*High quality salmon fry can be produced at a reasonable cost.*

# A New Incubator for Salmonids Designed by Alaska Laboratory

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*ABSTRACT—After several years of experimentation, Auke Bay biologists and the research design and devices fabricator have built a salmonid incubator that has the capability to produce high quality fry at a reasonable cost. The system is easy to modify for experimental work and is constructed from materials that facilitate use in the field.*

## INTRODUCTION

For over a century large-scale production of salmonid fry in hatcheries has been done in essentially the same manner. It has become increasingly apparent that egg-to-fry survival has been much better in hatcheries than in nature, but the quality of the hatchery fry has often been poor. The low quality may not be significant in species that are kept in the hatchery for a few months after emergence as fry—chinook salmon (*Onchorhynchus tshawytscha*) and coho salmon (*O. kisutch*). It may be a critical factor, however, in species that are released to the wild when the fry emerge from the spawning bed—pink salmon (*O. gorbuscha*) and chum salmon (*O. keta*).

Another problem has been the prohibitive cost of many hatchery systems. Some systems are so costly to build and maintain that even though they produce strong healthy fry, they are not feasible.

Personnel at the Auke Bay Laboratory have worked to find or develop an incubation system that produces high quality fry at a more reasonable cost than traditional hatchery methods. Among the popular traditional incubators tested here were the Heath and Bams models. Neither of these satisfied both quality and cost criteria. The Heath incubator produced large numbers of fry in a small area and required comparatively little water, but it did not significantly improve the quality of the fry. Although the Bams rugose substrate and water filtration system yielded high quality fry, it required expensive manpower and a great deal of water.

So the people at Auke Bay began to develop new incubator systems. The design presented here is the culmination of many years of experimentation. I believe that it will satisfy both quality and cost conditions. It is the result of a trial-and-error process, and would not have been possible without the work of people like Chester R. Mattson, Robert Dewey, Sidney G. Taylor, Jack Bailey, William Heard, and William McNeil (Mattson, 1968[1]; McNeil, 1970 and 1974; Bailey and Heard, 1973; Dewey, 1974[2] and Bailey and Taylor, 1974a and 1974b).

In 1967 Mattson experimented with an incubator featuring mesh trays that allowed fry to fall through as soon as they hatched. Dewey designed the first AstroTurf[3] substrate incubator during the winter of 1973-74. Later that same year Taylor and Bailey used the AstroTurf in an upwelling-type incubator.

The present Auke Bay incubator was started early in 1974. I was making improvements on an AstroTurf incubator for Bailey at the Auke Creek Hatchery, when Heard, Project Supervisor at the Little Port Walter Field Station, requested a Heath type incubator with an AstroTurf substrate that could be altered to allow voluntary escapement of fry. We decided to go ahead and design one incubator that would incorporate all the features Heard and Bailey were looking for. By combining Mattson's mesh fry trays and Dewey's AstroTurf substrate with Bailey's and McNeil's information on oxygen requirements, egg density data, and flow rates, I came up with the present design.

## CONSTRUCTION AND OPERATION OF THE NEW AUKE BAY INCUBATOR

The basic incubator unit consists of two sections—an insert section and a housing section. The insert section is nested in the housing section. The incubators can be operated in stacks or singly. When stacked, the extended lower sides of the housing section hold the insert section in place. Each stack has a base section and a cover section (Figs. 1 and 2).

Every section contains two removable egg trays which can be inserted or removed during incubator operation. While the incubator is operating, water is directed into the cover section. The water flows down into the head chamber of the housing section below and gravity carries it through the lower units.

Water enters the housing section head chamber and flows under the baffle. Some of the water then flows horizontally through the rugose substrate (AstroTurf), and some upwells through the egg trays and flows horizontally over the eggs. All the water passes

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[1]Mattson, C. R. 1968. Early Sea Life of Salmon, Pink Salmon Investigations, Quarterly Progress Report, 1 Jan.-31 Mar. 1968. On file at Auke Bay Laboratory, National Marine Fisheries Service, Auke Bay, AK 99821.

[2]Dewey, R. D. 1974. Red salmon aquaculture studies, Anadromous Fishes Investigations, Progress Report, 1 July-31 Dec. 1973. On file at Auke Bay Laboratory, National Marine Fisheries Service, Auke Bay, AK 99821.

[3]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

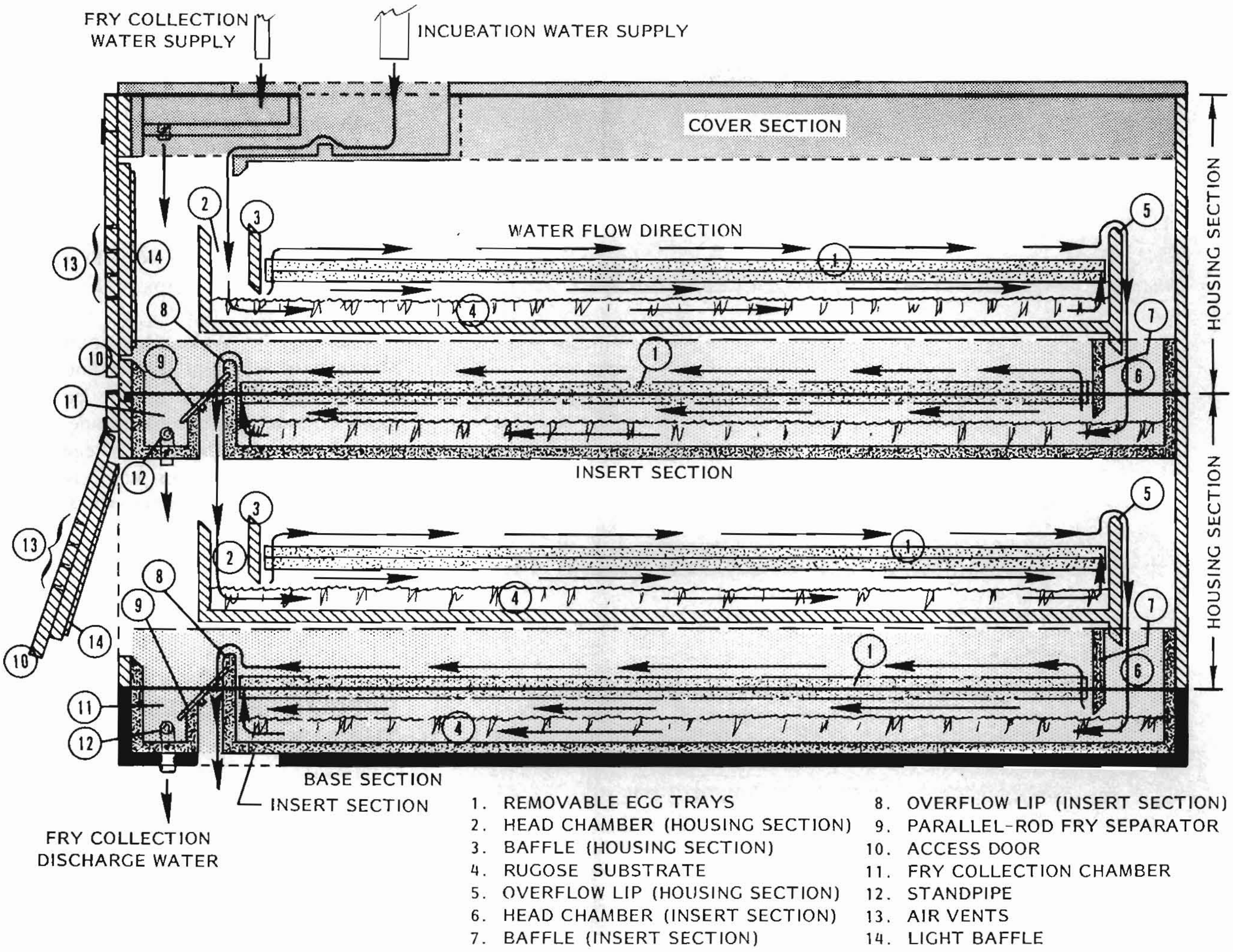


**Figure 1.—Cross section of the incubator developed by the Auke Bay Laboratory.**

in a thin sheet over the overflow lip and drops down to the head chamber of the next insert section. The water goes under the insert section baffle and proceeds as described above. The water spills over the overflow lip of the insert section and is discharged to the head chamber of the housing section below.

The incubators should be inspected periodically with a long-stem dental mirror to see when the eggs have hatched and the alevins have fallen through the plastic mesh of the egg trays to the substrate below. If desired, the parallel-rod fry separator can be inserted behind the overflow lip at an angle at this time. This will prevent any early alevin migration. After the alevins have fallen through the tray, the access door is opened and the egg trays are removed from the incubator by pulling a pair of cords attached to the sides of the tray. After the egg tray is removed from the incubator, the parallel-rod fry separator can be reinserted behind the overflow lip if early migration is still a problem.

The parallel-rod fry separator is inserted into the downstream face of the overflow lip just before the fry are expected to migrate. The fry separator allows the migrating fry to enter a fry collector rather than the lower sections of the incubator. Most of the water passing the overflow lip falls through the parallel rods into the lower head chamber and fry slide down the rods into the fry collector. When the fry separator is placed in the unit, a small stream of water starts flowing into the fry collector water intake of the stack cover section. This water falls down into the uppermost fry collector chamber and builds up to the top of the standpipe and then overflows to the fry collector of the next lower section. The water in the fry collector cushions the fry's fall off the parallel-rod fry separator. The emerging fry in each stack of incubators accumulate in the lowest section and are collected in the front of the stack of incubators. If desired, the fry from an individual tray can be collected by installing suitable plumbing.

The incubators can also be placed individually on vertical racks or shelves and operated just as if they were stacked. This will allow removal of any unit while lower units receive water from the unit above.

The overall size of the original Auke Bay incubator is approximately 48 inches long, 18 inches wide, and 13 inches

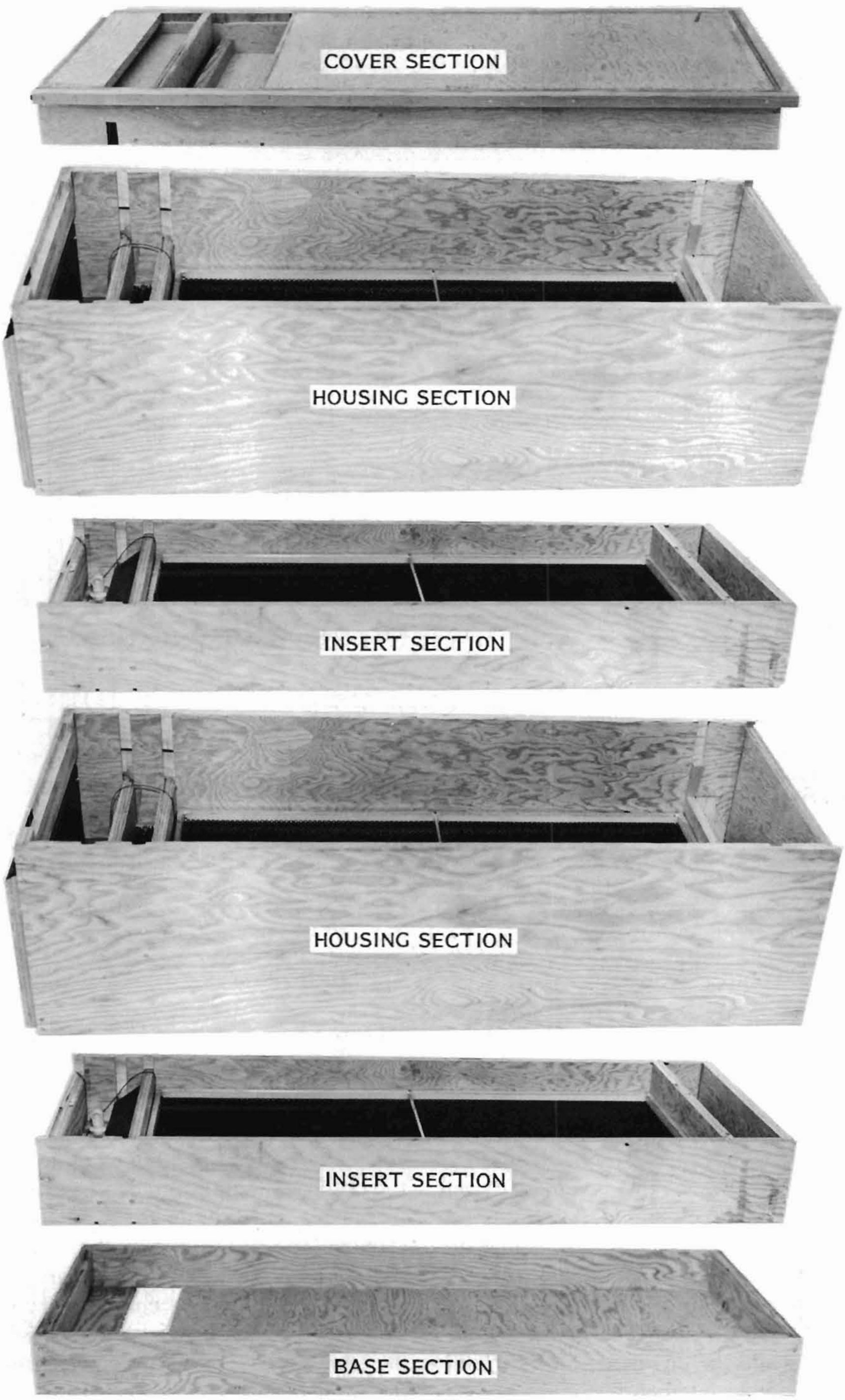


Figure 2.—Photograph of two incubator units with a base section and a cover section.

high. These dimensions were selected for efficient use of 4- × 8-foot sheets of plywood, but the exact dimensions are not critical. The units can be made longer but will still require only a narrow space between the faces of the stacks because the egg trays can be made in short sections instead of long ones and can be hooked together to fill the length of the incubator sections. As the trays are pulled out through the access door, they can be unhooked.

Removing trays of unhatched eggs without disturbing the fry, admitting light, or moving the incubators reduces the tendency for premature emergence, cuts down on fungus growth, and reduces the amount of oxygen needed. If alevins are prematurely flushed out of one tray, they will have multiple opportunities to settle out in a lower unit. The egg trays are made with a frame of aluminum channel and covered with plastic mesh held in place with appropriately sized strips of sheet polyethylene.

Stacking the Auke Bay incubator makes more efficient use of hatchery floor space. Each incubator can be modified to handle more than one layer of trays if higher densities of eggs are needed. The incubator can also be modified for experimental work that requires fry separators for each tray of eggs by replacing the insert section of each unit with a shallow trough with egg trays to return the water to the front.

## SPECIAL FEATURES OF THE AUKE BAY INCUBATOR

1. Migration of fry can be voluntary or controlled.
2. Water is used very efficiently.
3. Gas exchange occurs as the water flows and falls into the lower head chamber in a thin sheet. This exchange renews dissolved oxygen and eliminates some of the dissolved ammonia metabolic wastes.
4. Flow is horizontal through the substrate; this can be changed to upwelling by placing the substrate on a perforated false bottom about one-half inch above the bottom of the tray.
5. Egg trays can be easily removed from the front. Water intake for operation is at the front on the top. Water discharge and fry immersion is from the front on the bottom.
6. All light is sealed out in normal operation.
7. The incubators can be stacked with or without a rack.
8. When incubators are stacked, all sides are straight from top to bottom, facilitating insulation where freezing is a problem.
9. Fry can be raised on rugose substrate of various materials such as gravel or AstroTurf.
10. The units are small and lightweight and can be transported by plane to remote areas.

11. The incubator does not require attention after initial loading.

12. The total unit can be made from plywood with a table saw. For mass production, the design will permit use of molded plastics.

13. The incubator has no screens that might become plugged up with algae or sediment. The parallel-rod fry separator is required only under certain conditions and can be removed and cleaned without disrupting the system.

14. The units make efficient use of the hatchery space from floor to ceiling. They can be placed with their backs to a wall and put in stacks side by side.

15. The incubator can be easily modified for research use by dividing the trays and the fry-collecting chamber across the overflow lip.

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