CHILLED INCUBATION PROVIDES IMPROVED SURVIVAL FOR COHO SALMON

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Introduction

The Inch Creek Salmon Hatchery was built in 1982 to provide incubation and rearing capacity to help support local stocks of coho and chum salmon. The well water supply at Inch Creek Hatchery has a reverse temperature profile, making it warm (up to 13° C) in the winter and cool (down to 5° C) in the summer (Figure 1).

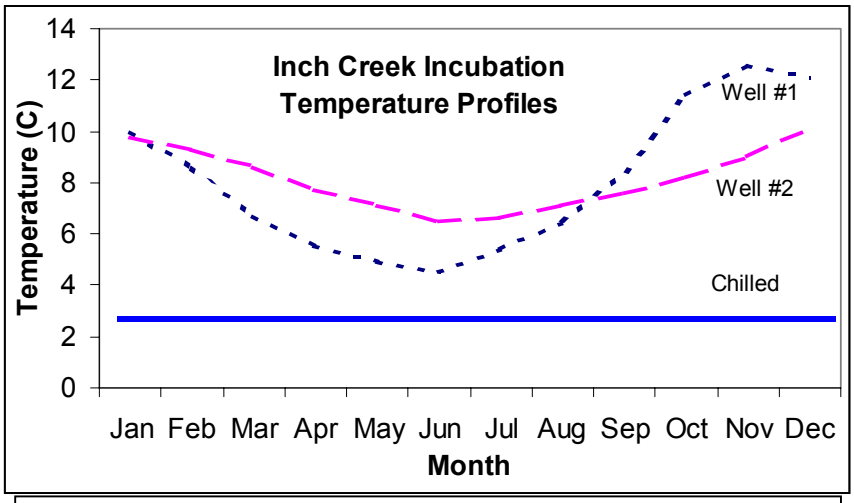


Figure 1. Annual temperature profile for Inch Creek Hatchery wells.

Two major problems when culturing coho have been encountered at this facility:

1. The warm water incubation causes an early ponding and very long rearing period for the fish, requiring a low ration level to meet a target release size of 20 grams. We do not consider near-starvation rearing to be good for the fish.
2. Periodic myxobacterial infections have occurred, usually in April and again in July. The virulence of these infections has been variable from year to year, stock to stock, and from container to container within the same stock and year. The infections required egg targets to be inflated by 20-30% to compensate for rearing mortality.

Delaying the onset of ponding would allow a higher ration feeding regime and might avoid the seasonal onset of myxobacterial infections. In 1994 we conducted a small-scale test on about 10% of our egg target to delay fry ponding by chilling incubation water to 4^{o} C. In 1995 we renovated our incubation room to chill the water to 2^{o} C for 30% of production. In 1998 we made further changes to incubate all coho (1 million eggs) on chilled water.

Methods

The chilled / recirculated incubation consists of a standard Heath tray system modified with the following components:

1. Pump: a 3 hp electric pump circulates about 400 Lpm flow through the system. Electrical power to the pump is backed by the hatchery emergency generator system.

2. Chillers: two 2 hp units and two 3 hp units in series with capacity to cool 400 litres / minute from 14^{o} C to 2^{o} C. An ultra violet sterilization tube treats ½ of the process water on each circuit.

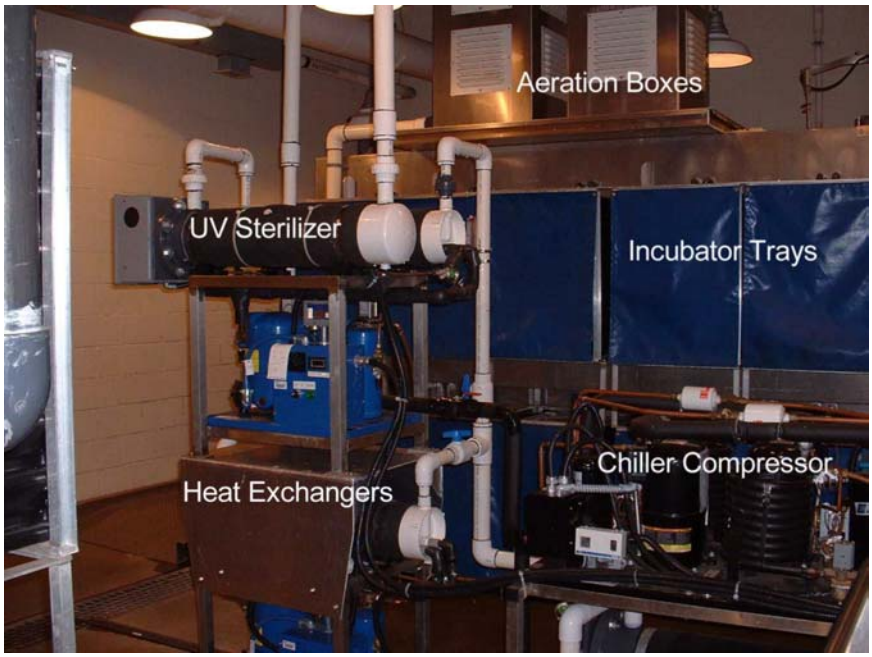
3. Aeration: two boxes, one each for the upper and lower banks of Heath trays. Each box consists of a calibrated distribution plate, a media bed of 1.5 inch diameter flexi-rings, and louvred walls to allow ventilation. This type of media filled box can also act as a biological filter for ammonia.

4. Incubators: Heath type incubation trays arranged in stacks of 8 trays, 10 stacks on an upper level in two rows and 10 stacks on a lower level in two

rows. Each stack is set to a flow of approximately 15 litres / minute and loaded with 7-10,000 coho eggs.

5. Sump: a 500 litre polypropylene box sunk in the incubation room floor. The sump box collects discharge from the Heath trays and acts as reservoir for the pump. Fresh make-up water, about 40 lpm, is added to the sump, and overflow from the system discharges over the lip of the sump tank directly to floor drains.

Photograph 1. Chilled water system at Inch Creek Hatchery.

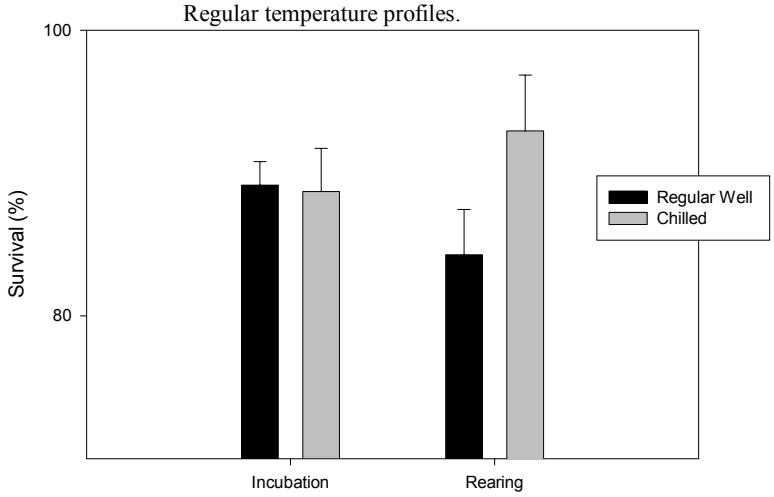


Results and Discussion

Incubation

Initially we were concerned that a prolonged incubation period in cold water could kill fish and reduce fry quality (Weatherly and Gill, 1995) or that a build-up of nitrogenous wastes in the incubators could have detrimental effects during incubation or subsequent rearing (Sigma, 1985). However, there has been no

Figure 1. Survival of fish incubated in Chilled versus Regular temperature profiles.



noticeable difference in overall incubation survival (Figure 1) for chiller versus regular well groups of coho; a mean of 89% from green egg to ponding for both groups. Nitrate and nitrite have remained well below toxic levels, perhaps due to the build-up of nitrifying bacteria on the aeration media.

Although wild coho often withstand cold incubation temperatures, Weatherly and Gill (1995) recommended an initial incubation requirement of 6 days at 6^{o} C

(up to the blastula stage of development). This would have limited our flexibility to manipulate ponding dates. Since Inch egg-takes occur from mid November to late December we needed to keep the chiller system adjusted to 6^{o} C until 6 days after the last egg-take. We have experimented with various groups to test the 6^{o} requirement with mixed results (Table 2). In most cases initial incubation at 6^{o} C gives the best survival.

Rearing

We have had no difficulty raising coho to the target release of 20 grams in mid May. We encountered a problem with pinheads in the first (1994 BY) trial group and had a systemic myxobacteriosis infection in a single channel of 1997 BY Inch coho. Otherwise all chiller incubation groups to date have been disease free. The mean rearing survival of chiller groups has been 93% compared to 84% for regular well groups (Figure 2).

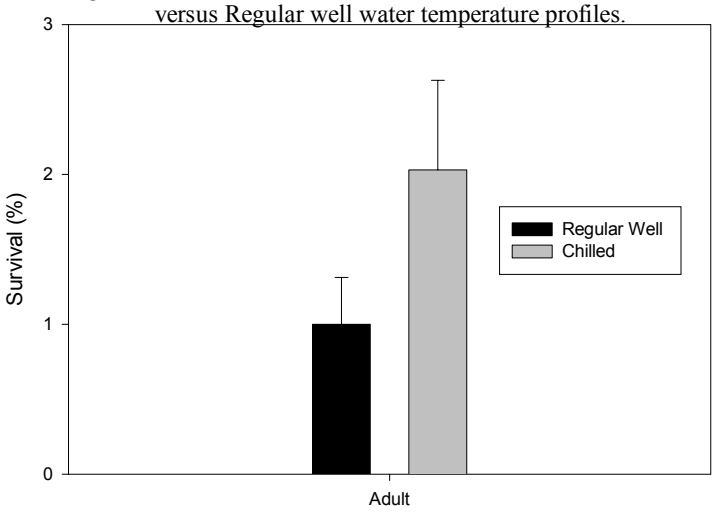
Use of the chiller has led to a major change in hatchery operation. In the past, 1 million coho were ponded in intermediate rearing troughs (IRTs) or circular tubs by mid February and required daily maintenance. These fish were normally 2 grams in size (reaching densities of 25 kg/m$^{3)}$ before release of the previous brood year's coho allowed transfer to concrete raceways. Now those 1 million fish remain in the incubation room an additional 5 months with minimal attention required. Chiller groups are transferred from IRTs to raceways in August at less than 1 gram and before densities reach 10 kg/m^{3}.

The low stress rearing conditions and higher ration level probably account for the reduced rearing mortality. We have adult survival results from 3 brood years of chilled Inch coho. These groups were marked with coded wire tags (CWTs) and released under nearly identical final rearing conditions. The chiller fish survived at twice the rate of regular well groups (Table 1).

Ocean Survival

The survival from smolt to adult of two brood years of coho from Inch Creek showed that the group incubated on chilled water survived at about twice the rate compared to fish incubated on the regular well water temperature profile (Figure 3.). This result should be taken with considerable caution, due to the large error associated with coded-wire tag returns.

Figure 3. Survival from Smolt to Adult of fish incubated in Chilled versus Regular well water temperature profiles.



Conclusions

In summary the use of chilled/recirculated water for coho incubation at Inch Creek Project has the following benefits:

- Equivalent incubation success to regular well water.
- Reduced rearing mortality.
- Reduced rearing program work load.
- Improved smolt quality.

The hatchery is supplied by wells that provide water of excellent quality but whose temperature profile is out of phase with surface waters. The well water can be as high as 13.5°C in the winter and as low as 5°C in the summer. This poses a problem for coho salmon culture because the hatchery's goal is to release coho smolts in the spring to mimic the natural life history of the stocks. Such high winter temperatures accelerate the development of eggs during incubation, such that the fish emerge prepared to feed in January, rather than in April when they would emerge in their natal streams.

References

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Weatherly, A.H. and H.S. Gill. 1995. Growth. Pp 101-158 in Groot, C., L. Margolis and W.C. Clarke. Physiological Ecology of Pacific Salmon. U.B.C. Press, Vancouver

Acknowledgements

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