Survival of Brown Trout Eggs: Two Planting Techniques Compared

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ABSTRACT: Vibert boxes are commonly used in planting trout eggs in streams for incubation. We compared survival of eggs, embryos, and swim-up fry of brown trout (*Salmo trutta*) in direct intragravel plants and in Vibert boxes. We found that egg mortality increased disproportionately in Vibert boxes after 4 weeks until time of hatching. Direct intragravel plants yielded the highest survival to the swim-up stage.

Conservation groups and agency fisheries personnel have planted fertilized trout eggs into stream gravels to introduce, restock, or supplement populations of stream salmonids. Eggs have either been planted in box-containers of some type (Vibert 1949; Anon. 1951; Rasmussen 1970) or deposited directly into the gravel (Stockley 1954; Sedgwick 1960). Boxes are usually used, but there are no data suggesting that this method is better than planting eggs directly in stream gravels (J. D. McIntyre, unpublished data). The purpose of this study was to determine whether one of the two methods resulted in greater egg and fry survival.

Methods

This study was conducted in conjunction with the planting of 1 million eyed eggs of brown trout (*Salmo trutta*) over a 9.5-km reach of the South Mills River in Henderson and Transylvania counties in western North Carolina. The river is a fourth-order stream, draining a forested watershed of 9159 ha. Channel gradient averages 2% over substrates of about 20% sand, 7% gravel, 70% rubble, and 3% boulder. Seven planting locations were selected in the fall of 1977 on the basis of spawning-size gravels, apparent subsurface flow (as indicated by topography), and protection from freezing. Vibert boxes and the methods described by Stockley (1954) and Sedgwick (1960) were used to introduce eggs into sites prepared by digging depressions 1 m in diameter and 25 cm deep in the stream bed. Both types of Vibert boxes were tested—the original single-compartment box (Vibert 1949) and the new two-compartment box designed by Whitlock (Federation of Fly Fishermen 1975).

At each planting location, each of the following treatments was replicated three to five times: a plant of four two-compartment Vibert boxes, each containing 500 eggs; a plant of two one-compartment Vibert boxes, each containing 500 eggs; and a direct plant of 5000 eggs. Each replicate shared comparable substrate and overgravel and subsurface water flow. The remaining eggs were planted in boxes and with direct plants in the most expeditious manner possible. All plantings were numbered and marked with metal stakes for future sampling.

To estimate the number of fry leaving the gravel, we selected one replicate at each of three locations and installed a fry trap (Phillips and Koshki 1969) on each treatment for the duration of the study. An attempt was made to excavate and evaluate at least two complete replications every 2 weeks. Waterborne eggs and fry were collected in a fine-mesh seine placed immediately downstream from the planting.

Eggs were planted in early December, about 20 days before scheduled hatching. Colder than normal weather, however, delayed hatching until late January. Heavy ice obscured plantings in mid-February, when only one replication was evaluated. Ice also destroyed four of the nine sites where fry traps were installed. Fry emerged in mid-March; all remaining plants were then evaluated for eggs, sac fry, and fry still in the gravel.

Results

Biweekly evaluation of planting sites revealed a mortality of 5% per week during the first two sampling periods, regardless of planting technique. Egg mortality for boxes and direct plants started diverging 4 weeks after planting and continued into the 7th week (Fig. 1). At this time, which was right before hatching, a threefold increase in mortality occurred at all sample sites. This increase corresponded with a period of very

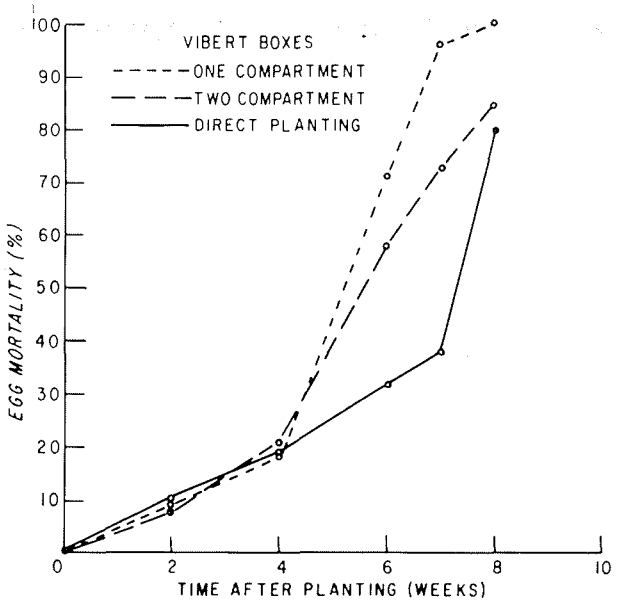

Fig. 1. Egg mortality observed in planting sites.

cold weather that produced anchor ice in the stream. Several nonsample sites were excavated during this period. Some contained frozen eggs, and freezing undoubtedly contributed to the low overall hatching success we observed (Table 1).

No eggs hatched in one-compartment boxes and only 15% of the eggs in two-compartment boxes produced sac fry. Production of swim-up fry from eggs planted directly into the gravel was 2.5 times greater than that from two-compartment boxes. Chi-square tests for heterogeneity showed that there was a highly significant difference ($P > 0.01$) in mean number of sac fry produced by the three planting techniques and a highly significant difference ($P > 0.01$) in mean survival to the swim-up stage for two-compartment boxes and direct plants.

Discussion

Contrary to the findings of Harris (1973), sediment deposition (Fig. 2) and fungal growth (Fig. 3) on eggs were extensive in both one- and two-compartment Vibert boxes. There were strong indications that sediment affected egg mortality in boxes (Fig. 4). Mortality per

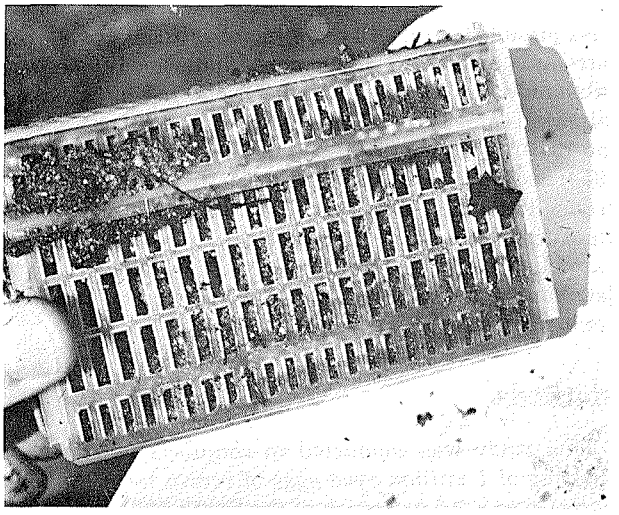

Fig. 2. Sedimented and fungus-entrapped eggs.

Table 1. Mean number and percentage of planted, eyed, brown trout eggs surviving at various times after planting.

Number of weeks after planting	Planting technique[a]											
	One-compartment Vibert box				Two-compartment Vibert box				Direct plant			
	Number examined	Survival			Number examined	Survival			Number examined	Survival		
		No.	%	S.D.		No.	%	S.D.		No.	%	S.D.
2	4	453.3	91	24.2	8	460.9	92	27.2	2	4508.5	90	275.1
4	4	408.5	82	18.4	8	395.9	79	39.9	2	4048.5	81	269.4
6	4	144.5	29	64.5	8	216.5	43	64.4	2	3402.3	68	357.1
Hatching												
8	4	0.0	0	0.0	6[b]	74.5	15	27.2	3	1010.0	20	434.2
10	2	0.0	0	0.0	4	34.3	7	19.4	1	808.0	16	—
12	4	0.0	0	0.0	8	31.1	6	23.8	2	551.0	11	101.8
Swim-up												
14	2	0.0	0	0.0	6[c]	20.3	4	20.2	2	507.1	10	171.1

[a] One- and two-compartment Vibert boxes each contained 500 eggs; 5000 eggs were deposited at each direct plant site.
[b] Two of eight sample boxes were not included because they washed out of the gravel.
[c] Fry were trapped from only six of eight boxes because of an incorrectly positioned fry trap.

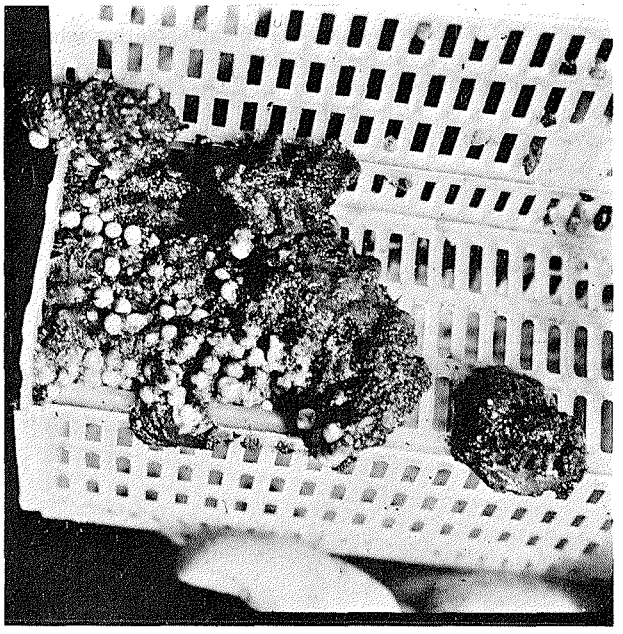

Fig. 3. Fungal growth observed on eggs in Vibert boxes.

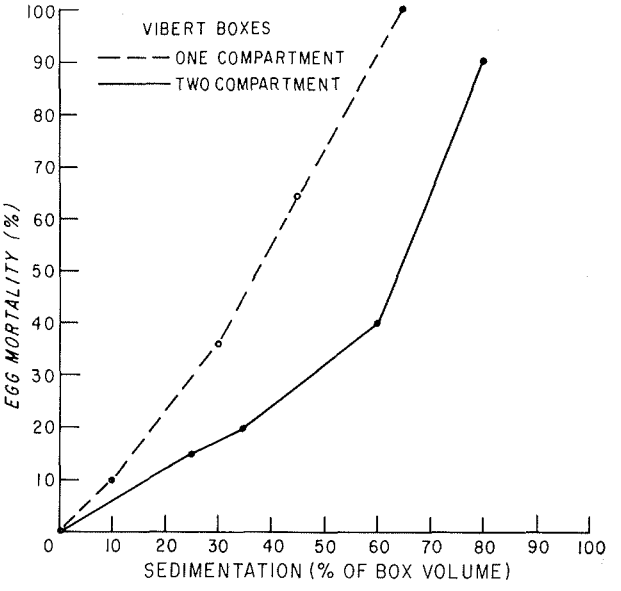

Fig. 4. Relation of egg mortality in Vibert boxes to estimates of observed sediment accumulation.

unit volume of sediment was greatest in one-compartment boxes where eggs and sediment deposition occurred in the same zone. Eggs in two-compartment boxes were not immediately affected by sediment accumulating below them in the lower chamber. Observations made when anchor ice was present indicated that eggs in boxes containing sediment were more likely to freeze than those in unsedimented boxes. Heat transfer theory confirms these observations. A large number of the Vibert boxes contained not only dead embryos and fry, but also live fry trapped past the point of swim-up. Entrapment by sediment was not observed at the intragravel plant sites.

In addition to sample boxes, we also evaluated sediment deposition at the end of the study in more than 65% of the other 250 nonstudy boxes planted. In these boxes, sediment accumulation was estimated to the nearest quarter of box volume. Estimates of accumulation ranged from 25 to 100% and averaged 75%.

There were clear differences between the deposition of sediment in Vibert box plants and direct intragravel plants. Boxes impeded water movement and induced sediment deposition in and immediately around the egg box. Direct intragravel plants, on the other hand, did not exhibit this characteristic. Sediment appeared to move through planted sites, with deposition occurring only on the downstream outer perimeter of the prepared site.

We also observed large numbers of fungus-covered eggs in box plants which were not evident in intragravel plants. Mycelia were observed in boxes 4 weeks after planting and became more of a problem as time progressed. After 15 weeks, the eggs and dead fry that remained were consolidated into a mass of fungi. This finding suggests that eggs confined in boxes are more susceptible to fungal agents than eggs in intragravel plants, where egg distribution is similar to that in natural redds.

In summary, no differences were apparent between the two techniques until 4 weeks after planting. Thereafter, sediment accumulation and fungus development in Vibert boxes appeared to increase mortality of eggs and fry. Results of this study were obtained in a year when the weather was unusually cold. Any conclusions that are made, therefore, must be regarded as tentative. In this one experiment, however, it appeared that intragravel egg plants were superior to Vibert boxes for introducing large numbers of eggs into streams for incubation.

Acknowledgments

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