AQUACULTURE update

Number 90 Editor: C. Clarke Date April 7, 2003
Pacific Biological Station

New Mechanical Shock Sensitivity Units In Support Of Criteria For Protection Of Salmonid Eggs From Blasting Or Seismic Disturbance

Jensen and Alderdice (1983, 1989) showed that salmonid egg sensitivity increased soon after fertilization and that eggs became extremely sensitive to shock during epiboly or yolk overgrowth. In addition, they reported the magnitude of sensitivity in units of drop height (cm) and energy (ergs) that caused 50% and 10% mortality. These units were useful in illustrating the changes in egg sensitivity during egg incubation. However, these units were not directly applicable to such forms of shock as blasting, pile driving, or seismic shock.

This Aquaculture update describes a new approach (Jensen, 2003) to convert the original data to the final velocity ($cm \cdot s^{-1}$) that the eggs reach when dropped from a height resulting in 10% mortality. The new unit of egg sensitivity can then be compared to the peak particle velocity (PPV) criteria of 1.3 $cm \cdot s^{-1}$ recommended by Wright and Hopky (1998) for blasting. The species tested were chinook (*Oncorhynchus tshawytscha*), chum (*O. keta*), coho (*O. kisutch*), pink (*O. gorbuscha*), and sockeye salmon (*O. nerka*), and rainbow or steelhead trout (*O. mykiss*).

Jensen and Alderdice (1983, 1989) used a device (Fig. 1) developed to expose small groups of eggs to a series of standardized quantifiable shock intensities. The drop heights that were determined to cause 10% mortality were used to determine the corresponding final velocity reached by the eggs. The relationship of the parameters of drop height (h; cm), initial velocity (vo; $cm \cdot s^{-1}$), final velocity at time of impact (vt; $cm \cdot s^{-1}$), and acceleration due to gravity (g; $cm \cdot s^{2}$) is illustrated in the following equation:-

$$vt = (vo^2 + 2 \bullet g \bullet h)^{1/2}$$

where vo=0, g=980. The LD10 velocities were calculated by substituting LD10 drop heights for h.

To illustrate these changes in egg sensitivity as embryonic development progresses, the predicted LD10 velocities (based on log-linear models and parabolic models) for chinook salmon eggs, are plotted against ATUs (°C-days) from fertilization (Fig. 2). Similar models and predictions can be found in Jensen (2003) and in the WinSIRP program available for downloading from the following website:-

http://www-sci.pac.dfo-mpo.gc.ca/aqua/sirp/sirp_e.htm

LD10 velocity minima were determined from parabolic models for each species. These LD10 velocity minima and the ATUs when they occur, for the six salmonid species tested, are listed in Table 1.

These values are at least ten times greater than the PPV of 1.3 $cm \cdot s^{-1}$ recommended as a safe criterion for the use of explosives by Wright and Hopky (1998).

Hence, these new mechanical shock units of LD10 velocities indicate that the current guidelines for the use of explosives near salmonid spawning redds provide at least a ten-fold margin of protection for Pacific salmon eggs at their most sensitive stages.

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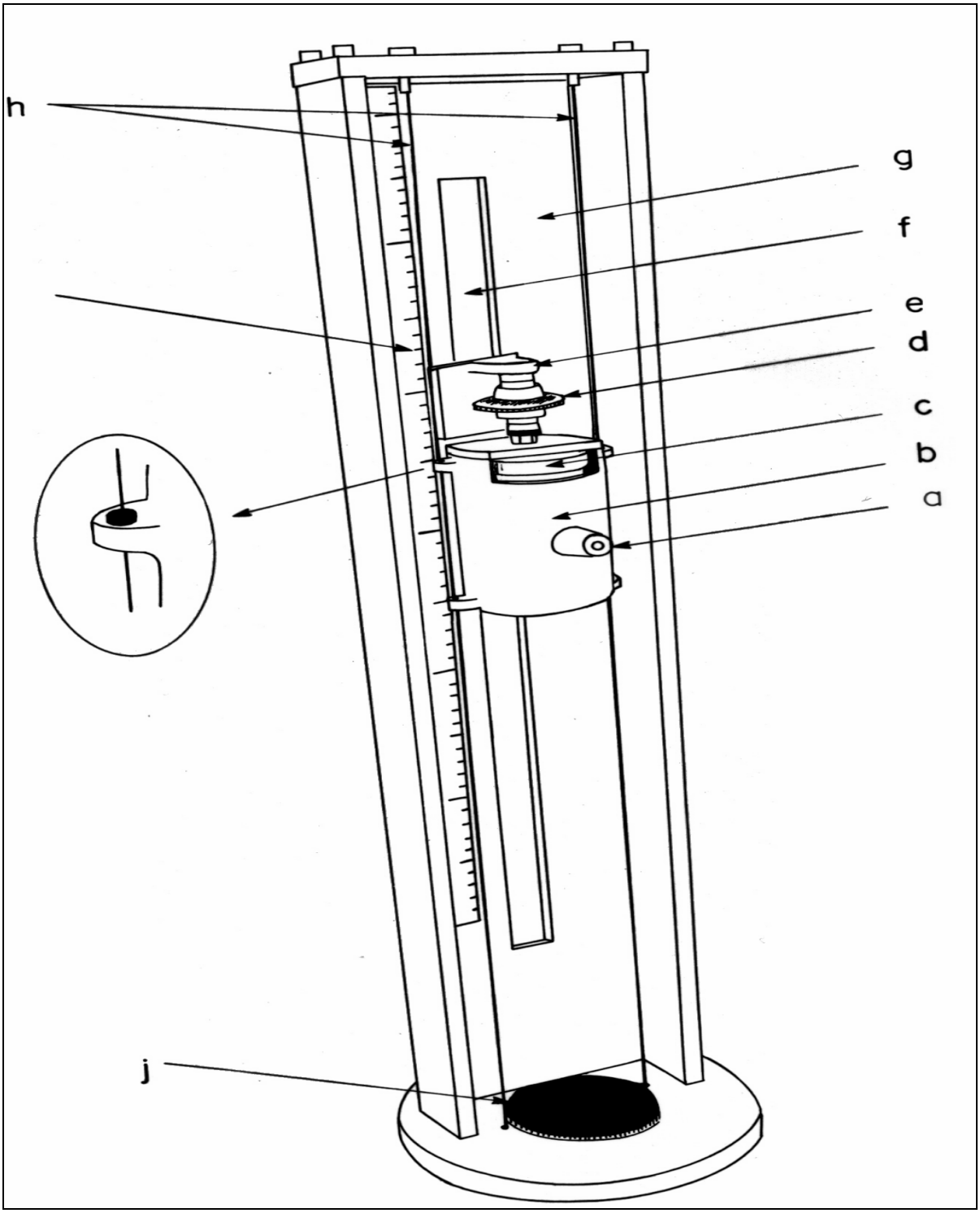

Figure 1. Mechanical device for shocking salmonid eggs (from Jensen and Alderdice, 1983).

a: handle for raising carrier; **b:** metal carrier; **c:** slot for petri dish in position; **d:** release trigger; **e:** release platform; **f:** slot for adjustment of release platform height; **g**: stage frame; **h**: metal guide wires; **i:** 100-cm scale; **j:** base plate. Inset: showing guide wire passing through Teflon® sleeve.

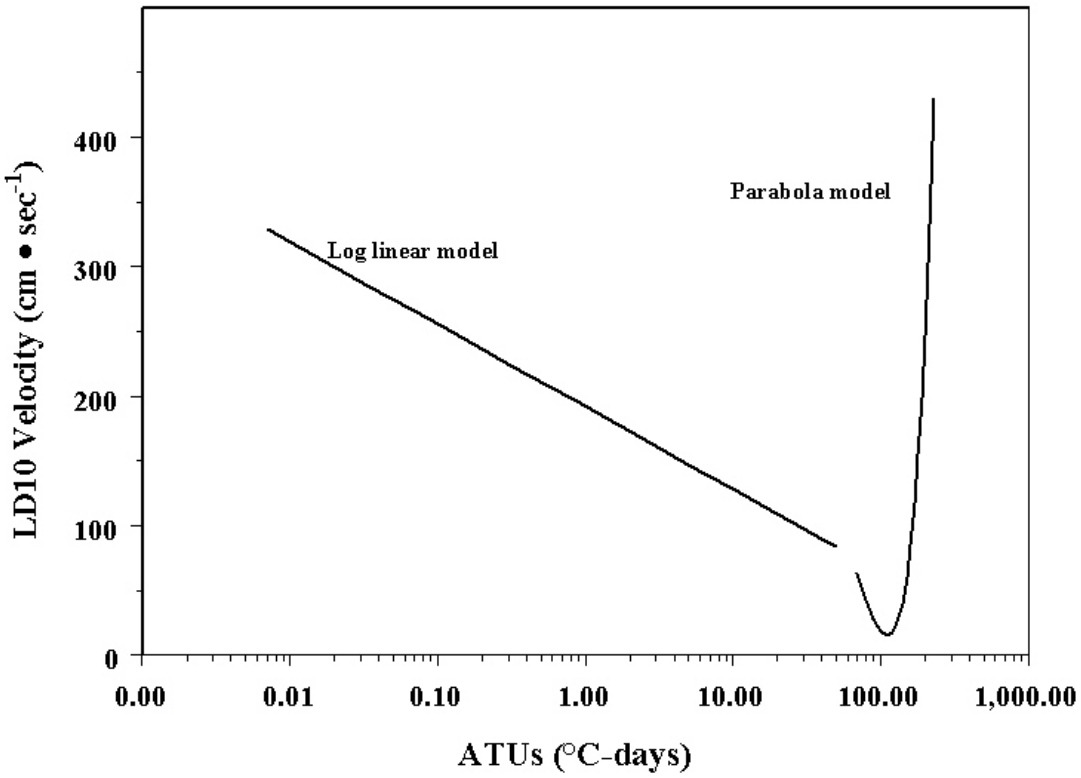

Figure 2. Predicted LD10 velocities for chinook salmon eggs are plotted against ATUs (°C-days) from fertilization. The minimum LD10 velocity was 14.6 cm · s^{-1} and occurred at 110.8 ATUs.

Table 1. Predicted minimum LD10 velocities (cm · s^{-1}) at ATUs (°C-days) post-fertilization.

Species	**Minimum LD10 Velocity** (cm · s^{-1})	**ATUs** (°C-days)
Chinook	14.6	110.8
Chum	41.6	99.8
Coho	23.1	94.7
Pink	62.3	87.8
Sockeye	83.8	90.6
Steelhead	33.2	78.3

References

Jensen, J.O.T. 2003. New mechanical shock sensitivity units in support of criteria for protection of salmonid eggs from blasting or seismic disturbance. Can. Tech. Rep. Fish. Aquat. Sci. 2452: 18 p.

Jensen, J.O.T. and Alderdice, D.F., 1989. Comparison of mechanical shock sensitivity of eggs of five Pacific salmon (*Oncorhynchus*) species and steelhead trout (*Salmo gairdneri*). Aquaculture, 78: 163-181.

Jensen, J.O.T. and D.F. Alderdice. 1983. Changes in mechanical shock sensitivity of coho salmon (*Oncorhynchus kisutch*) eggs during incubation. Aquaculture. 32: 303-312.

Wright, D.G. and G.E. Hopky, 1998. Guidelines for the use of explosives in or near Canadian fisheries waters. Can. Tech. Rep. Fish. Aquat Sci. 2107: iv + 34p.