

Results of Rotary Auger Trap Sampling in the Nanaimo River, 1998

D.A. Nagtegaal and E.W. Carter

**Fisheries and Oceans Canada
Science Branch, Pacific Region
Pacific Biological Station
Nanaimo, British Columbia
V9R 5K6**

1998

**Canadian Manuscript Report of
Fisheries and Aquatic Sciences 2468**



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Cat. No. Fs 97-4/2468E

ISSN 0706-6473

Correct citation for this publication:

Nagtegaal, D. A. and E. W. Carter. 1998. Results of rotary
auger trap sampling in the Nanaimo River, 1998. Can.
Manuscr. Rep. Fish. Aquat. Sci. 2468: 24 p.

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ABSTRACT

Nagtegaal, D. A. and E. W. Carter. 1998. Results of rotary auger trap sampling in the Nanaimo River, 1998. Can. Manuscr. Rep. Fish. Aquat. Sci. 2468: 24 p.

In 1998, a study of juvenile chinook salmon (*Oncorhynchus tshawytscha*) productivity was conducted by Fisheries and Oceans Canada, Pacific Biological Station together with the Nanaimo First Nations. The three key elements of this yearly project are: i) enumeration of juvenile out migrants, ii) monitoring growth of hatchery and naturally-reared fry, iii) monitoring hatchery releases and interaction between hatchery and naturally-reared fry in the river. A rotary screw trap was used to estimate fry production. Bismarck Brown dyed naturally-reared fry were released above the trap site and recapture results of these marked fry were used to expand trap catches to estimate total production. The minimum estimate of production of naturally-reared juvenile chinook for the 1997 brood year was 44,910 (range: 24,950 - 134,730). Contrary to previous years, minimal recapture data were obtained from hatchery fry. Only nine hatchery fry were recovered because only two hatchery fry releases occurred (May 7, May 15) while the project was active. It was assumed that these hatchery fry emigrated out of the river shortly after release and those that remained in the river for a period of time did not migrate down to the trap site prior to the end of the project. The other hatchery releases (May 26, July 23) occurred after the project completion. It is believed therefore that hatchery and naturally-reared fry interaction is minimal. Based on hatchery records, releases of chinook fry and smolts in 1998 totalled 253,413.

INTRODUCTION

Chinook salmon (*Oncorhynchus tshawytscha*), have in the last several years showed a decline in stock size in the southern part of the Strait of Georgia and have been a focus of study since then because of their importance to the local fisheries (Farlinger et al. 1990). Three stocks, the Nanaimo, Squamish, and Cowichan, are used to indicate the status of the lower Georgia Strait chinook stock. The objectives of this assessment include: i) quantitatively determining the optimum spawning requirement for chinook salmon (this involves investigations of the factors contributing to juvenile production, interactions between hatchery and wild chinook, and estimation of the spawning escapement and catch attributed to the hatchery and wild components of the total run), and ii) developing guidelines for establishing escapement targets for other B.C. chinook stocks (Nagtegaal et al. 1994a). In 1988, a detailed study of chinook productivity using the three previously mentioned indicator stocks was implemented by Fisheries and Oceans Canada, Pacific Biological Station. Results of these studies could then be used to assess rebuilding strategies and determine the effects of harvest management policies for these stocks.

Prior to this study, research on Nanaimo River chinook stocks was limited to overflight information and standardized swim surveys carried out by the Nanaimo River hatchery in conjunction with the Fishery Officers. The opportunity then arose in 1995 to implement an extensive adult chinook enumeration study in conjunction with Nanaimo First Nations on the Nanaimo River. A counting fence was then constructed and was in operation from the beginning of August to the end of October. In the spring of 1996, the juvenile portion of this study was initiated. The juvenile portion allowed assessment of: i) the timing and abundance of juvenile chinook out-migrants, ii) the growth of hatchery and naturally-reared juveniles, iii) monitoring hatchery releases, and iv) the interaction between the hatchery and naturally-reared juveniles in the river and in the estuary.

Chinook salmon in the Nanaimo River show three juvenile life history types demonstrated by different ages and size at the time they leave the river and migrate into the ocean (Healey and Jordan 1982; Carl and Healey 1984). The first type migrates to the sea immediately after leaving the spawning gravel and rears in estuarine habitats, the second leaves the river after developing for approximately two months ('90 day smolts'), and the third type enter the sea after rearing in fresh water for about a year. It is believed that these types are created due to

subpopulations that spawn in separate areas of the river (Healey 1980).

Production of hatchery chinook fry on the Nanaimo River began in 1980 (Cross et al. 1991). Chinook fry releases have increased since then from 61,474 to 637,235 in 1997. Coded-wire tagged chinook releases began in 1980 where a portion of the hatchery fry released were marked with a coded-wire tag implanted in the nose of the fish. In 1998, approximately 45% of releases were tagged. Hatchery release of Nanaimo R. chinook fry is generally done in three parts. First is an early release, where 5g pre-smolts are released in the beginning of May just downstream of the Island Highway bridge in the lower river. Second is the lake release, where 6-7g pre-smolts are reared in the hatchery until they reach this point, then are moved to lake net pens situated at the mouth of First lake. They are then released into the lake in late May. The third, which is the late release, consists of 6g pre-smolts also released downstream of the Island Highway bridge in late May.

The purpose of this report is to present the results obtained from the juvenile chinook downstream migration study conducted in the spring of 1998. Hatchery fish are referred to as those that were spawned and reared in a hatchery setting regardless of parental origin and naturally-reared fish as those that spawned and reared in the river setting.

METHODS

STUDY AREA

The Nanaimo River flows into the estuary on the east coast of Vancouver Island, British Columbia, just south of the city of Nanaimo and approximately 80 km north of Victoria (Fig. 1) It flows for approximately 56 km and has a watershed of 830 km². The system includes four small lakes and two storage reservoirs. Flow ranges from about 3 m³/sec in the summer to over 400 m³/sec during winter freshets and averages about 42 m³/sec. The Nanaimo River system supports populations of chinook, coho (*O. kisutch*), pink (*O. gorbuscha*), and chum (*O. keta*) salmon (Aro 1973).

A Community Economic Development Program (CEDP) hatchery is situated alongside the Nanaimo River approximately 8 km upstream from the Nanaimo estuary. The hatchery is managed by the Community Futures Development Corporation of Central Island Society under the auspices of the Habitat and Enhancement Branch

of Fisheries and Oceans Canada. The facility began chinook production with adults from the 1979 brood year.

FISH CAPTURE

During the period of Feb. 19 - May 20, 1998, a 2.4 m diameter rotary screw trap¹ was used to trap salmonid juveniles migrating downstream to the estuary. The trap was placed approximately 5 km upstream of the estuary (Fig. 1) and held in place by galvanized steel cables suspended across the river. The trap was used to fish overnight on Monday, Wednesday, and Friday evenings. After each approximately 12-hour period, the trap was checked and the fish were sampled. On some occasions the trap was set to fish during the day or fished for 24 hours to observe diel movement. When fishing for 24 hours, the trap was still checked every twelve hours to distinguish and observe the differences between day and nighttime movement. As well, when Bismarck Brown dyed fry were released above the trap for efficiency readings, the trap was set to fish every day for approximately a week to record recapture data.

All fish collected were enumerated and recorded on data sheets according to species, time period, and capture date. Chinook juveniles were identified as being either hatchery or naturally-reared fry based on length and weight characteristics. As a general rule, the weight and length of hatchery fry at the time of release are substantially larger than that of a naturally-reared fry. No hatchery fish were assumed to be in the river prior to the first release on May 7. The number of adipose-clipped hatchery fish was also recorded. Coho were recorded as being fry, one year, or two year old smolts. Water temperature, flow rate², and weather conditions were also recorded at each sampling time. River discharge information was obtained from Water Survey Canada.

ABUNDANCE ESTIMATES

Trap efficiency information was used to expand the trap catch to estimate the total number of fish migrating past the trap site. The mark-recapture method was used with chum fry as explained below since few chinook were available. Approximately 300 wild chum fry were stained with Bismarck Brown dye (Ward and VerHoeven 1963) and then released about 500 m upstream from the trap site. The number of stained fish recaptured over subsequent days was recorded. This was repeated four times throughout the study. The proportion of dyed to undyed recaptures was used to

¹ Manufactured by E.G. Solutions, Corvallis, Oregon, U.S.A.

² Flow Metre, Model 2030R, General Oceanic, 1295 NW 163rd St., Miami, Florida, U.S.A.

obtain trap efficiency data and then used to expand the unmarked fish catch and therefore estimate the total number of fish migrating past the trap site.

Trap efficiency was estimated using:

$$E_{ij} = R_{ij} / M_{ij}$$

where:

E is the estimated trap efficiency at site i and sampling date j

R is the number of marked fish recaptured

M is the number of marked fish released

Inherent in these efficiency tests were the following assumptions:

- i) marking of the fish does not affect short term survival of these fish
- ii) all marked fish released above the trap site migrate downstream past the trap
- iii) marked fish behave the same as unmarked fish
- iv) all recaptured fish were counted

The total number of fish was estimated by:

$$N_i = U_{ij} / E_{ij}$$

where:

N is the estimated number of marked fish

U is the catch of unmarked fish in the trap

The estimates of daily fish migration were obtained by taking the mean of the days when the trap was in operation to fill in the days when the trap was not operating. For example, the mean of the total number of fry fished on Monday and Wednesday would be inserted for Tuesday. Twenty-four hour estimates were extrapolated for the parts of the day when the trap was not fishing. The total production number is the sum of the daily catch estimates for the period of study (Nagtegaal et al. 1997)

The adjusted Peterson estimate (Ricker 1975) was used to obtain confidence limits of trap efficiency. A minimum confidence limit was used since there is added uncertainty from irregular trap efficiencies, interpolation of unsampled days, and

extrapolation for unsampled parts of the day (Nagtegaal et al. 1995; Candy et al. 1996).

GROWTH

Length and weight of naturally-reared fry were measured to observe growth. Each sampling time, a sample of fry was taken and their fork length was measured to the nearest mm and weight was measured to the nearest one hundredth of a gram.

Growth information on hatchery fry was obtained from the Nanaimo River hatchery. A sample of 40-50 fry were measured in length and weight periodically prior to release. After release of the hatchery fry, monitoring of growth was very limited because of this year's low hatchery fry production and few being recaptured in the trap.

RESULTS

BIOPHYSICAL CONDITIONS

Over the course of the study, discharge on the Nanaimo River had a few fluctuations but generally decreased from approximately $109\text{m}^3/\text{s}$ in mid February to about $11.5\text{m}^3/\text{s}$ in mid May. The mean discharge for February was $74.3\text{m}^3/\text{s}$; for March $44.5\text{m}^3/\text{s}$; for April $15.9\text{m}^3/\text{s}$; for May $20\text{m}^3/\text{s}$. Flow rates reached a high of $2.8\text{m}^3/\text{s}$ and a low of $0.12\text{m}^3/\text{s}$. Water temperature increased from 5°C to 14°C .

MIGRATION TIMING

Upon completion of the project, a total of 2,236 naturally-reared chinook juveniles and 9 hatchery chinook juveniles had been counted. Table 1 shows the naturally-reared chinook catch data but the hatchery juveniles were not tabulated due to the small number recorded. The migration of the naturally-reared juveniles was observed from Feb. 19 until May 20. The first evidence of chinook was on Mar. 7 when one naturally-reared fry was counted. Two peaks in migration of the naturally-reared fry were observed, the first in the middle of April and the second in the beginning of May. The 9 hatchery chinook were captured on May 9, two days after the first hatchery release. The second hatchery release occurred on May 15. The project remained active until May 20. It is assumed that the hatchery fry either left

the river almost immediately after release or they simply did not migrate down to the trap site.

DIEL MIGRATION

Trapping was done for two 24-hour periods approximately every two weeks to determine daytime vs. nighttime movement. Chinook, chum, and coho samples were all tabulated to show percent daytime movement (Table 2). As in previous years, approximately 95% of chinook were caught at night. Chum and coho samples showed a slightly higher percentage caught at night.

HATCHERY RELEASES

The Nanaimo River hatchery had four releases this year, two lake pen releases, and two releases directly into the lower Nanaimo River. Approximately 253,413 hatchery chinook juveniles were released of which 113,539 were coded-wire tagged (Table 3). 169,098 of these were released during the study period of which 50,413 were coded-wire tagged. Even though there were four releases this year, the total of 253,413 released is substantially lower (less than half) than that of the past two years. In 1998, the releases consisted of two lake net pen releases on May 7 and May 15 as well as two separate releases into the river on May 26 and July 23. As a result of this, only the two lake net pen releases occurred while the study on the Nanaimo River was active and therefore minimal data were obtained about hatchery fry migration for 1998. It can be assumed that the hatchery fry behaved this year much like that of previous years where interaction of hatchery and naturally-reared fry has been believed limited (Nagtegaal and Carter 1997). Generally the hatchery fry leave the river shortly after release.

TRAP EFFICIENCIES AND ABUNDANCE

Trap efficiency tests this year were all conducted using chum fry because of the low numbers of chinook migrating past the trap site. Four tests were run; one each on Mar. 18, Apr. 1, Apr. 15, and Apr. 29. The mean efficiency of these tests was found to be 11.05% (Table 4). This mean efficiency is substantially higher than it has been in previous years.

Based on the efficiency calculations, the total number of naturally-reared chinook in the Nanaimo River was estimated to be 44,910 (Table 1). The small number of efficiency tests completed and their wide variation of results yielded a high efficiency value that may have caused the total abundance to be

underestimated. The number of chinook observed was also less than in previous years. The minimum and maximum values in Table 5 cover a wide range due to the extreme efficiency values. Due to this wide variation, two independent fry production estimates were calculated using 1) the 1997 data and 2) combining the 1997 with the 1996 efficiency estimates (Table 5). The latter may be a more probable estimate of fry production.

A total estimate for hatchery fish present in the river was not calculated because only nine hatchery chinook were recovered. This is in part due to releases occurring after the project was completed.

GROWTH

The size of naturally-reared chinook fry remained generally the same until the beginning of May at which time both length and weight steadily increased. Length was consistently around 40mm until an increase to a mean of 50mm was observed in May. Weight remained around 0.4 grams until May when it increased to a mean of 1.2 grams. Between May 7 and May 9 length and weight of the naturally-reared fry had unusually high means recorded (Figs. 5 and 6). This may have been due to incorrectly identifying hatchery chinook (which were released on May 7) for naturally-reared chinook. Before release, hatchery fry grew in length from a mean of 38mm on Feb. 13 to a mean of 55.4mm on Mar. 26. They increased in weight from a mean of 0.52 grams on Feb. 13 to a mean of 1.65 grams on Mar. 26. No other length and weight measurements were taken of hatchery fry.

DISCUSSION

Healey (1980) indicated that the majority of juvenile outmigrants in the Nanaimo River move to the estuary in the first few weeks after emergence. It was assumed that the numbers of chinook outmigrants generated from our calculations reflect an estimate of the size of this group. What is not included in these calculations is the number of fry that remain in the river for more than a few weeks. Healey and Jordan (1982) reported that only upper river spawners (Spring stock) produced juveniles (approx. 7.6%) that remained in the river for up to a year ('stream type' life history strategy). Lower river spawners primarily produced juveniles (> 99%) that immediately migrate to the estuary ('ocean type' life history strategy). It was assumed that these results indicate what would happen this year as well, had it been monitored in the same way.

The greatest potential for significant error in the abundance estimates would be from the efficiency tests. No obvious problems were observed during these tests and all dyed fish used in the tests were in good condition at the time of release. If the dyeing reduced fish health and therefore caused the trap efficiency to be biased high, then abundance would be underestimated. If the dyed fish that were released upstream were not uniformly distributed in the river when they moved past the trap site, this could have also caused the trap efficiency tests to be incorrect. Whatever the cause, the trap efficiencies were very high which may have resulted in an underestimation of fry production. Because of this, a second abundance estimate was calculated using the trap efficiencies from 1996 (Table 5). Although this estimate is still relatively lower than previous years, it may be a more reasonable reflection of fry production.

EGG TO FRY SURVIVAL

Escapement of fall chinook to the Nanaimo River in 1997 was estimated to be 690 of which 67% were females. Based on swim survey results (P. Preston, 271 Pine Street, Nanaimo, B.C., V9R-2B7, pers. comm.), the spring stock was estimated to be 600 adult chinook of which approximately 67% were considered to be females. According to hatchery broodstock records, average fecundity of the 1997 chinook fall stock was calculated to be 4,712 eggs per female and for the spring stock it was calculated to be 4,576 eggs per female. Based on these data, we estimated egg deposition to be a little more than 4 million (Table 5). Egg to fry survival for the 1997 brood was estimated to be 1.12% (range: 0.62% - 3.35%). This was calculated using the fry estimate derived from the 1998 trap efficiencies. Egg to fry survival using the fry estimate derived from the 1996 trap efficiencies was calculated to be 5.59% (range: 1.12% - 6.58%).

These egg to fry survival rates are both low compared to last year in the Nanaimo River (Nagtegaal and Carter 1997). However, they resemble the Cowichan River egg to fry survival rates of 1.3% - 3.4% in 1995 and 1996 (Candy et al.). As well, these rates were considered conservative since according to Healey (1980) approximately 8% of the progeny of upper river spawners rear in the upper river for up to a year.

SIZE

Since the mean size of naturally-reared outmigrant chinook fry only marginally increased over the course of the study until May, we assumed that we were likely not monitoring fry growth by measuring and weighing fry at the trap site. During the entire

sampling period we were likely trapping only juveniles that had emerged and immediately moved downstream to the estuary. Our length and weight measurements simply reflect the size of juveniles moving downstream. By the end of May, some larger fry were caught in the trap and were likely from a portion of the population that remained in the river above the trap for some weeks prior to migrating downstream, as observed in previous studies (Healey and Jordan 1982; Healey et al. 1977). These larger fry may be indicative of the '90-day' life history strategy described by Healey (1991) and likely represent some of the progeny from upper river spawners. It could also be that some of the larger fry caught later were actually hatchery fry from the late release.

INTERACTION

It was assumed that chinook juveniles behaved like those in previous years, which showed minimal interaction. Since the study period overlapped with only one hatchery release, the remaining three were not monitored and therefore no comment could be made in regards to the interaction between these late hatchery releases and the naturally-reared fry.

ACKNOWLEDGEMENTS

We would like to especially thank Dave Key for coordinating the field activities, Chris Good and James Patterson for their involvement in the installation of the fry trap and collection of catch and biological data. We thank the Nanaimo First Nations for providing the funding for some of the labour for this project. We thank Paul Preston, manager of the Nanaimo hatchery, for providing broodstock capture and chinook fry release data. We thank the B.C. Transportation and Finance Authority for allowing us to use their facilities on the Nanaimo R. and granting us power and water. We also thank Water Survey Canada for providing the discharge data for the Nanaimo River.

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Table 1. Naturally-reared chinook rotary trap catch data at the trap site, Nanaimo River, 1998.

Date	Observed	Missing cells Interpolated	24-hour Estimates	Extrapolated Estimates	Cumulative Totals
19-Feb			0	0	0
26-Feb			0	0	0
27-Feb			0	0	0
28-Feb			0	0	0
29-Feb			0	0	0
1-Mar			0	0	0
2-Mar			0	0	0
3-Mar			0	0	0
4-Mar			0	0	0
5-Mar			0	0	0
6-Mar			0	0	0
7-Mar	1		1	9	9
8-Mar		2	2	18	27
9-Mar		2	2	18	45
10-Mar		2	2	18	63
11-Mar		2	2	18	81
12-Mar	2		2	18	99
13-Mar		3	3	27	126
14-Mar	4		4	36	162
15-Mar		3	3	27	189
16-Mar		3	3	27	216
17-Mar	3		3	27	243
18-Mar		6	7	63	306
19-Mar	10		11	99	405
20-Mar	8		9	81	486
21-Mar	4		4	36	522
22-Mar		28	31	279	801
23-Mar		28	31	279	1080
24-Mar	52		58	522	1602
25-Mar		35	39	351	1953
26-Mar	19		21	189	2142
27-Mar		27	30	270	2412
28-Mar	35		39	351	2763
29-Mar		31	35	315	3078
30-Mar		31	35	315	3393
31-Mar	28		31	279	3672
1-Apr		51	57	513	4185
2-Apr	74		83	747	4932
3-Apr	49		55	495	5427
4-Apr	26		29	261	5688
5-Apr		32	36	324	6012
6-Apr		32	36	324	6336
7-Apr	38		43	387	6723
8-Apr		230	258	2322	9045
9-Apr	423		474	4266	13311
10-Apr		218	244	2196	15507
11-Apr	14		16	144	15651

Table 1. (cont'd)

Date	Observed	Missing cells Interpolated	24-hour Estimates	Extrapolated Estimates	Cumulative Totals
12-Apr		16	18	162	15813
13-Apr		16	18	162	15975
14-Apr	19		21	189	16164
15-Apr		37	41	369	16533
16-Apr	56		63	567	17100
17-Apr	52		58	522	17622
18-Apr	2		2	18	17640
19-Apr		15	17	153	17793
20-Apr		15	17	153	17946
21-Apr		15	17	153	18099
22-Apr		15	17	153	18252
23-Apr	29		32	288	18540
24-Apr		50	56	504	19044
25-Apr	71		80	720	19764
26-Apr		42	47	423	20187
27-Apr		42	47	423	20610
28-Apr	13		15	135	20745
29-Apr		49	55	495	21240
30-Apr	85		95	855	22095
1-May	185		207	1863	23958
2-May	415		465	4185	28143
3-May		341	382	3438	31581
4-May		341	382	3438	35019
5-May	267		299	2691	37710
6-May		194	217	1953	39663
7-May	121		136	1224	40887
8-May		103	115	1035	41922
9-May	85		95	855	42777
10-May		49	55	495	43272
11-May		49	55	495	43767
12-May	13		15	135	43902
13-May		9	10	90	43992
14-May	5		6	54	44046
15-May		15	17	153	44199
16-May	25		28	252	44451
17-May		14	16	144	44595
18-May		14	16	144	44739
19-May		14	16	144	44883
20-May	3		3	27	44910
21-May			0	0	44910
22-May			0	0	44910
23-May			0	0	44910
	2236			44910	

Table 2. Diel migration pattern observed for chinook fry, Nanaimo River, 1998.

Date	Day Movement			Night Movement			% Daytime Movement		
	chinook	chum	coho	chinook	chum	coho	chinook	chum	coho
19-Mar	1	686		9	3812	1	10.00	15.25	0.00
20-Mar	3	1554		5	5023	1	37.50	23.63	0.00
2-Apr	11	1356	1	63	10910	6	14.86	11.05	14.29
3-Apr	14	794	1	35	6955	6	28.57	10.25	14.29
16-Apr	8	208	1	48	2032	5	14.29	9.29	16.67
17-Apr	5	177	3	47	1894	4	9.62	8.55	42.86
30-Apr	1	65		84	295	8	1.18	18.06	0.00
1-May	7	175		178	545	7	3.78	24.31	0.00
16-May	3	4		25	46	2	10.71	8.00	0.00
TOTAL:	53	5019	6	494	31512	40	14.50	14.26	22.02

Table 3. Juvenile chinook releases, Nanaimo hatchery, 1990-1998.

Tag Code	BY	Number Tagged	Number Release	CWT % Mark	Weigh (gram)	Release Date ddmmyy:ddmmyy	Release Site
26303	89	27171	74720	36.4	6.5	12Jun90:14Jun90	0126-NANAIMO RIVER
26304	89	26837	74720	35.9	5.4	:07May90	0126-NANAIMO RIVER
26305	89	27074	50174	54.0	6.7	28May90:29May90	0126-NANAIMO RIVER
26308	89	26352	49452	53.3	6.7	28May90:29May90	0126-NANAIMO RIVER
21141	90	26389	26389	100.0	6.6	17May91:17May91	0126-NANAIMO RIVER
21142	90	27006	27006	100.0	5.4	10May91:10May91	0126-NANAIMO RIVER
21143	90	26199	26199	100.0	6.5	31May91:31May91	0126-NANAIMO RIVER
26156	90	10645	19897	53.5	5.7	24May91:24May91	0126-NANAIMO RIVER
26157	90	10799	20052	53.9	5.7	24May91:24May91	0126-NANAIMO RIVER
180523	91	27353	112904	24.2	4.8	21May92:27May92	0126-NANAIMO RIVER
180524	91	27443	112995	24.3	4.8	21May92:27May92	0126-NANAIMO RIVER
180525	91	27564	193704	14.2	3.3	26May92:28May92	0126-NANAIMO RIVER
180526	91	27406	193546	14.2	3.3	26May92:28May92	0126-NANAIMO RIVER
180548	92	26234	112389	23.3	6.0	04May93:26May93	0126-NANAIMO RIVER
180549	92	26398	113091	23.3	6.0	04May93:26May93	0126-NANAIMO RIVER
181013	92	27361	118399	23.1	6.0	04May93:26May93	0126-NANAIMO RIVER
181014	92	27103	117286	23.1	6.0	04May93:26May93	0126-NANAIMO RIVER
181032	93	25157	49954	50.4	6.0	02May94:02May94	0126-NANAIMO RIVER
181033	93	25106	66474	37.8	6.7	12May94:12May94	0126-NANAIMO RIVER
181034	93	25130	66538	37.8	6.7	12May94:12May94	0126-NANAIMO RIVER
181035	93	24896	187781	13.3	6.1	24May94:24May94	0126-NANAIMO RIVER
181323	94	25286	96450	26.2	6.6	24May95:24May95	0126-NANAIMO RIVER
181324	94	25147	95919	26.2	6.6	24May95:24May95	0126-NANAIMO RIVER
182159	94	25347	111844	22.7	5.5	04May95:04May95	0126-NANAIMO RIVER
180355	95	24978	38928	64.2	6.3	09May96:09May96	2726-FIRST LAKE/GSVI
180356	95	25003	38967	64.2	6.3	09May96:09May96	2726-FIRST LAKE/GSVI
180357	95	25137	310220	8.1	7.0	29May96:30May96	0126-NANAIMO RIVER
180358	95	25086	216293	11.6	5.7	01May96:02May96	0126-NANAIMO RIVER
181716	96	10025	83484	12.0	4.9	20May97:21May97	0126-NANAIMO RIVER
182306	96	9132	36827	24.8	5.4	05May97:05May97	0126-NANAIMO RIVER
182746	96	27690	230592	12.0	4.9	20May97:21May97	0126-NANAIMO RIVER
182747	96	28525	115033	24.8	5.4	05May97:05May97	0126-NANAIMO RIVER
183452	96	10052	42755	23.5	6.2	20May97:20May97	2726-FIRST LAKE/GSVI
183453	96	10077	42861	23.5	6.2	20May97:20May97	2726-FIRST LAKE/GSVI
183454	96	10095	42937	23.5	6.2	20May97:20May97	2726-FIRST LAKE/GSVI
183455	96	10050	42746	23.5	6.2	20May97:20May97	2726-FIRST LAKE/GSVI
182408	97	10050	15610	64.4	6.0	26May98:26May98	0126-NANAIMO RIVER
183220	97	25240	70000	36.1	6.7	07May98:07May98	2726-FIRST LAKE/GSVI
183221	97	25173	99098	25.4	6.0	15May98:15May98	2726-FIRST LAKE/GSVI
183222	97	24824	24824	100.0	15.5	23Jul98:23Jul98	0126-NANAIMO RIVER
183223	97	28252	43881	64.4	6.0	26May98:26May98	0126-NANAIMO RIVER

TOTALS **930792** **3612939**

Tag Code: refers to a coded-wire tag code

BY: refers to brood year

Data compiled from the Mark Recovery Program (MRP) database
(Kuhn 1988)

Table 4. Trap efficiency data for the rotary screw trap, 1998.

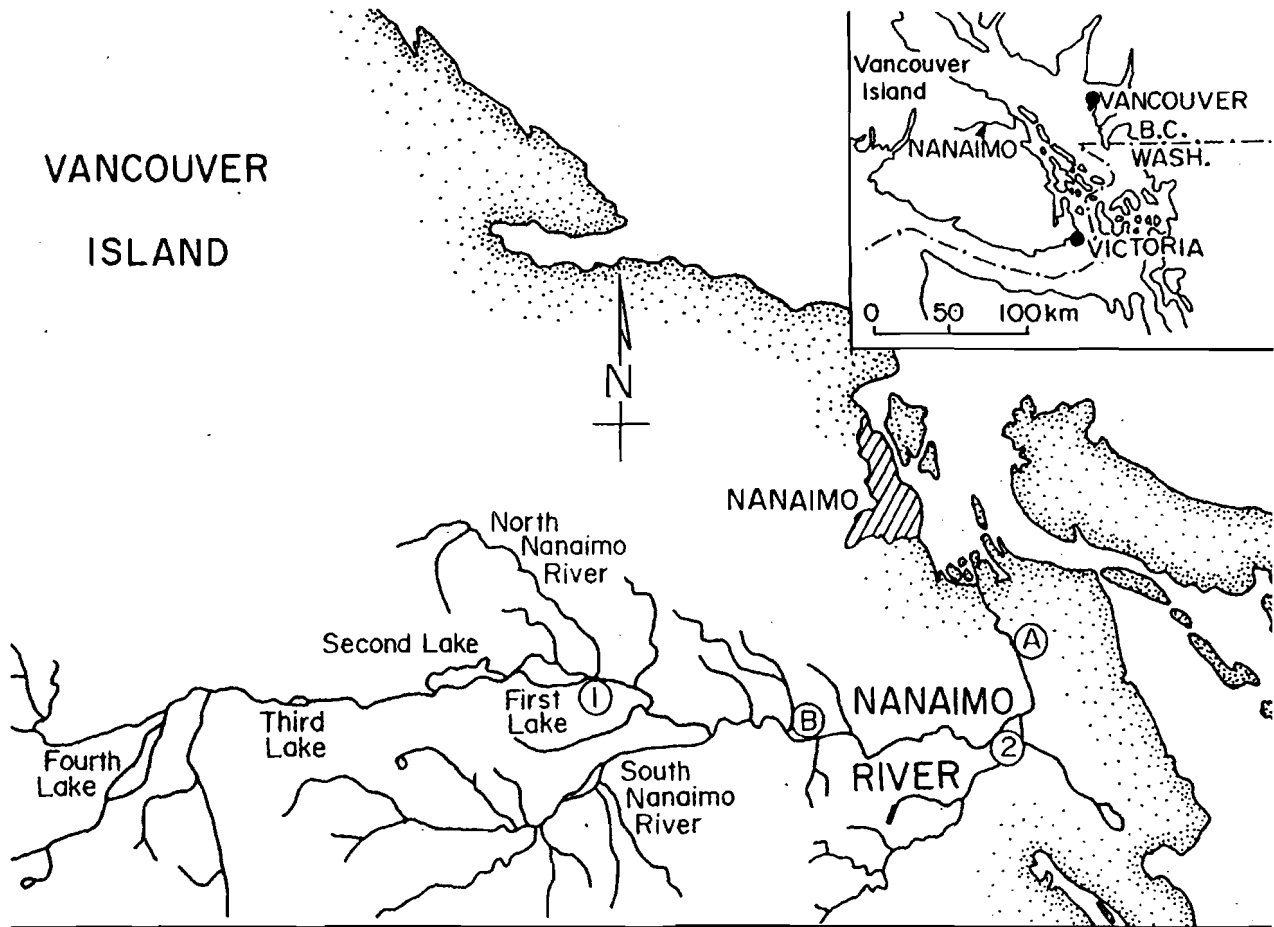
Date	Releases	Recoveries	Efficiency (%)
18-Mar	298	11	3.69
1-Apr	297	62	20.89
15-Apr	298	42	14.09
29-Apr	292	16	5.48
TOTAL	1185	131	11.05

Table 5. Egg to fry chinook survival estimates¹, for 1997 brood year, Nanaimo river.

Brood Year	Escapement Estimate	% Females	Estimated Fecundity Females	Estimated Egg Production	Estimated Fry	Egg/Fry Survival
1997						
Fall Stock	690	67%	462	4,712	2,176,944	
Spring Stock	600	67%	402	4,576	1,839,552	
Total Stock					4,016,496	44,910 1.12%
				Minimum:	24,950	0.62%
				Maximum:	134,730	3.35%
				Estimates using 1996 efficiency data:	Efficiency data:	
					4,016,496	224,550 5.59%
					Minimum:	44,910 1.12%
					Maximum:	264,470 6.58%

¹Escapement estimate based on fence count and swim survey data (E.W. Carter, pers comm.)

Fecundity data provided from broodstock data (P. Preston, pers comm.)



Legend:

- 1 Upper river hatchery release site
- 2 Lower river hatchery release site
- A Enumeration fence site
- B Downstream trapping site

Fig. 1. Trap sampling and hatchery release sites on the Nanaimo River.

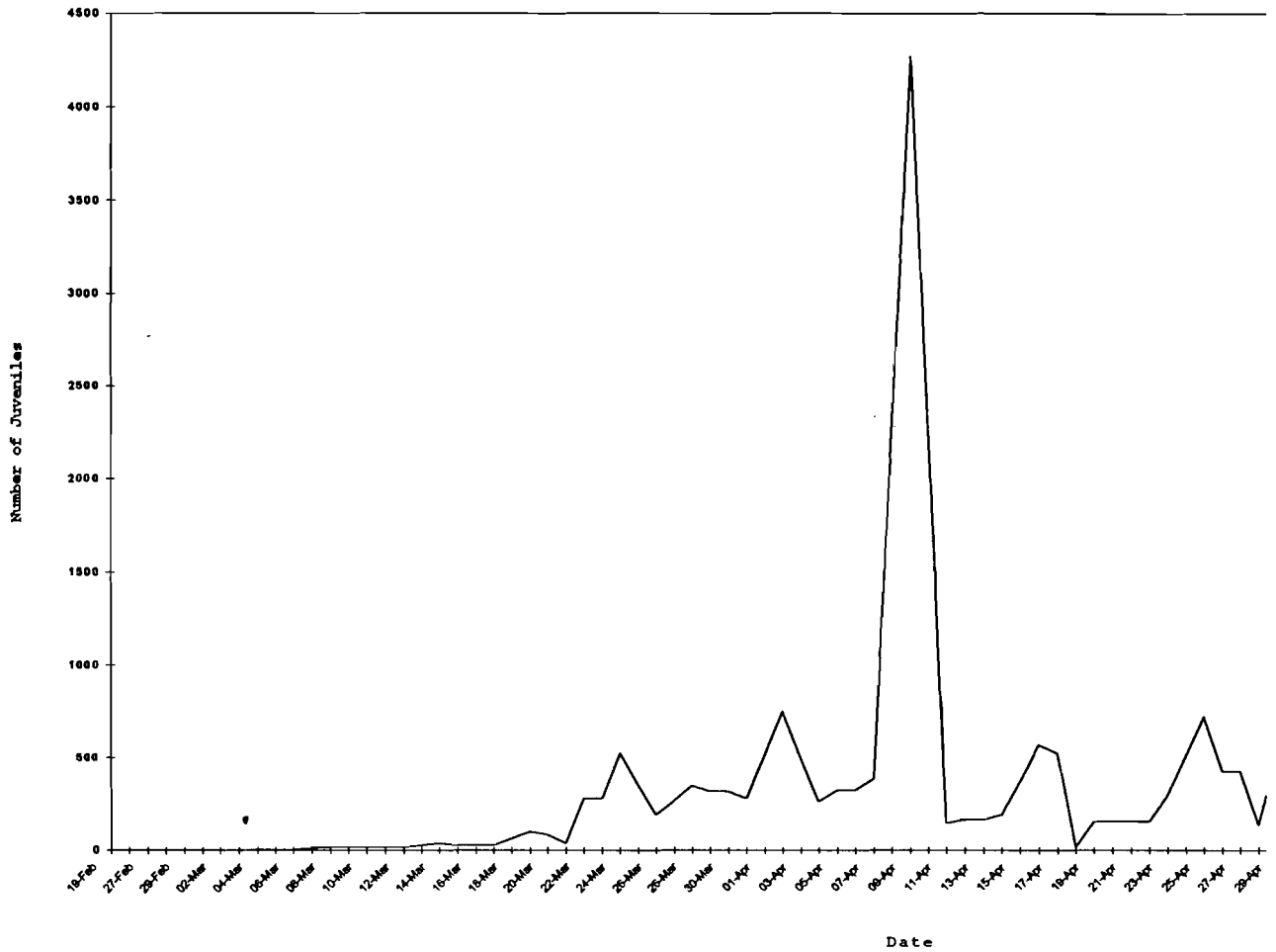


Fig. 2. Expanded estimates of chinook juvenile migration by day at the trap site on the Nanaimo River, 1998.

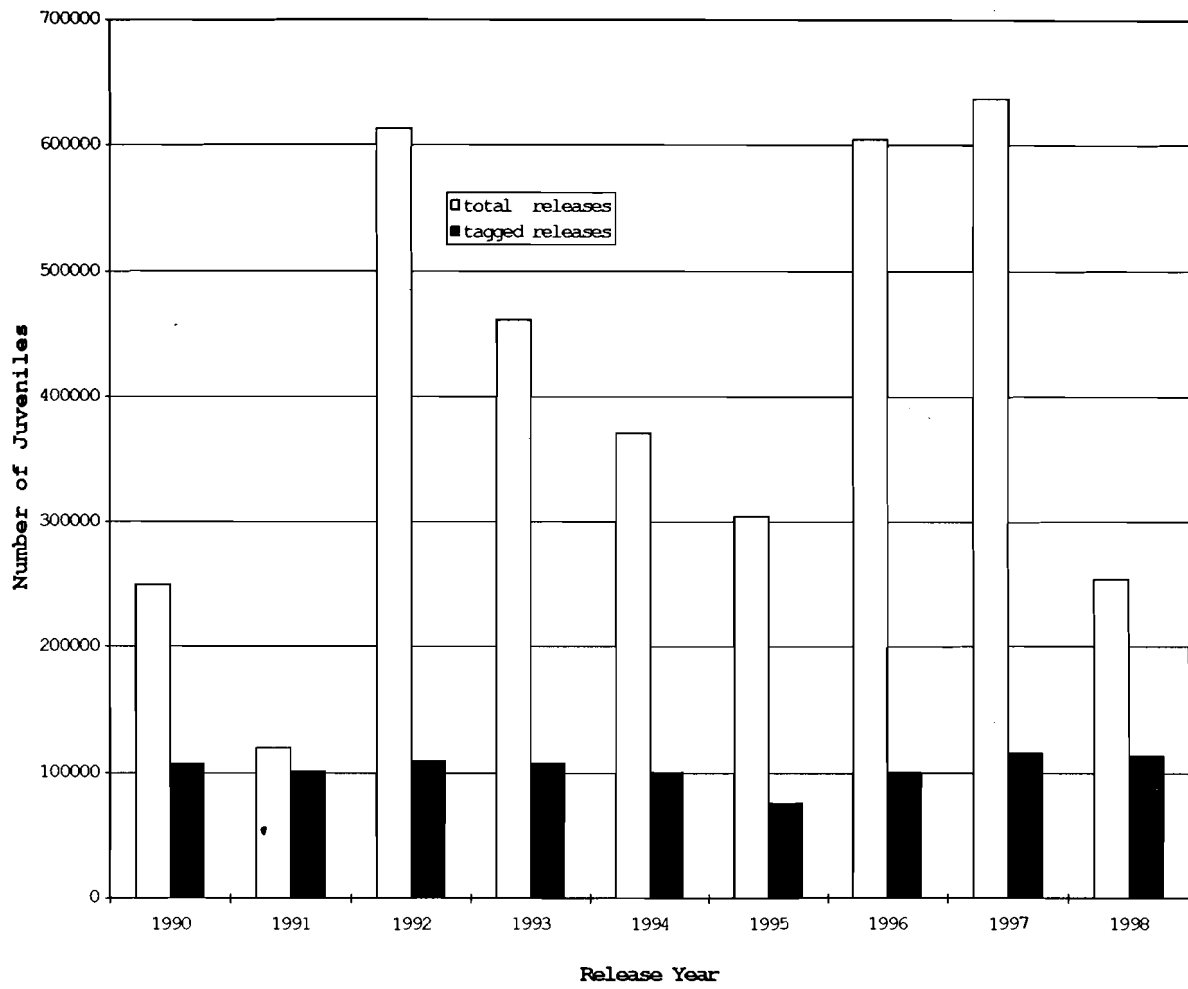


Fig. 3. Hatchery chinook released into the Nanaimo system as fry (3g) and as pre-smolts (6g).

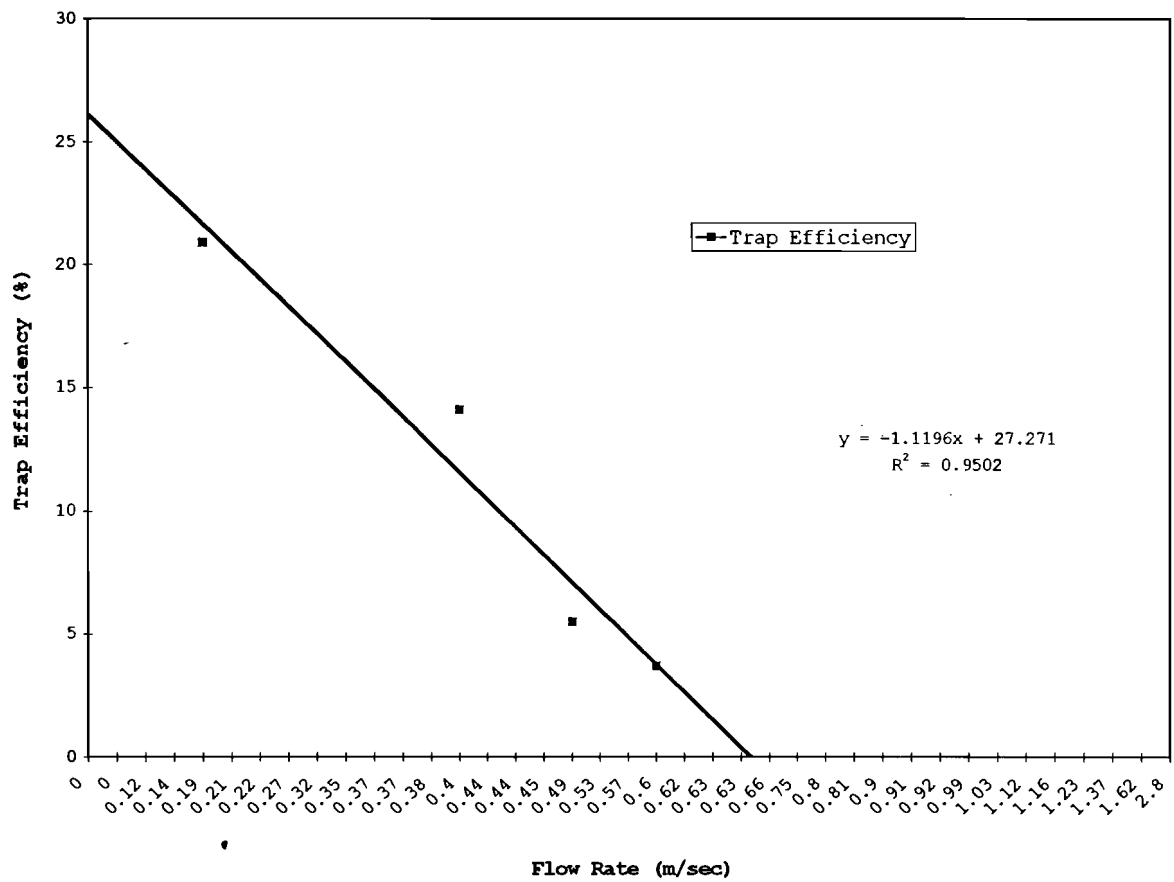


Fig. 4. Flow rate at the trap compared with trap efficiency.

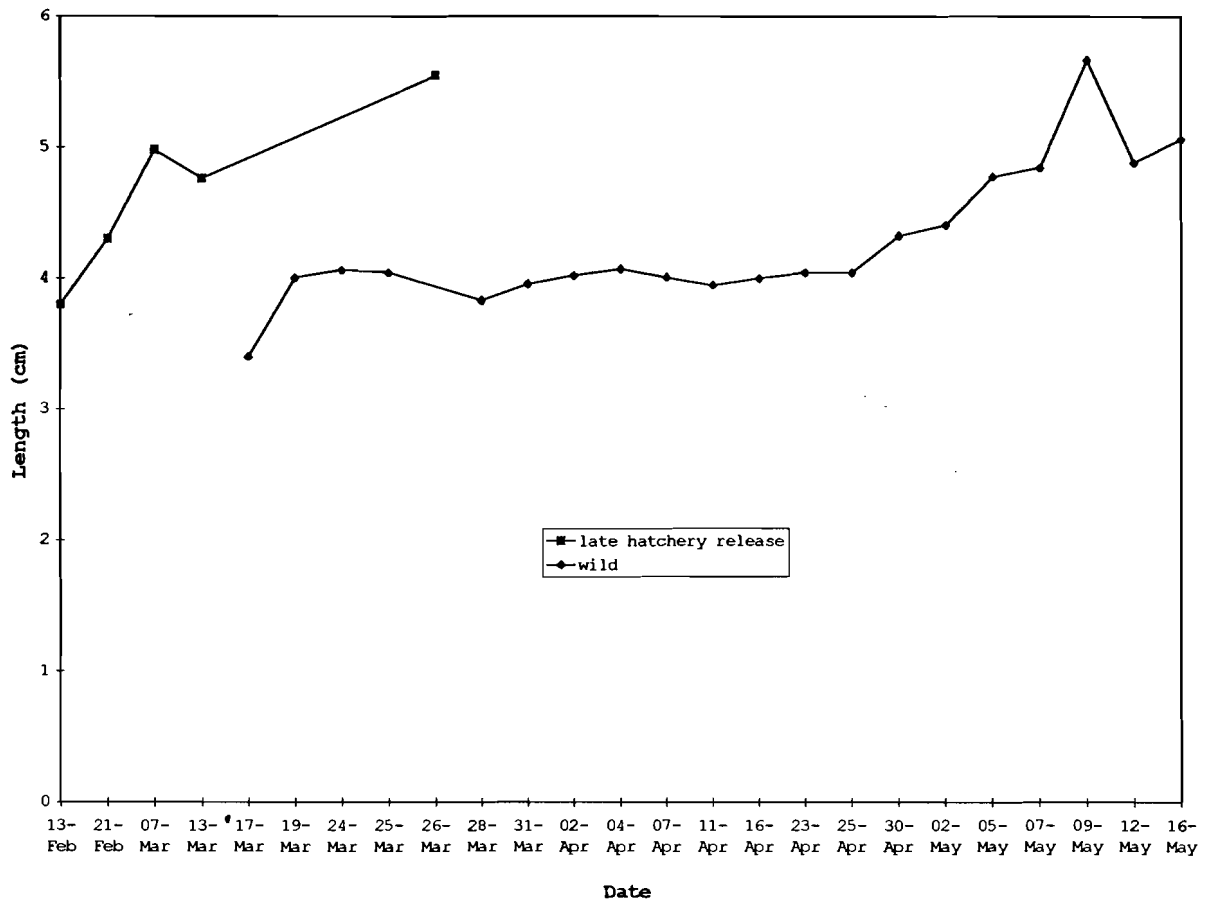


Fig. 5. Mean length of chinook fry by day, Nanaimo River, 1998.

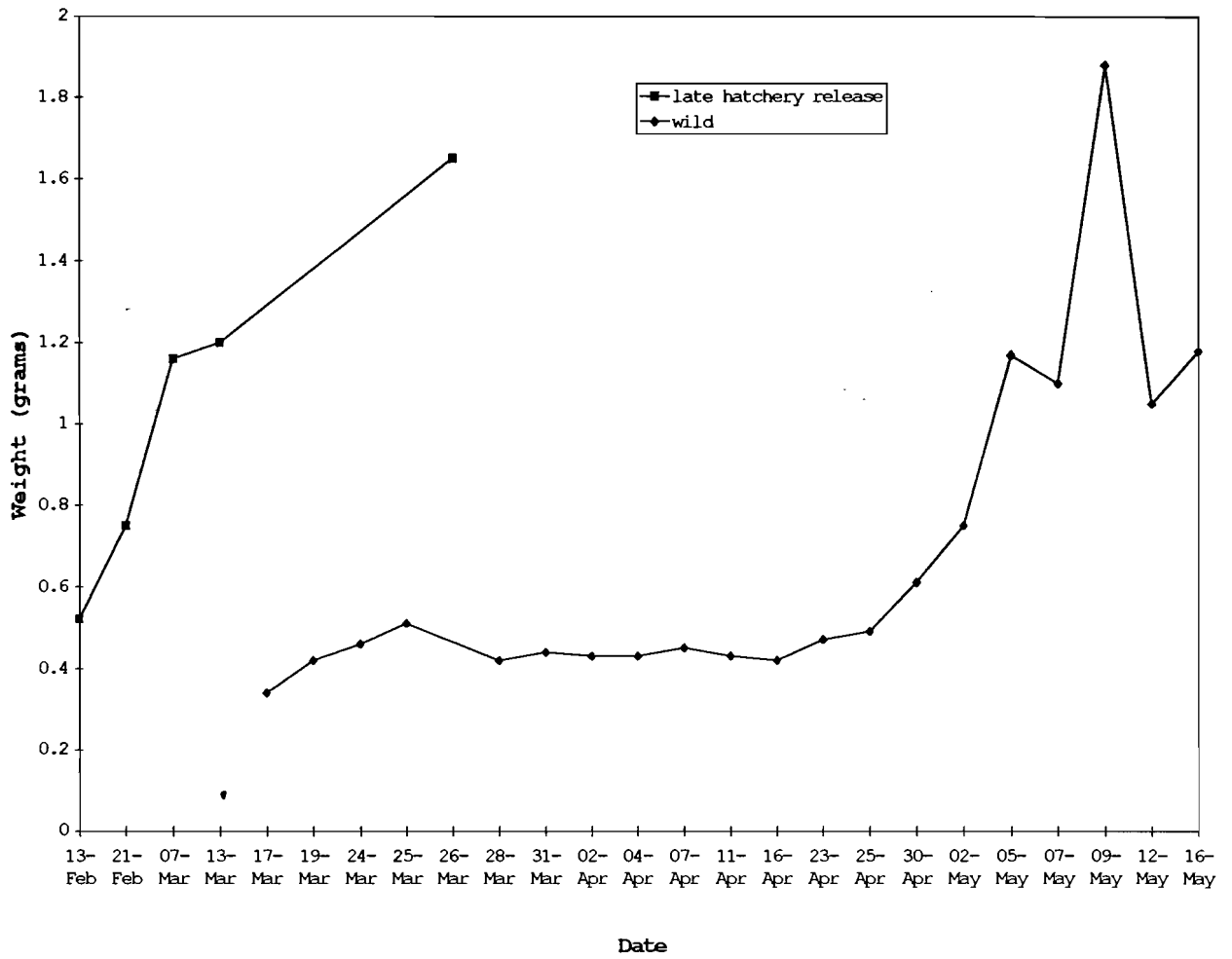


Fig. 6. Mean weight of chinook fry by day, Nanaimo River, 1998.

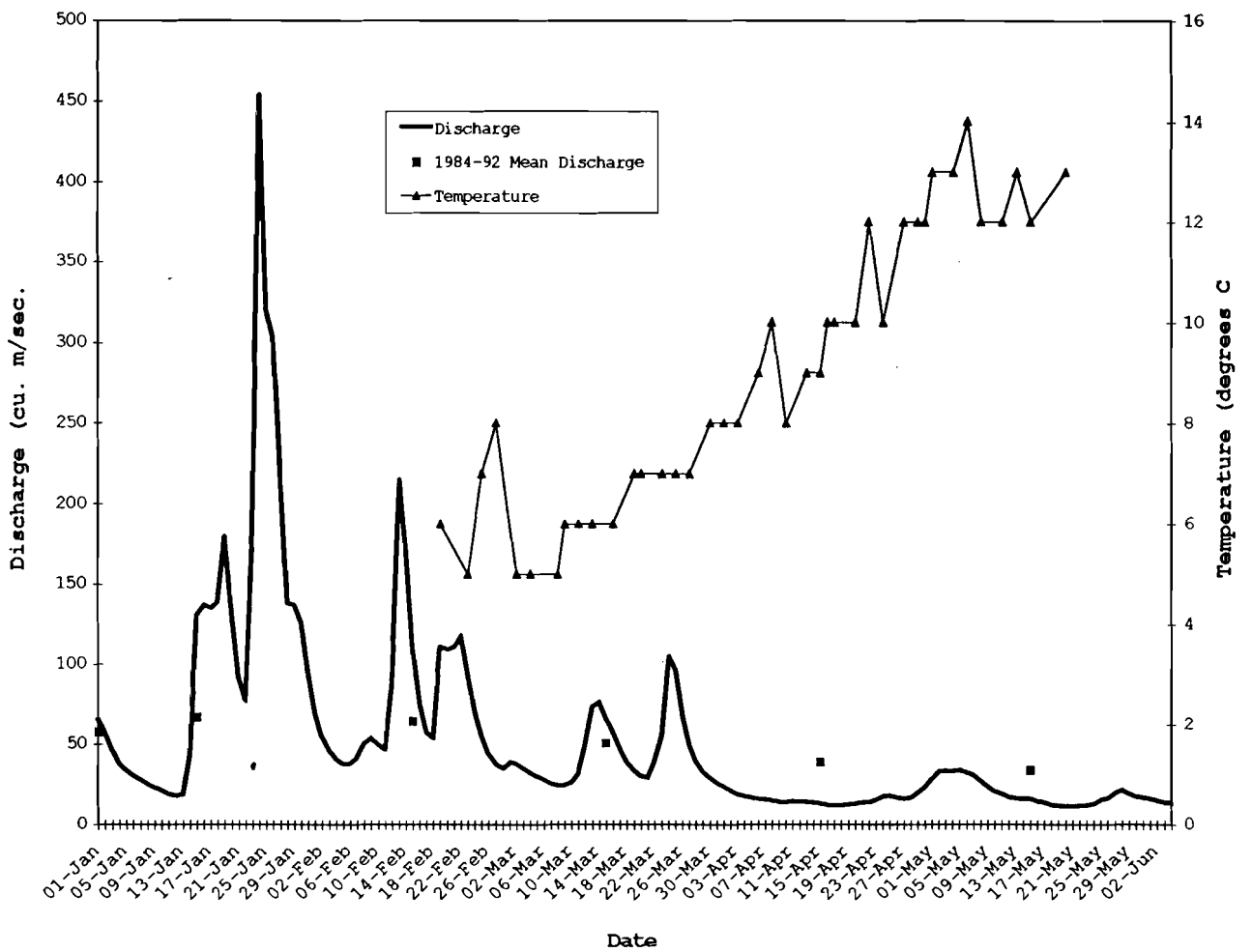


Fig. 7. Monthly discharge measured at the Island Highway bridge in Nanaimo.