# GRAVEL INCUBATION AND FRY-TO-SMOLT REARING OF CHINOOK SALMON (ONCORHYNCHUS TSHAWYTCHA) AT FULTON RIVER



by
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• Cover design by Christine Rusk

# GRAVEL INCUBATION AND FRY-TO-SMOLT REARING OF CHINOOK SALMON (*Oncorhynchus tshawytcha*) AT FULTON RIVER

by

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DEPARTMENT OF FISHERIES AND THE ENVIRONMENT
ENHANCEMENT SERVICES BRANCH
PACIFIC REGION

# ERRATUM

Page 5

Paragraph 4

Line 3

"... in 1977 were at a later stage..."

Should read:

"... in 1977 were at an earlier stage..."

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## ABSTRACT

Chinook salmon *(Oncorhynchus tshawytscha)* eggs, taken from the Babine River stock, were planted in a gravel incubator at Fulton River. Emergent fry were reared to smolt size in circular tanks. The fry were reared for a maximum of 63 days, coded-wire tagged, and released in the Babine River. The application of coded-wire tags should provide valuable biological information on migration timing, and the contribution to the sport, Indian and commercial fisheries.


Key words: chinook, eggs, gravel incubator, reared, smolt, tagged, released, biological information, migration timing, fisheries.


## RÉSUMÉ

Des oeufs de saumons chinook *(Oncorhynchus tshawytscha)*, du stock de la rivière Babine, ont été placés sur du gravier, dans un incubateur déposé dans la rivière Fulton. Les alevins ont été gardés dans des bacs circulaires jusqu'a là smoltification. Après avoir été gardés pendant au plus 63 jours, les alevins, munis d'une marque métallique codée, ont été mis en liberté dans la rivière Babine. Grâce au marquage, il sera possible d'obtenir d'utiles données biologiques sur la période migratoire et d'évaluer les prises à caractère commercial, sportif ainsi que celles des Indiens.


Mots clés: saumon chinook, oeufs, incubateur sur gravier, élevage, smolt, marquage, mise en liberté, données biologiques, période migratoire, pêche.

## INTRODUCTION

Chinook salmon *(Oncorhynchus tshawytscha)* egg and sperm were, for the second year in 1976, taken from the Babine River stock. They were then airlifted to Fulton River, fertilized and planted in an upwelling gravel incubator. After emergence, chinook fry were reared to smolt size under hatchery conditions, tagged and airlifted to Babine River, where they were released in 1977.

The application of coded-wire tags to the juvenile chinook salmon should provide valuable information on the adult timing, interception rate and fishery contribution of this stock.

## MATERIALS AND METHODS

### Incubation

Adult donors were obtained from the Babine River, where 30 females and 18 males were collected over a 10-day period. After stripping, the eggs and sperm were flown 100 km south to Fulton River for fertilization and planting. Standard procedures of collection and fertilization were practised. The eggs were volume-counted (average egg size was 0.31 ml and 74 mm in diameter) and planted in gravel in the upwelling incubators while soft. Loading density was at an average of 3,954 eggs/layer and 11 layers/section in each of the four sections, A to D (Figure 1).

At the beginning of fry emergence, all fish were collected in live boxes, counted either individually or volumetrically on a daily basis, and transferred to indoor circular tanks (Figure 2).

More details on incubation are presented in the 1976 report (Technical Report Series No. PAC/T-77-3 by J. E. MacDonald and R. Ginetz).

Figure 1: Sectional breakdown of loading densities and planting dates of chinook eggs in the incubator, 1976

INLET

| | | |
|---|---|---|
| No eggs planted | F | |
| No eggs planted | E | |
| 4,077 eggs/layer (4 layers)<br>2,774 eggs/layer (2 layers)<br>4,075 eggs/layer (3 layers)<br>4,487 eggs/layer (1 layer) | D | October 1, 1976<br>Total plant: 38,560 |
| 4,077 eggs/layer (11 layers) | C | September 27, 1976<br>Total plant: 44,817 |
| 3,943 eggs/layer (11 layers) | B | September 22, 1976<br>Total plant: 43,373 |
| 3,943 eggs/layer (12 layers) | A | September 22, 1976<br>Total Plant: 47,316 |

DISCHARGE

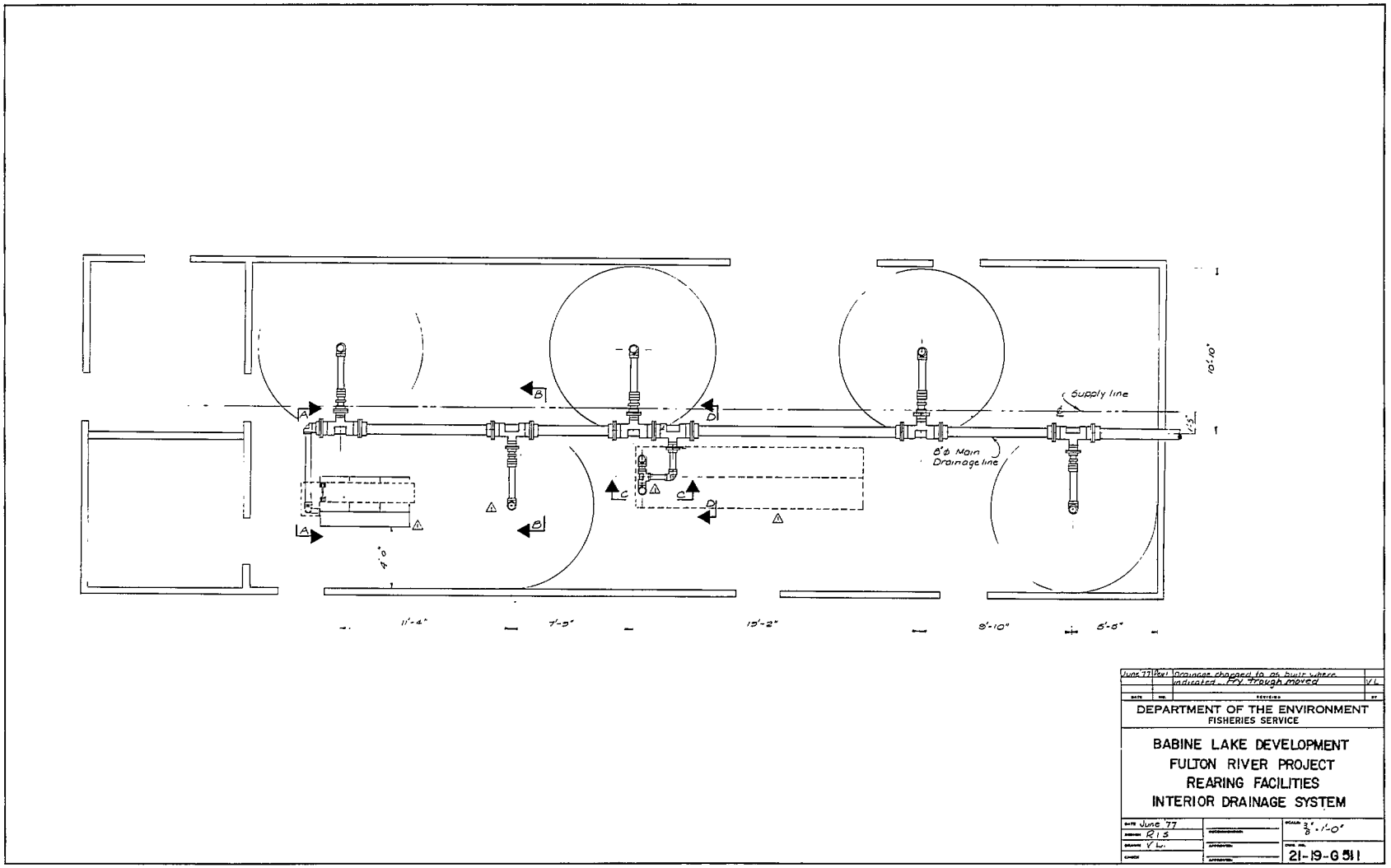


Figure 2: Top view of hatchery, showing location and design of circular rearing tanks at Fulton River, 1977.

Rearing

Fry were reared in five circular tanks, with a water capacity of 6.6 cu.m. (235 cu. ft.). Water flow to the tanks was supplied by an electric pump which delivered 680 ℓ/min (150 gals/min (Imp)) against a 9 m head. Outflow was through center standpipes and discharged directly into Fulton River. The rate of flow to each tank was 136 ℓ/min. This was later supplemented by an additional 35 ℓ/min.

Tanks were loaded to capacities determined by water volume, rate of flow and fish size (Burrows, 1972).

Dissolved oxygen was determined daily for each tank, using the Winkler iodometric technique. Maximum and minimum temperatures were also recorded daily, using an Ertco calibrated thermometer.

Subsamples of 50 fry were taken from each tub at initial ponding and prior to tagged-release. These were anesthetized with 2-phenoxyethanol (0.2 ml/ℓ) and enumerated for fork length, wet weight and development index ($K_D$). Subsamples of fry were weighed each week to determine fry/gm. This enabled calculation of feeding level and feeding frequency.

The fish were treated with malachite green (California flush method; Woods, 1974) for fungus control (*Saprolegnia* sp.) on six occasions in late June and mid-July. The method 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.

Tagged Release

Before being marked by a clipped adipose fin and the insertion of a coded-wire nose tag, fry were starved for 24 hours and then graded as large or small. They were then tagged and allowed to revive in live boxes for at least two hours. They were then transferred at 100 g/ℓ to garbage pails containing a 5 percent saline solution. Salt is known to reduce hauling losses due to stress and handling injuries by reducing the

osmotic difference between the blood and the water. Salt will also rid the fish of excess mucus and expose any parasites or bacteria to chemical treatment (Warren 19__). Ice was added in order to maintain a temperature of $8^{o}$ to $12^{o}$C. During the airlift, pails were supplied with bubbles of oxygen through an air stone from a bottle of compressed oxygen.

## RESULTS

### Egg to Fry Survival

Egg to fry survival from individual sections ranged from 72.6 percent to 86.7 percent. The overall survival was 79.5 percent, as compared to 76 percent in 1976 (Table 1).

### Emergence Timing

Migration from the incubator began in mid-May and ended in early June, peaking four times during this period. These peaks were influenced by staggered planting dates which resulted in different accumulated heat units for each section. An increase in the total daily migration appears to follow an increase in temperature throughout the migration period (Figures 3, 4, 5 and 6). Figure 7 shows that from $8.4^{o}$ to $11.6^{o}$C ($47.1^{o}$ to $52.9^{o}$F) and between 1520 and 1830 heat units daily migration from each section exceeded 2 percent of the total migration for that section. In 1976, migration peaked two times, in early and late May, at water temperatures of $4.5^{o}$ to $8.0^{o}$C ($40.1^{o}$ to $46.4^{o}$F).

The mean development index at emergence was 2.13 in 1977, as compared with 2.00 in 1976 (Table 2). This indicates that fry migrating in 1977 were at a later stage of development than those in 1976.

### Rearing

The fry were fed approximately 405 kg (894 lbs) of fish food (Oregon Moist Pellets) over the rearing period (Table 3). Fluctuations in utilization are evident throughout the rearing period (Figure 8). This may be due to low oxygen content, high temperatures of the water, and outbreaks of fungus. Results of fish samples sent to Nanaimo for

Table 1: Comparison of chinook egg densities and survival to the fry stage, 1976-77.

| Section | No. of Eggs | No. of Layers of Eggs | % Survival |
|---|---|---|---|
| A | 47,316 | 12 | 83.3 |
| B | 43,373 | 11 | 86.7 |
| C | 44,817 | 11 | 74.3 |
| D | 38,560 | 10 | 72.6 |
| E | No eggs planted | | |
| F | No eggs planted | | |
| TOTAL | 174,066 | 44 | 79.5 |

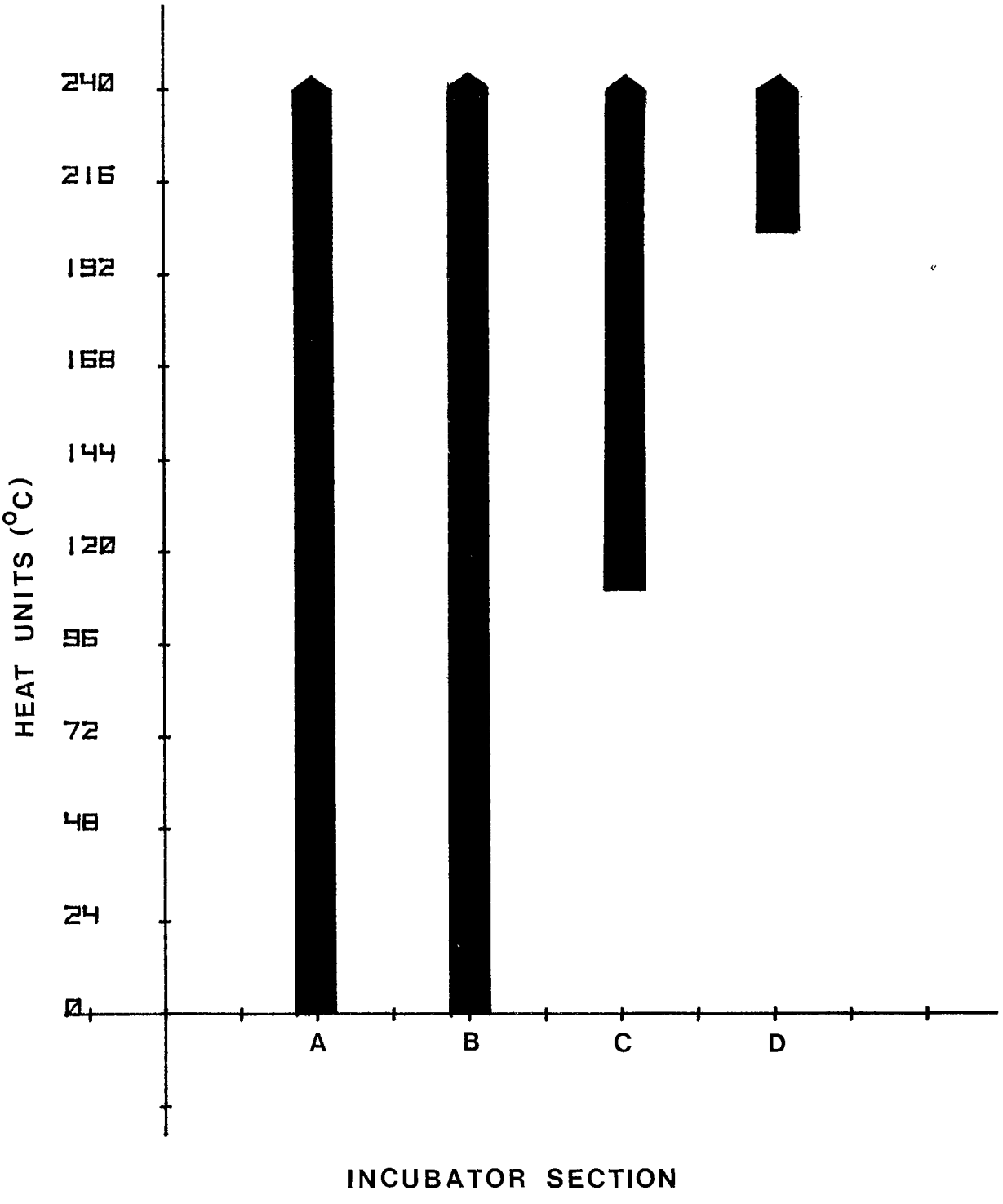


Figure 3: Differences in accumulated heat units between incubator sections during planting.

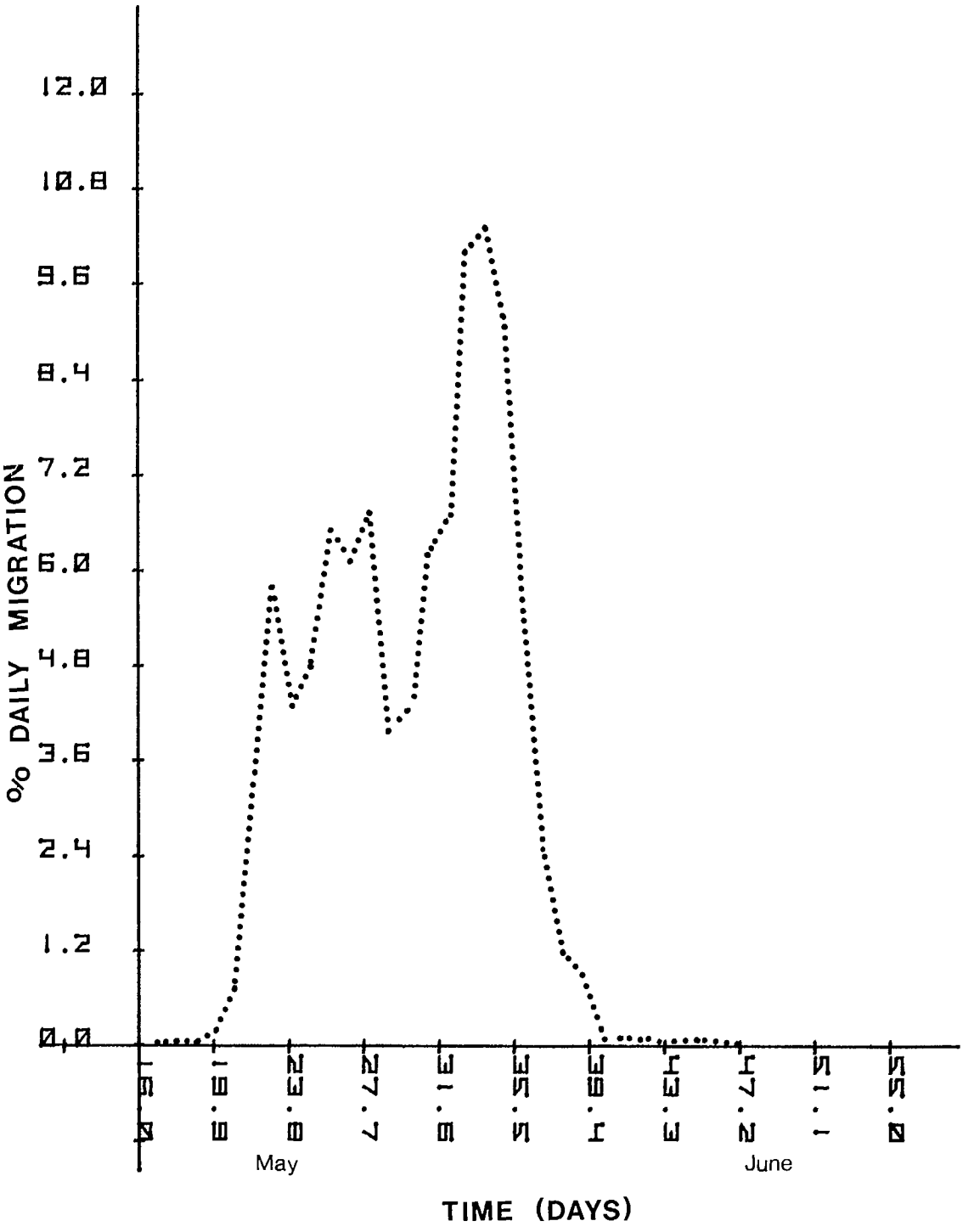


Figure 4: Total percent daily migration of chinook fry, May-June, 1977.

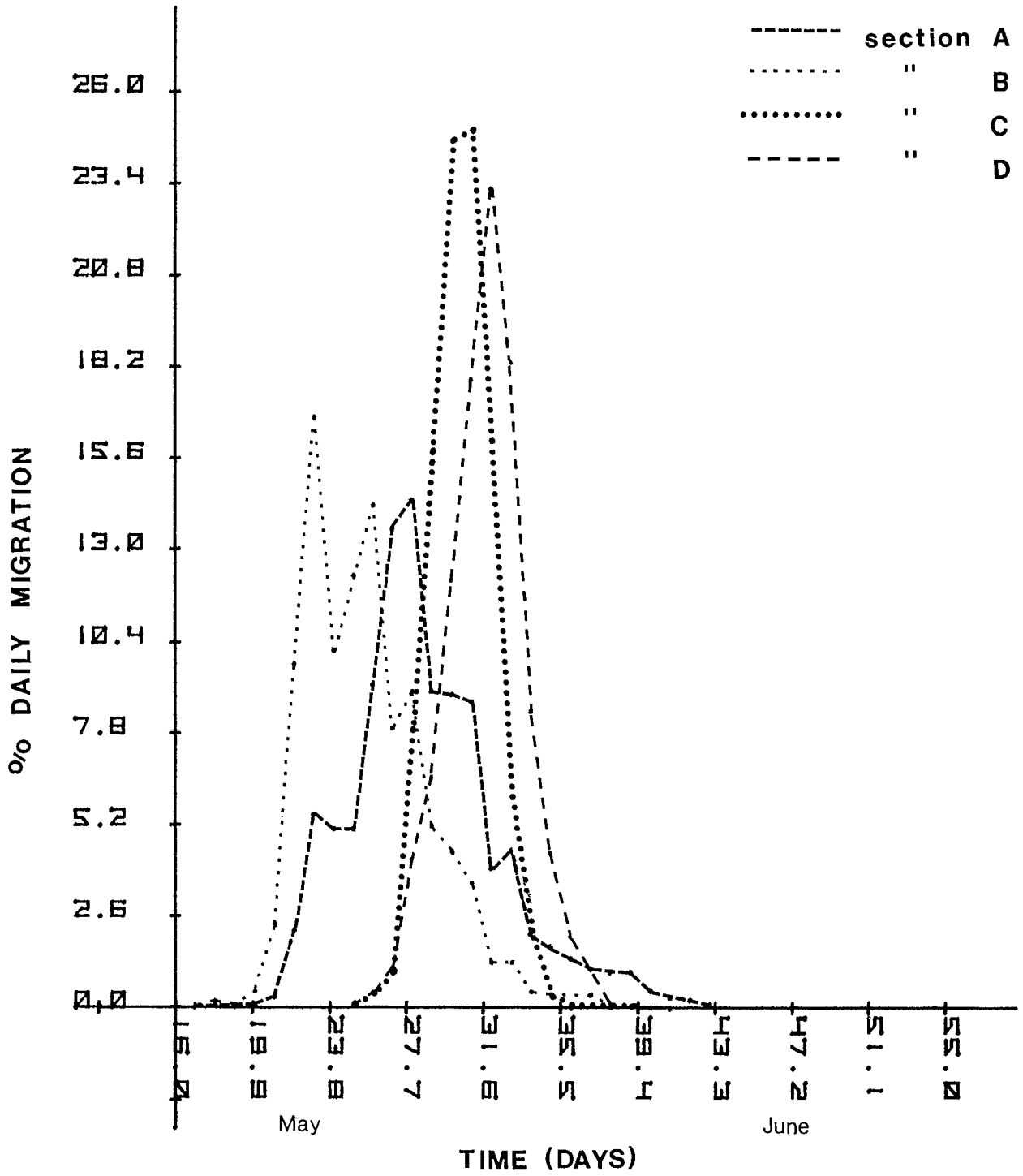


Figure 5: Percent daily migration from each incubator section, May-June, 1977.

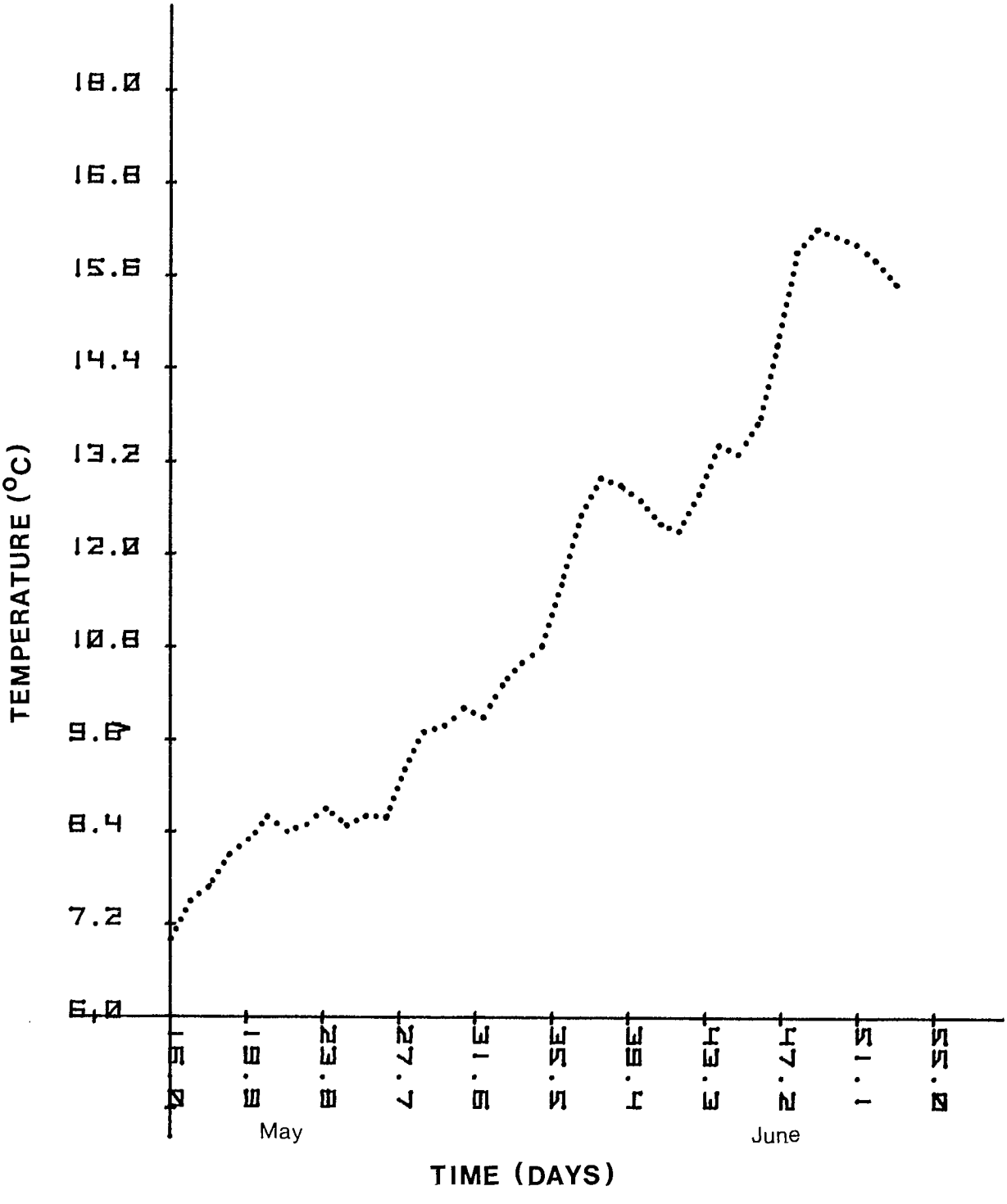


Figure 6: Average daily temperatures during migration, May-June, 1977.

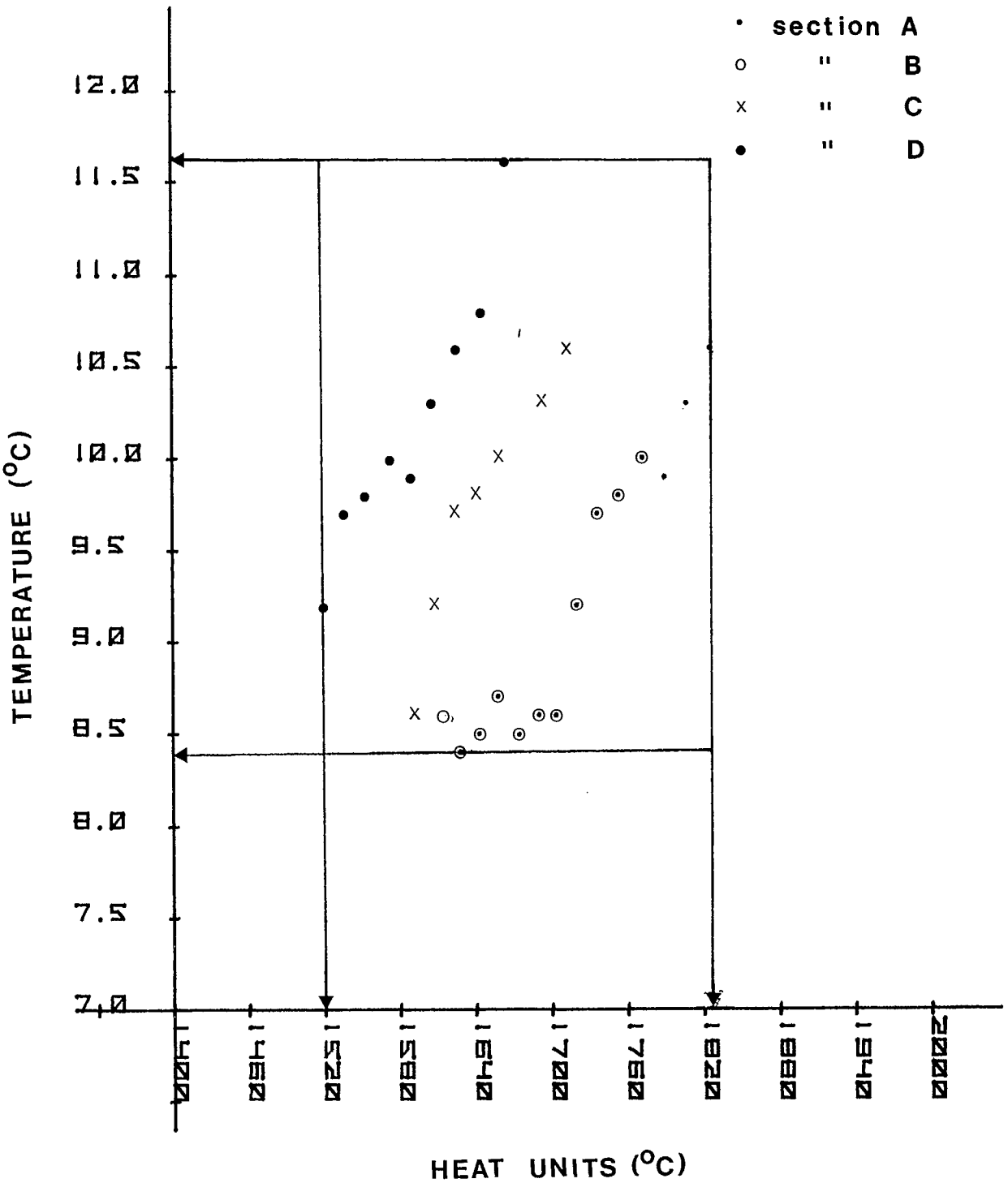


Figure 7: Number of heat units and temperature at which greater than two percent migration occurred from each section, May-June, 1977.

Table 2: Mean lengths, weights and developmental indices of chinook fry taken in samples from Fulton River rearing tanks, 1977.

| Date | Tank# | Mean Length in mm | Mean Weight in mg | Dev. Index $K_D$ | |
|---|---|---|---|---|---|
| May 31/77 (tanks loaded to capacity) | 1 | 36.34 | 417 | 2.05 | |
| | 4 | 40.32 | 724 | 2.22 | $\bar{x}$ = 2.13 |
| | 5 | 37.65 | 501 | 2.11 | |
| July 15/77 (Just before tagged release) | 1 | 57.72 | 2282 | 2.25 | |
| | 2 | 59.96 | 2516 | 2.25 | |
| | 3 | 62.08 | 2924 | 2.28 | $\bar{x}$ = 2.27 |
| | 4 | 63.36 | 2918 | 2.22 | |
| | 5 | 65.51 | 3583 | 2.33 | |

Table 3: Weekly growth, average weekly temperature, accumulated feed and % food utilization for chinook fry from Fulton River rearing tanks before tagged release, 1977.

| | | Tank #1 | | | Tank #2 | | | Tank #3 | | | Tank #4 | | | Tank #5 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Avg. Weekly Temp. °C (°F) | Fry/gram (Fry/lb) n | Accum. Feed kg (lbs) | % U. | Fry/gram (Fry/lb) | Accum. Feed kg (lbs) | % U. | Fry/gram (Fry/lb) | Accum. Feed kg (lbs) | % U. | Fry/gram (Fry/lb) | Accum. Feed kg (lbs) | % U. | Fry/gram (Fry/lb) | Accum. Feed kg (lbs) | % U. |
| May 31 | 9.4 (49) | | | | | | | 2.1 (965) | 1.0 (2.2) | | 1.8 (809) | 5.3 (11.7) | | 2.0 (888) | 3.1 (6.8) | |
| June 7 | 11.7 (53) | 2.2 (1000) 300 | 3.0 (6.5) | | 2.1 (929) | 3.6 (8.0) | | 1.7 (750) | 5.3 (11.7) | 85.4 | 1.3 (588) | 10.4 (22.8) | 73.3 | 1.5 (682) | 7.5 (16.4) | 88.5 |
| June 14 | 13.3 (56) | 1.5 (696) 300 | 9.9 (21.9) | 87.0 | 1.4 (654) | 10.7 (23.5) | 80.4 | 1.3 (587) | 12.3 (27.0) | 60.4 | 1.0 (455) | 18.0 (39.6) | 65.7 | 1.1 (508) | 14.4 (31.8) | 75.7 |
| June 22 | 15.6 (60) | 1.2 (526) 300 | 17.7 (38.9) | 82.4 | 1.1 (488) | 21.3 (47.0) | 63.4 | 0.8 (380) | 25.1 (55.3) | 85.5 | - | 33.9 (74.6) | 75.4 | 0.7 (335) | 28.0 (61.6) | 82.9 |
| June 28 | 15.0 (59) | 0.8 (359) 300 | 31.6 (69.7) | 88.4 | 0.8 (353) | 35.1 (77.3) | 71.6 | 0.6 (283) | 38.3 (84.3) | 83.4 | 0.5 (233) | 47.9 (105.4) | 75.6 | 0.5 (242) | 41.9 (92.2) | 89.2 |
| July 5 | 14.4 (58) | 0.6 (263) 200 | 52.8 (116.3) | 62.2 | 0.6 (250) | 56.0 (123.4) | 72.5 | 0.5 (202) | 57.7 (127.1) | 86.1 | 0.4 (172) | 69.0 (151.9) | 76.6 | 0.4 (179) | 62.6 (137.8) | 77.1 |
| July 11 | 15.0 (59) | 0.5 (213) 100 | 72.5 (159.6) | 63.6 | 0.4 (201) | 76.2 (167.9) | 61.0 | 0.4 (180) | 76.3 (168.1) | 35.7 | 0.4 (162) | 88.7 (195.3) | 20.1 | 0.3 (148) | 92.0 (202.7) | 62.9 |
| July 16 | 15.0 (59) | 0.5 (213) 100 | - | - | - | - | - | - | - | - | - | - | - | 0.3 (125) | - | - |
| July 17 | | | | | | | | | | | | | | | | |
| July 19 | | | | | | | | | | | | | | | | |

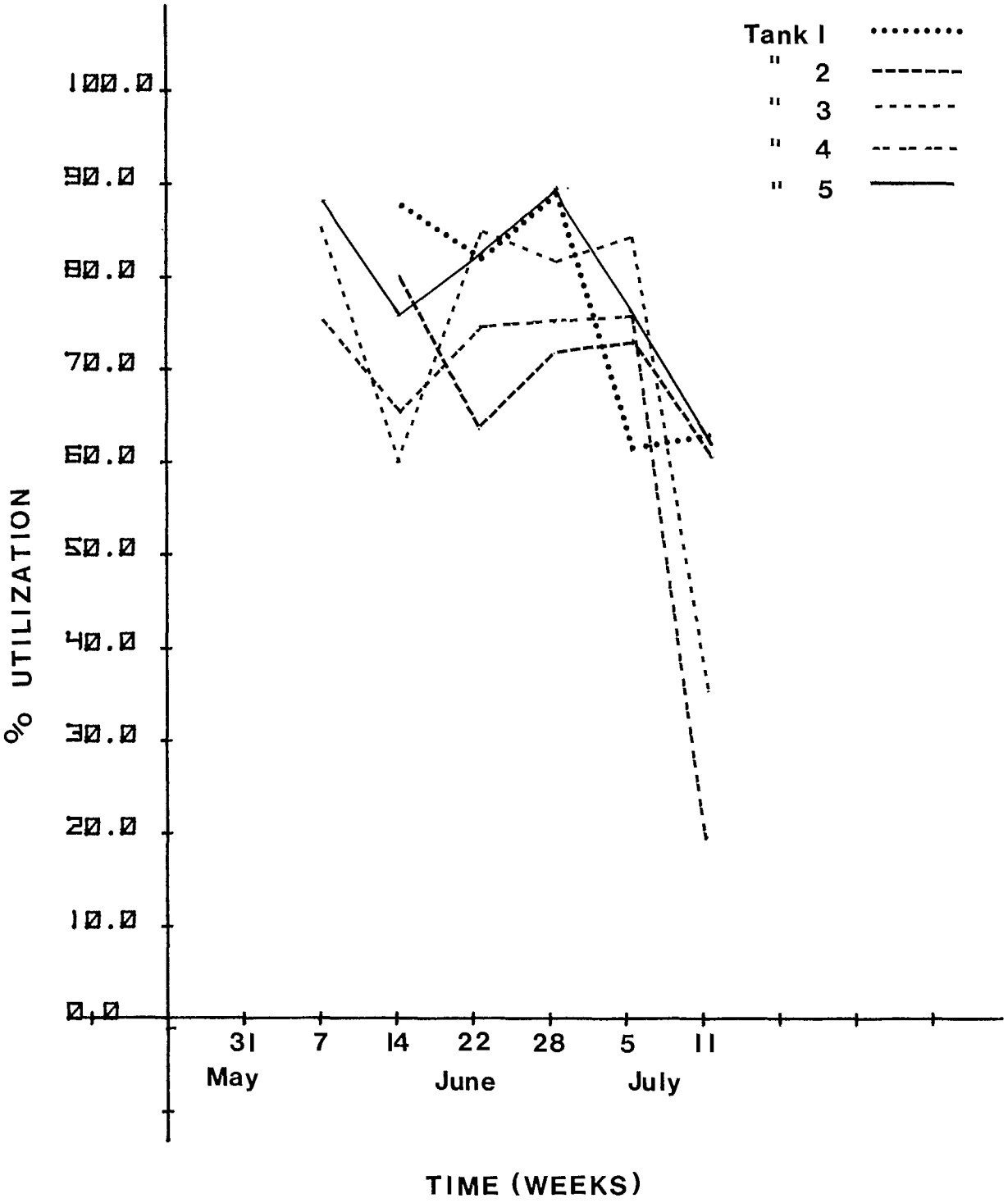


Figure 8: Percent food utilization of chinook fry throughout rearing period, May-July, 1977.

pathology also indicated the presence of an external protozoan *(Chilodonella* sp.*)*. No treatment was made for this protozoan, as its presence was not known at the time of release.

Weight of fry at ponding was 0.4 g/fry (2.2 fry/g) in tank #1 and 0.5 g/fry (2.0 fry/g) in tank #5; the development index was 2.05 and 2.11, respectively. After seven weeks, the fish were between 2.0 g/fry (0.5 fry/g) in tank #1 and 3.3 g/fry (0.3 fry/g) in tank #5; the development index was 2.25 and 2.33, respectively (Tables 2 and 3).

Survival over the rearing period ranged from 89.8 percent in tank #3 to 97.7 percent in tank #4. The overall survival was 94.5 percent. Survival from original number of eggs planted to release was 69.5 percent (Table 4).

Tagged Release

At the end of the rearing period, 70,446 large fry, greater than 2.5 g/fry (0.4 fry/g), and 40,593 small fry, less than 2.5 g/fry, were successfully tagged, airlifted and released in the Babine River (Table 4).

## DISCUSSION

Overall egg to fry survival was higher in 1977 than that of the previous year. Emergence timing and peak migration was later this year, probably due to later planting dates. An increase in daily migration appears to follow an increase in temperature. Migration patterns appear to have varied according to time intervals between planting sections.

It may be suggested that, although temperature and heat units are both of primary significance in migration, a rise in temperature may stimulate migration at a lower number of heat units. It is also possible to outline a temperature and heat unit range between which significant migration will take place.

The range in sizes of fry between tanks at ponding followed through until the time of release. This was obviously due to differences

Table 4: Initial and final numbers of chinook fry in rearing tanks showing number of large and small fry tagged and released, 1977.

| Date | Tank 1 | Tank 2 | Tank 3 | Tank 4 | Tank 5 |
|---|---|---|---|---|---|
| June 7 (Final loading of tanks) | 31,329 | 28,733 | 20,040 | 23,689 | 24,206 |
| TOTAL | 127,997 | | | | |
| July 15 (Before tagged release) | 29,288 | 27,448 | 17,991 | 22,628 | 23,650 |
| TOTAL | 121,005 | | | | |
| % survival | 93.5% | 95.5% | 89.8% | 95.5% | 97.7% |
| TOTAL | 94.5% | | | | |
| % survival from original number of eggs (174,066) | 69.5% | | | | |

Large, tagged fry released - 70,446

Small, tagged fry released - 40,593

TOTAL - 111,039

in size of fry at emergence; those emerging in the last few days were much smaller and less well-developed in comparison to early fry.

ACKNOWLEDGEMENTS

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