HEATH TRAY INCUBATION AND REARING OF STEELHEAD TROUT (SALMO GAIRDNERI) AT FULTON RIVER

by
Christine Banford

Enhancement Services Branch
Fisheries and Marine Service
Department of Fisheries and the Environment
Vancouver, B.C. V6G 2P1

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DEPARTMENT OF FISHERIES AND THE ENVIRONMENT
ENHANCEMENT SERVICES BRANCH
PACIFIC REGION

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ABSTRACT

Steelhead trout *(Salmo gairdneri)* egg and sperm were taken from the Babine River stock and placed in Heath trays at Fulton River in 1977. The application of coded-wire tags to juveniles should provide valuable information concerning steelhead survival and ocean growth, migrational patterns, migrational timing and the degree of interception by commercial, sport and Indian fisheries. 113,500 eggs were fertilized and incubated in Heath trays. Following the incubation and rearing period (May to December), the number of steelhead surviving was 31,273.

Key words: steelhead, placed, Heath trays, coded-wire tags, survival, growth, migrational patterns, timing, interception, fisheries, fertilized, incubated, rearing.

RÉSUMÉ

En 1977, on a ensemencé des bacs Heath prés de la rivière Fulton avec des oeufs et du sperme de truites steelhead *(Salmo gairdneri)*, prélevés du stock de la rivière Babine. Grâce à l'insertion de fils métalliques codées dans les jeunes, on devrait recueillir des renseignements utiles sur la survie et la croissance de l'espèce dans l'océan; sur la période et les mouvements migratoires; sur l'importance de la pêche commerciale, sportive et de celle qui est pratiquée par les Indiens. Au total, 113,500 oeufs ont été fécondés et incubés dans les bacs Heath. Après la période d'incubation et d'élevage (de mai à décembre), le nombre de survivants s'élevait à 31,273.

Mots clés: truite steelhead; ensemencement; bacs Heath; fils métalliques codées; survie; croissance; mouvements migratoires; période migratoire; prise; pêches; fécondation; incubation; élevage.

INTRODUCTION

The Fish and Wildlife Branch, together with the Department of Fisheries, are working on the Salmonid Enhancement Program. The program is largely concerned with intense research and management regarding steelhead trout in British Columbia. A major Fish and Wildlife commitment is to arrest the declines and increase the number of steelhead available to the angler. Under the influence of Fish and Wildlife, the Department of Fisheries has undergone the present steelhead project located at Fulton River.

In the spring of 1977, steelhead trout (*Salmo gairdneri*) eggs and sperm were taken from the Babine River stock. The eggs were flown 100 kilometers south to Fulton River where facilities were available for incubation and rearing. In the spring of 1978, one-year-old steelhead are to be tagged with coded-wire nose tags, reared for another year, and released as two-year-old smolts in Babine River in 1979. In 1978, steelhead eggs will again be incubated and reared similarly, and released as smolts into Babine River in 1980. An expected 25,000 smolts are to be released in each year.

The application of coded-wire tags to juvenile steelhead should provide valuable information concerning steelhead survival and ocean growth, migrational patterns and timing, and the degree of interception by commercial, sport and Indian fisheries.

The following report summarizes the steelhead program at Fulton River from May to December, 1977.

MATERIALS AND METHODS

Egg Take and Incubation

Adult steelhead donors were obtained from the Babine River stock in early May, where 30 females and 20 males were taken over a three-week period, and eggs and sperm were taken over a three-day period. After stripping live adults, eggs and sperm were airlifted 100 km south to Fulton River (Figure 1). During transport, sex products were held separately in clear plastic bags and placed inside pails partially filled with cold water. Eggs were measured volumetrically, placed into 10 ℓ buckets and fertilized. Depending on availability of adults each day, ova from one or two females were fertilized with milt from three or four males (30 - 50 mls). Milt was mixed thoroughly and poured over eggs inside buckets, followed by gentle hand-mixing. Green eggs were washed and placed in Heath incubators where they were water hardened for two hours and disinfected for 10 minutes with a 1:150 dilution of commercial Wescodyne[1] (1.6% available iodine) buffered with 0.05 percent sodium bicarbonate. After the 10-minute exposure, trays of eggs were placed into troughs of running water to dissipate the disinfectant. All water exposed to eggs prior to disinfection was held back and disinfected before its release, using Woods' (1974) technique.

Twelve heath trays were distributed into three vertical stacks, each stack receiving a water flow of 18 ℓ/min (Figure 2). To inhibit growth of fungus, the eggs were initially treated once with malachite green (California flush method; Woods, 1974). Stacks were covered with black plastic sheets to prevent light from entering trays. Eggs were checked every three to four days for development stage and signs of fungus.

Inflow and outflow oxygen levels were determined daily, using the Winkler iodometric technique. Inflow maximum and minimum temperatures were recorded daily, using an Ertco calibrated thermometer. Average daily temperature was calculated, from which heat units were determined. Water flow through stacks was monitored regularly at the outflow, by determining the time required to fill a 23 ℓ bucket.

Dead eggs were removed when the eggs clearly showed eye spots. The eggs were picked with 15 cm long, 9 mm diameter pyrex pippettes, equipped with rubber squeeze bulbs for suction (Lewis _et al._, 1976).

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[1] West Chemical Products.

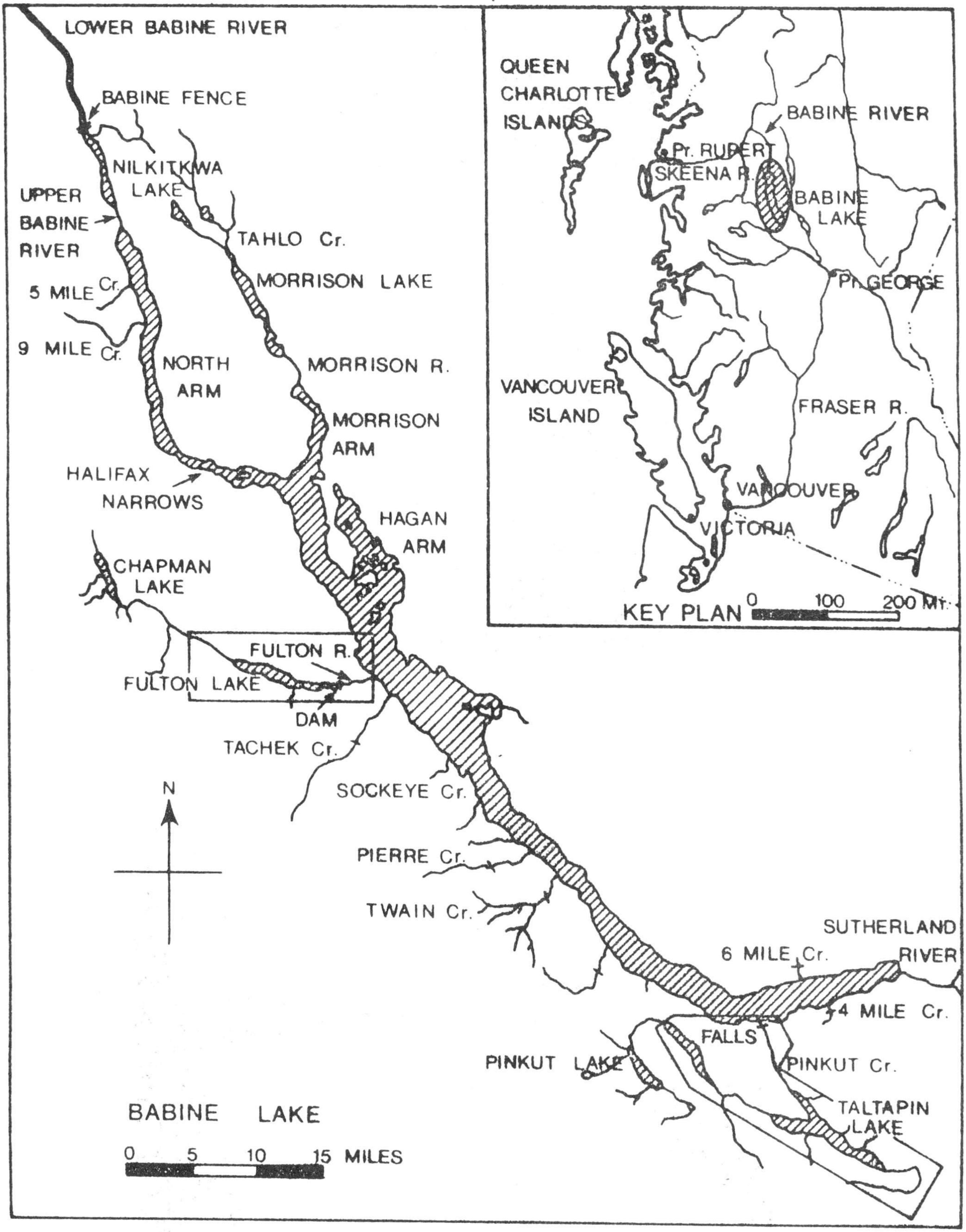

Figure 1: Map showing location of Babine River (fence) where steelhead eggs were collected and airlifted to Fulton River for incubation, 1977.

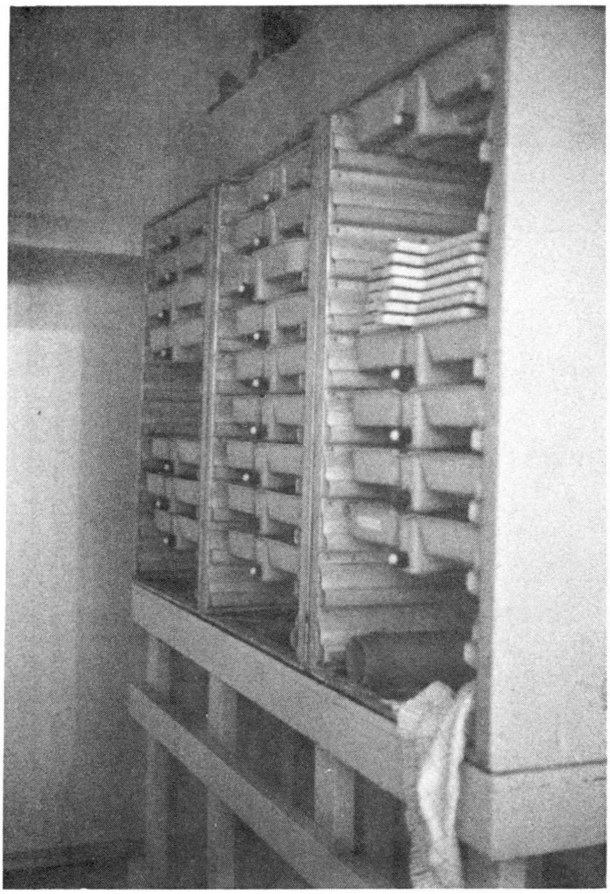

Figure 2: Heath tray incubators.

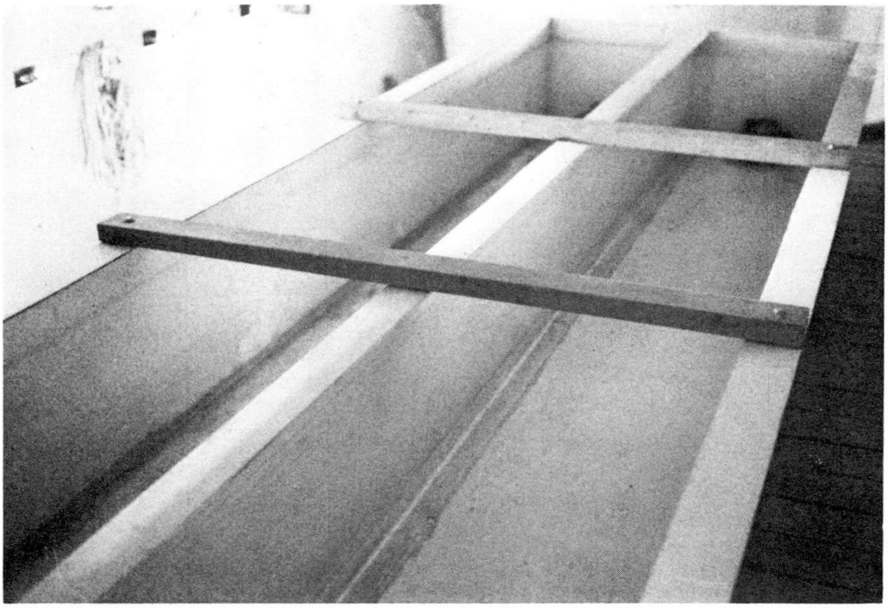

Figure 3: Troughs.

By July 9, fish had absorbed their yolk sac and were ready to feed. Tray units were moved to troughs of running water, placed on the bottom, cover screens removed, and the fish allowed to swim out.

Rearing

In two flow-through troughs, each 0.6 m wide, 4.6 m long, 0.4 m water depth, with a capacity of 1100 ℓ, fish were fed small quantities of starter mash every hour during the day (Figure 3). Water flow was 50 to 70 ℓ/min, depending on size and strength of fry. On July 24, fish were volume counted and transferred to three circular rearing tanks, 3 m diameter, 1.0 m water depth, with a capacity of 7390 ℓ (Figure 4). Outflow was through center standpipes and discharged directly into Fulton River. Bottoms and sides of tanks were brushed when necessary.

Weekly subsamples of fish were anesthetized with 2-phenoxyethanol (0.2 ml/ℓ) and weighed in an aluminum pan on a triple beam balance. The number of fish in samples decreased as fish size increased. Calculations were made to determine g/fry, feeding level and feeding frequency. As the fish increased in size, food size was increased as per the recommendations of Lewis, et al., (1976).

Fish were treated with uniodized salt for an external protozoan (*Chilodonella* sp.) on July 26, August 2, and August 30. Fish were transferred to a small tub, 0.5 m wide x 0.9 m long x 0.3 m water depth, with a capacity of 162 ℓ, and bathed in either a 1 percent or 3 percent salt solution, depending on age of fish, oxygen level and temperature of water. The fish were bathed for 10 to 15 minutes every day for five to seven days, during which time water was aerated with oxygen (Bell, 1977).[2]

On October 1, fish were treated with terramycin[3] for the control of myxobacteria. This was used as a bath treatment at a concentration of 2 ppm for one to two hours. Treatment continued every day for five to seven days. The water level in circular rearing tanks was lowered to a depth of one foot, and a 10 ℓ dilution of the antibiotic was mixed thoroughly into the tank. Water was aerated with oxygen during treatments.

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[2]Through personal communication, Gordon Bell outlined technique for salt treatment.

[3]See footnote on following page.

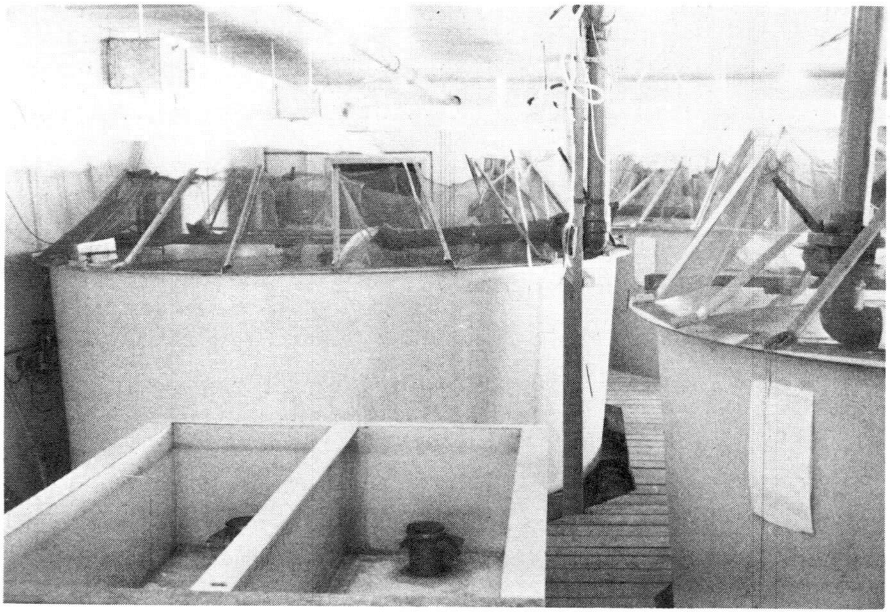

Figure 4: Circular rearing tanks.

TM-50D[3] was mixed in with daily feed following the period of terramycin bath treatments, in order to prevent further invasion of myxobacteria. TM-50D is in a water-dispersible form, containing 1 g terramycin in each 9 g TM-50D. The drug was administered at a rate of 36 g TM-50D/454 g fish, every day for 10 to 15 days.

Fish were treated with malachite green (0.5 ppm) for control of fungus *(Saprolegnia* sp.) beginning in early October. Treatment was initially given every day, decreasing to once a week as fish health improved. The method (California flush; Woods, 1974) involved dissolving the powdered chemical in a bucket of water and mixing thoroughly into each tank. The water was then allowed to recirculate until clear.

RESULTS

Egg Take and Incubation

A total of 113,500 ± 13,620 eggs (95 percent confidence limit) were fertilized. The average egg size was 0.20 ml (S = ± 0.01 ml). Loading density was based on availability of eggs from day to day, and varied from 4,000 to 12,000 eggs per tray (Table 1).

Oxygen level of inflow to heath trays decreased from 11 ppm in May to 8 ppm in June (Figure 5). Water temperature increased from 8^{o}C in May to 15.5^{o}C in June (Figure 6).

Eggs fertilized on May 19 began hatching with 568 ^{o}C/days (29 days at an average water temperature of 10.5^{o}C). Eggs fertilized on May 20 began hatching with 554 ^{o}C/days (28 days at an average water temperature of 10.6^{o}C). Eggs fertilized on May 24 began hatching with 512 ^{o}C/days (25 days at an average water temperature of 11.1^{o}C). In each group of eggs, hatching began on the 29th, 28th, and 25th day and was completed on the 32nd, 31st, and 28th day (Table 2, Figure 7). Yolk absorption was complete 18 days after hatching.

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[3]Terramycin and TM-50D are trade names of the Charles Pfizer Company for the antibiotic oxytetracycline.

Table 1: Total number of steelhead eggs incubated and egg to fry survival, Fulton River, May, 1977.

Tray #	# Eggs Incubated	95% Confidence Limits	Egg to Fry Survival #	%
1	12,000	± 1,440	6,440	53.7
2	12,000	± 1,440	10,060	83.8
3	7,000	± 840	0	0
4	4,000	± 480	0	0
5	11,500	± 1,380	6,025	52.4
6	10,000	± 1,200	3,120	31.2
7	10,000	± 1,200	5,480	54.8
8	10,000	± 1,200	6,840	68.4
9	10,000	± 1,200	5,670	56.7
10	10,000	± 1,200	6,220	62.2
11	10,000	± 1,200	0	0
12	7,000	± 840	3,520	50.3
TOTAL	113,500	±13,620	53,375	47.0

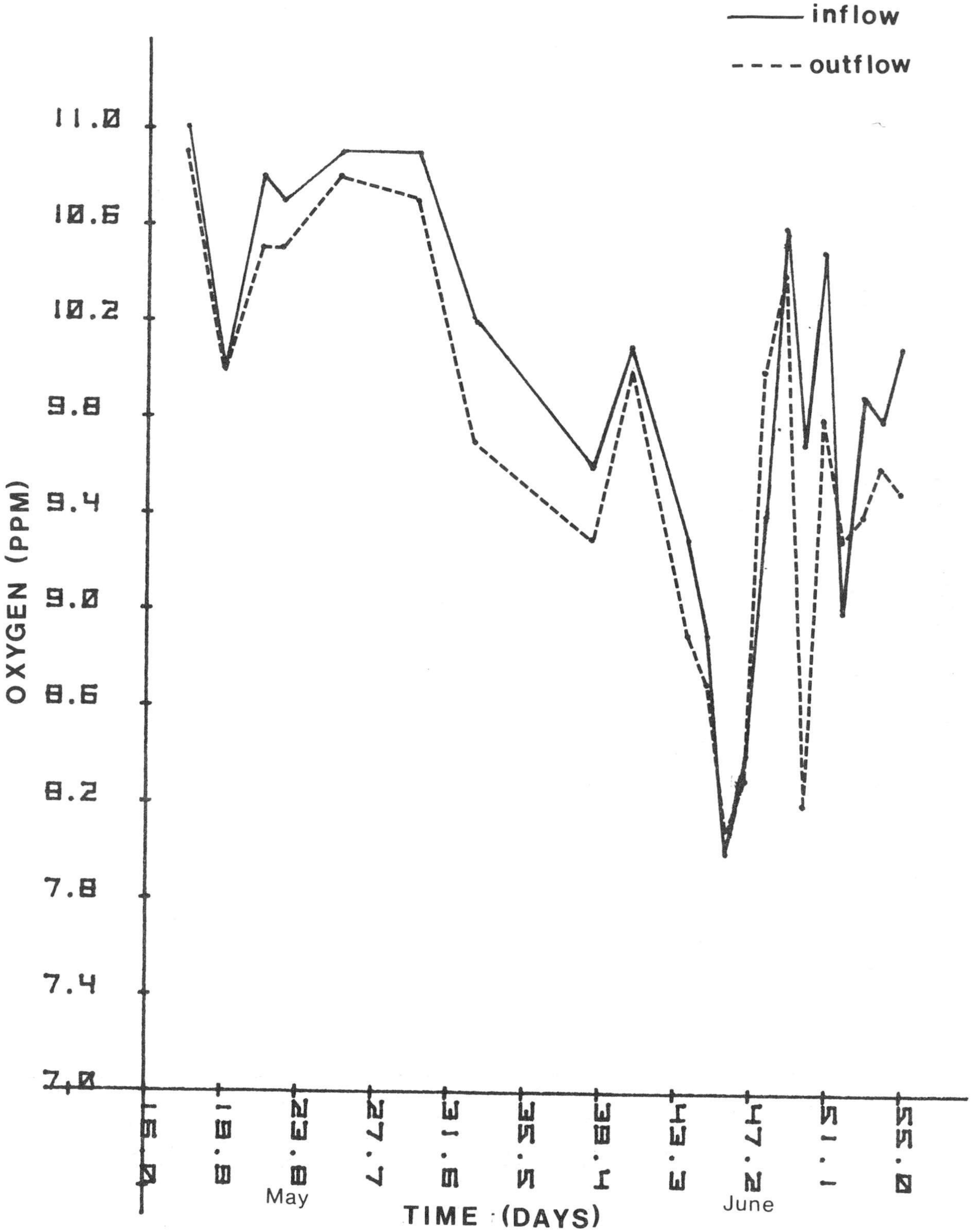

Figure 5 : Oxygen content of water flow to and from heath trays during incubation period, Fulton River, 1977.

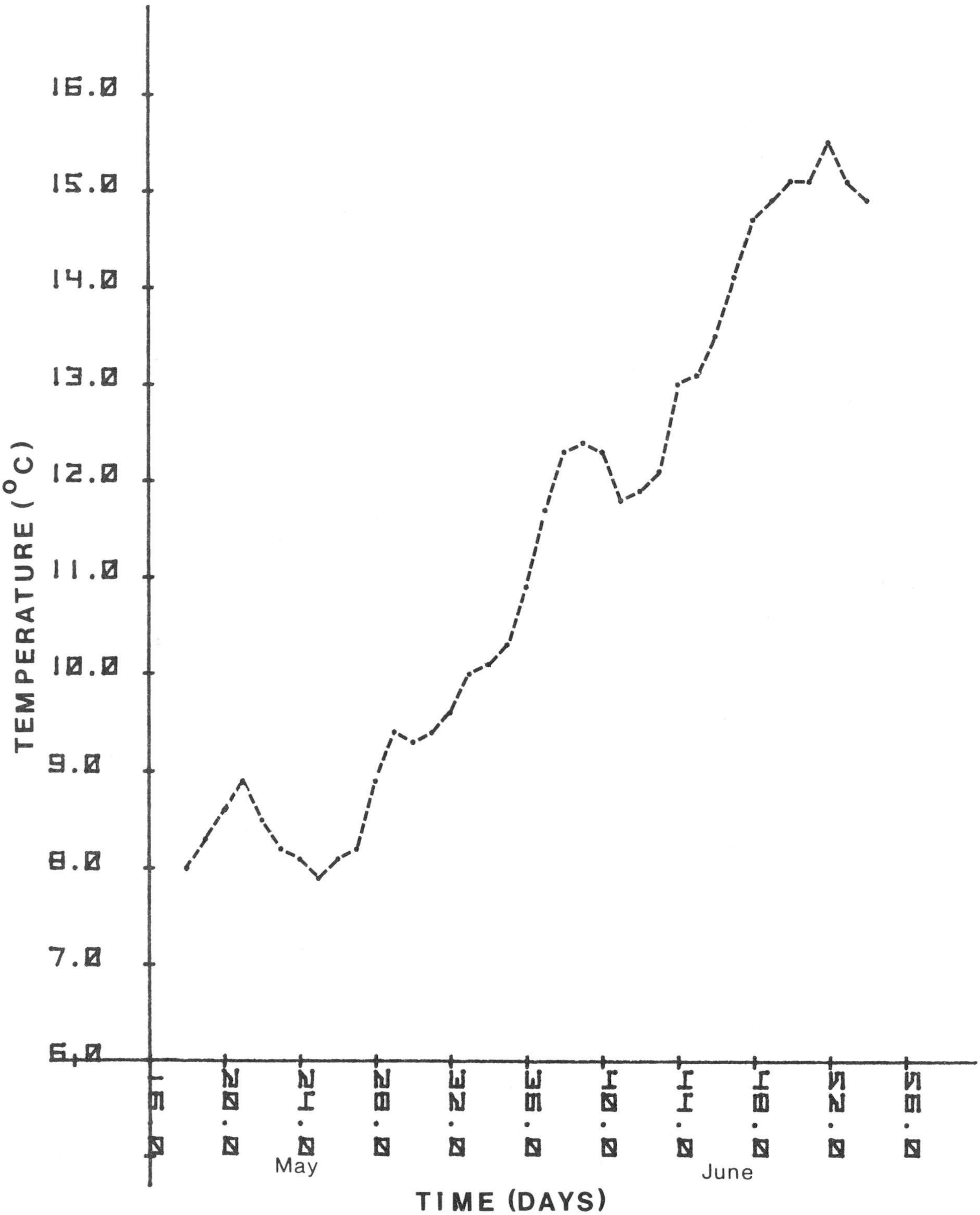

Figure 6 : Average daily temperatures during incubation period, Fulton River, 1977.

Table 2: Planting dates of steelhead eggs, average temperature during incubation and accumulated heat units at time of hatching, Fulton River, 1977.

Tray	Planting Date	Date of Hatching	Avg. Temp. (°C) During Incubation	Accumulated Heat Units (°C/days) at Hatching
1	May 19	June 17-20	10.5	568
2	"	"	"	"
3	"	No Survival	"	"
4	"	No Survival	"	"
5	May 20	June 17-20	10.6	554
6	"	"	"	"
7	May 24	June 18-21	11.1	512
8	"	"	"	"
9	"	"	"	"
10	"	"	"	"
11	"	No Survival	"	"
12	"	"	"	"

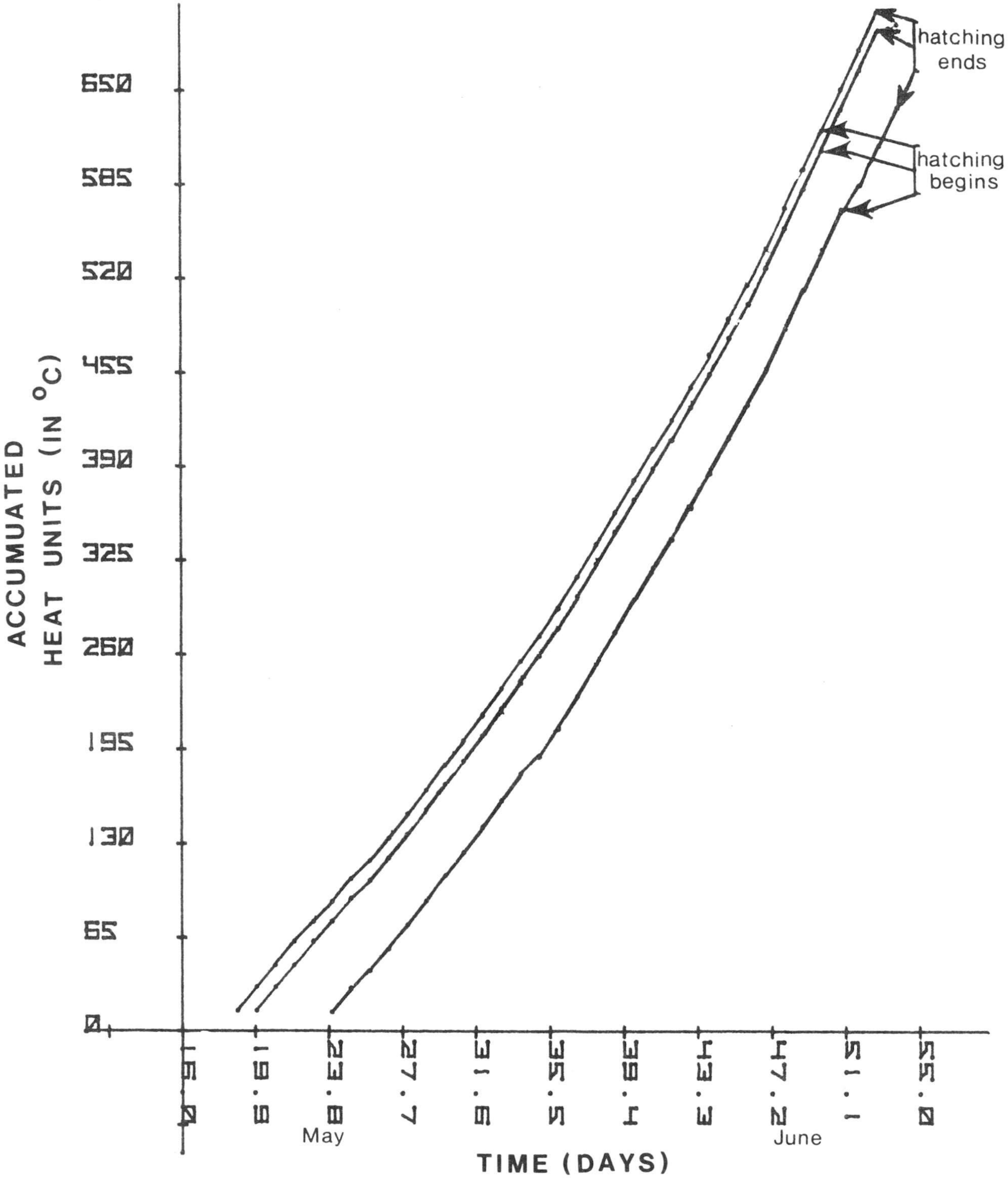

Figure 7 : Relative accumulated heat units and hatching dates of steelhead eggs planted in heath trays at Fulton River, 1977.

Wales (1941) concluded from his experiments that steelhead eggs began hatching with 536 heat units at an average water temperature of 10.6°C. Hatching began on the 28th day and was complete on the 30th day.

Rearing

On July 9, an estimated 53,375 fish (47 percent survival from egg stage) were ponded in troughs at 0.18 g/fry. They were given small quantities of starter mash every hour throughout the day for two weeks.

On July 24, an estimated 45,556 fish (40.2 percent survival from egg stage) were transferred to live boxes inside tanks at 0.24 g/fry. They were graded as large or small and released back into the tanks on September 4. A total of 32,099 (28.3 percent survival from egg stage) fish were transferred to three tanks of large fish at 3.33 g/fry and one tank of small fish at 2.5 g/fry (Table 3).

Fish were treated with uniodized salt on three occasions, in July, August and September, for the control of *Chilodonella* sp. Fish received terramycin bath treatments in October for the control of myxobacteria, and TM-50D was administered in the food for 15 days after the terramycin baths. This was followed by malachite treatments to control *Saprolegnia* sp., particularly evident on the dorsal and caudal fins. Daily malachite treatments decreased to weekly treatments as fish health improved. A summary of treatments and fry survival following treatments is shown in Table 4.

DISCUSSION

Throughout the incubation and rearing period (May to December, 1977) the overall survival from stripped eggs was 27.6 percent.

Three-quarters (53 percent) of the overall mortality occurred during incubation (May to July) and appeared to be related to the presence of fungus (*Saprolegnia* sp.). This mortality could possibly have been reduced if daily malachite treatments had been applied.

Table 3: Weekly growth, total surviving, temperature, feeding level and accumulated feed for steelhead, Fulton River, 1977.

Date	Sample Size (n)	No. of fry/g No. of fry/lb	g/fry	Total Fry	Avg. Weekly Temp. °C	Feeding Level (% Body Wt.)	Accum. Feed (g)
July 9	300	5.507 2,500	0.182	53,375	14.6	9.1	
July 24	300	4.079 1,852	0.245	45,556	16.0	9.1	3,600
July 28	300	3.608 1,638	0.277	43,214	16.3	9.1	
Aug. 5	300	2.024 919	0.494	38,443	15.2	9.1	
Aug. 12	300	1.430 649	0.699	37,571	15.7	9.1	27,000
Aug. 19	300	0.949 431	1.054	37,384	16.5	9.1	43,600
Aug. 26	200	0.626 284	1,597	36,939	14.9	6.7	68,700
Sept. 3	200	0.414 188	2.416		16.0	5.9	87,250

Date	Sample Size (n)	Large Fry	g/fry	Small Fry	g/fry	Total Fry	Avg. Weekly Temp. °C	Feeding Level Large Fry	Feeding Level Small Fry	Accum. Feed (g)
Sept.10	100	0.337 153	2.967	0.441 200	2.268	32,099	14.0	5.0	5.0	105,500
Sept.17	100	0.269 122	3.718	0.363 165	2.755	32,069	14.0	4.2	5.0	138,100
Sept.24	100	0.249 113	4.016	0.293 133	3.413	32,045	12.0	3.5	3.5	161,300
Oct. 1	50	0.229 104	4.367	0.289 131	3.460	31,713	11.4	3.3	3.3	181,700
Oct. 8	50	0.205 93	4.878	0.291 132	3.436	31,423	10.0	2.8	2.8	202,000
Oct. 15	50	0.198 90	5.051	0.231 105	4.329	31,353	8.9	2.7	2.7	231,105
Oct. 22	50	0.185 84	5.405	0.225 102	4.444	31,316	7.2	2.2	2.4	250,400
Oct. 28	50	0.176 80	5.682	0.223 101	4.484	31,299	6.7	2.1	2.3	275,650
Nov. 4	50	0.170 77	5.882	0.203 92	4.926	31,292	5.6	1.9	2.1	299,200
Nov. 11	50	0.166 75	6.024	0.214 97	4.673	31,284	4.6	1.6	1.9	321,100
Nov. 18	50	0.165 75	6.061	0.223 101	4.484	31,283	3.6	1.7	2.0	342,900
Nov. 25	50	0.162 73	6.173	0.227 103	4.405	31,274	1.7	1.3	1.6	360,000
Dec. 2	50	0.167 76	5.988	0.200 91	5.0	31,273	2.4	1.4	1.8	378,750

Table 4: Survival of steelhead fry following disease treatments, Fulton River, 1977.

Date	No. of Eggs Planted	Egg to Fry Survival	Infection / Treatment	Survival after Treatment	
				No. of Fry	%
May 19-24	113,500				100
July 9		53,375			47.0
July 26-30			*Chilodonella* sp. (1%) salt	45,556	40.2
Aug. 2-6			*Chilodonella* sp. (3%) salt	38,443	33.9
Aug. 30-Sept.7			*Chilodonella* sp. (3%) salt	32,099	28.3
Oct. 1-Oct. 7			myxobacteria (2 ppm)terramycin	31.423	27.7
Oct. 9-Dec. 1			*Saprolegnia* sp. (0.55 ppm)malachite	31,273	27.6

One-quarter (19.4 percent) of the total mortality occurred from the time of ponding to date (July 9 to December 2). This was due to the frequent outbreak of diseases discussed previously.

Poor fertilization may have contributed to the disappointing egg to fry survivals. Forcible pressure during stripping of anesthetized adults could have ruptured the eggs, which would greatly hamper and, at times, completely stop the process of fertilization (Lewis et al., 1976). Recent experiments done at Quinsam Hatchery indicate significant egg loss in the use of 2-phenoxyethanol for anesthetizing adult females before stripping (J. VanTine, 1978).[4] The storage temperature of egg and sperm during transport may have affected the success of fertilization. Results of previous studies have shown that storage at lower temperatures may extend the fertile period of the sex products, and, when necessary, permit greater duration between spawn-taking and fertilization (Withler et al., 1967). Time of stripping adults is also crucial for egg viability. If eggs are taken at a time before or after optimum ripeness of females, lower fertility of eggs will result due to underripe or overripe eggs, respectively (Lewis et al., 1976; Reingold, 1968).

Construction work in the vicinity of stacks could have caused jolting of eggs while in the "tender period" (that stage in egg development when the embryo is easily injured by nechanical shock), resulting in significant egg mortality (Wales, 1941).

Periods of low oxygen content and high temperatures of the water during rearing would have increased the presence of disease and further decreased the resistance of fish to disease (Bisset, 1946; Reichenback - Klinke, 1973; Lewis et al., 1976).

It may be suggested that future egg takes be done using the incision method. This would eliminate the risk of injury to eggs, or egg loss through the use of 2-phenoxyethanol. Storage temperature of the sex products should be maintained as low as that of the parent river.

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[4]Unpub. data; pers. com.

Disturbances near incubator stacks should be avoided until the eggs are clearly eyed. Daily malachite treatments to eggs would help eliminate mortalities due to high incidence of fungus.

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