Mesh must be fine enough to hold the eggs inside, with holes wide enough to allow newly hatched fish to slip into the substrate. Egg baskets should be removed after alevins have settled into the substrate to free up room in the egg box.

For more information on eggs, see *A Note on Eggs*, below.

Seasons: When to Set up Egg Boxes

In nature coho salmon spawn in late fall, from October until about December. One reason for this is that a weather event or similar disaster that ruins or blocks access to the spawning stream won't destroy the entire spawn. There's a better chance that the fish will reach their grounds and spawn successfully. This also buys spawning fish time to wait for favorable water temperatures.

Egg boxes should be run concurrently with the natural spawn.

Preparations

Several things need to be done before the egg boxes are activated on a stream:

RESEARCH HISTORICAL INFORMATION

Before planning a salmon incubation project, it's important to understand the historical populations and character of a particular stream. What species are native to it? In what numbers? When did those numbers begin to decline, and what caused it?

Incubation projects should be appropriate to given streams. Individual species should not be introduced where they are not native. Obstacles to healthy stocks should be removed or eliminated prior to undertaking incubation projects.

CONDUCT STREAMSIDE SURVEYS

It's critical to work in conjunction with a hydrologist and with fishery biologists, preferably associated with a hatchery, for a project. These experts can study a target stream and help plan a project, including determining the following information:

Nutrient level. A healthy level of nutrients must be ensured in the stream before egg boxes can be considered. Without the proper nutrients in the stream, salmon fry will not survive once they're hatched. It's important to work with the appropriate hydrologists and fisheries biologists to ensure the stream holds appropriate nutrients for the fry to survive after the hatch.

Egg count. A determination of the appropriate number of eggs should be made in advance of installing egg boxes. This count must weigh both the number of fish a river can successfully handle and the target population count. This figure also will help determine which model and size egg boxes to purchase, and how many will be needed.

Egg sourcing. Working with a hatchery can also provide an optimal source of salmon eggs appropriate for a local stream. See *A Note on Eggs*, below.

MOUNT A TEST RUN

Egg boxes should be installed in their streamside locations and plumbed prior to loading them with eggs. This allows an opportunity to run the egg boxes to ensure that all the piping works correctly and that the water flow is unfettered. Any adjustments that need to be made to the boxes or their location should be made prior to loading them with eggs.

A Note on Eggs

Eggs should be ordered from a hatchery. The hatchery will deliver eggs that have been fertilized, or *eyed*. Eyed eggs have reached the developmental stage at which the embryo's eye is visible and the egg itself is durable and unlikely to rupture with handling. In some cases these eggs are taken from salmon native to the target stream. It's also possible to remove fertilized eggs from natural redds; whatever the means of procuring eggs, it should be conducted in conjunction with trained biologists.

From the time an egg is fertilized to the time it hatches takes about a month. Because of the unpredictability and potential for destructiveness of the weather, hatcheries keep fertilized eggs until they are from eight to 15 days away from hatching.

At that point, they're delivered and loaded into the baskets in the streamside incubators. This provides for a 90-plus percent success rate, a considerable improvement over nature. It's the only part of the process humans perform better than nature. Each egg box should host 10,000 to 100,000 eggs. Some egg boxes allow for multiple layering of substrate and egg baskets.

OTHER CONSIDERATIONS

Gather as much information about a target stream in advance of permitting and planning a project. In the course of the research, you're likely to discover other information you may not have known to look for.

Such information gathering is also likely to identify contacts and sources familiar with a stream who can help, or put you in touch with someone who can help, mount a project.

ADDITIONAL INFORMATION & RESOURCES

Copies of this document are available through Fish First, and can be found on the Web at www.fishfirst.org. You'll also find a library of how-to guides and fact sheets as well as other resources and information to help with salmon restoration projects.

In addition, here's a list of links to help you find more information on streamside incubation.

- Washington State Department of Ecology
  www.ecy.wa.gov
- Washington State Department of Fish and Wildlife
  www.wdfw.wa.gov

Additional information in this document was provided by the Alaska Department of Fish and Game, the Washington State Department of Fish and Wildlife and StreamNet.

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